FINGERPRINT BASED GENDER IDENTIFICATION USING FREQUENCY DOMAIN ANALYSIS

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ABSTRACT
Although Fingerprints are one of the most mature biometric technologies and are considered legitimate proofs of evidence in courts of law all over the world, relatively little machine vision method has been proposed for gender identification. Few researchers addressed the use of fingerprint for gender identification which will be more helpful in short listing the suspects. In this paper, a novel method is proposed to estimate gender by analysing fingerprints using fast Fourier transform (FFT), discrete cosine transform (DCT) and power spectral density (PSD). A dataset of 220 persons of different age and gender is collected as internal database. Initially the fingerprints of the subject were tested and after the manual analysis threshold is specified. Frequency domain calculations are compared with predetermined threshold and gender is determined. Of the samples tested, 99 samples identified exactly out of 110female samples and 87 samples identified exactly out of 110 male samples.

KEYWORDS: *Discrete cosine transform, frequency domain, fast Fourier transform, gender identification, and power spectral density.*

I. INTRODUCTION

Within today's environment of increased importance of security and organization, identification and authentication methods have developed into a key technology. Such requirement for reliable personal identification in computerized access control has resulted in the increased interest in biometrics. Fingerprints are one of the most mature biometric technologies and are considered legitimate proofs of evidence in courts of law all over the world. Based on the varieties of the information available from the fingerprint we are able to process its identity along with gender, age and ethnicity.

Fingerprint is an impression of friction ridges, from the surface of the finger-tip. Fingerprints have been used for personal identification for many decades; more recently becoming automated due to advancements in the computing capabilities Fingerprints have some important characteristics that make them invaluable evidence in crime scene investigations:

1. A fingerprint is unique to a particular individual, and no two fingerprints possess exactly the same set of characteristics.
2. Fingerprints do not change over the course of person's lifetime (even after superficial injury to the fingers).
3. Fingerprint patterns can be classified, and those classifications then used to narrow the range of suspects.

In this paper, we proposed a method that detects the gender of a person using fingerprints by frequency domain analysis. Here we obtain the fundamental frequency of various transforms and use them for gender Classification. This application is helpful in short listing the suspects and victims from crime and to boost the performance of a system which is used for person recognition and human computer interfaces. The remainder of this paper is organized as follows: brief literature of various gender recognition algorithms using fingerprint is discussed in section 2. Frequency domain analysis is discussed in section 3. The proposed system is discussed in section 4. The dataset and experimental results are described in section 5.

II. RELATED WORKS

Although the fingerprint plays vital role in the identification and verification, relatively few machine vision method has been proposed for gender identification. In this section we briefly review and summarize the prior researches in gender classification.

M.D. Nithin et al [1] has applied baye's theorem on the rolled fingerprint images belonging to south Indian population and found fingerprint possessing ridge density < 13 ridges/25 mm^2 is most likely to be of male origin and ridge count > 14 ridges/25mm^2 are most likely to be of female. Similar results is obtained by Dr. Sudesh Gungadin MBBS [2] using Ridge density by counting the ridges in the upper portion of all fingers which shows that a finger print ridge of < 13 ridges/25 mm^2 is more likely of male origin and finger print ridge of > 14 ridges/25$mm^2$is more likely of female origin.

Acree MA [6] used Ridge density in a particular space to classify gender using fingerprint. He showed that female have a higher ridge density compared with male. Kralik M and Vladimir Novoiny [5] showed that the males have higher ridge breadth defined as the distance between the centers of two adjacent valleys, than females.

Ahmed Badawi et al [7], used ridge thickness to valley thickness ratio (RTVTR), and white lines count features for the classification. According to them, the female's fingerprint is characterized by a high RTVTR; while the male's fingerprint is characterized by low RTVTR Dr. A. Bharadwaja et al [8] correlated relation between the fingerprint pattern and blood groups between male and female.

In this paper, instead of traditional ridge related analysis, we proposed a frequency domain analysis of fingerprint using FFT, 2D-DCT and PSD.

III. FREQUENCY DOMAIN ANALYSIS

The gender identification is made through the frequency domain instead of the traditional spatial domain. The transforms FFT, DCT and PSD are chosen for the fingerprint analysis. Fourier transform plays a vital role in image processing applications. It contains most of the information of the spatial domain image. DCT transforms an image from the spatial domain to the frequency domain and provide better approximation of image. DCT transforms a set of data which is sampled at a given sampling rate to its frequency components.

The fundamental frequencies of these transforms are used for gender identification. The 2D FFT pair is given by

$$F[k,l] = \frac{1}{\sqrt{MN}} \sum_{n=0}^{N-1} \sum_{m=0}^{M-1} f[m,n]\, e^{-j2\pi\left(\frac{mk}{M}+\frac{nl}{N}\right)}$$

$$F[m,n] = \frac{1}{\sqrt{MN}} \sum_{l=0}^{N-1} \sum_{k=0}^{M-1} f[k,l]\, e^{-j2\pi\left(\frac{mk}{M}+\frac{nl}{N}\right)}$$

Where, $0 \le m, k \le M-1$, $0 \le n, l \le N-1$

The discrete cosine transform (DCT) is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. The equation for the two-dimensional DCT is

$$F[m,n] = \frac{2}{\sqrt{MN}}\, C(m)C(n) \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f[x,y] \cos\frac{(2x+1)m\pi}{2M} \cos\frac{(2y+1)n\pi}{2N}$$

Where C(m),C(n)= $1/\sqrt{2}$ for m,n=0 and C(m),C(n)=1 otherwise

The 2D DCT is computed by applying 1D DCT (vertically) to columns and the resulting vertical DCT is applied with 1D DCT (horizontally).Let F(signal) is Fourier transform of the signal and the PSD is found by ,

PSD=|abs(F(signal))|^2/N

where N is Normalization factor.

IV. PROPOSED SYSTEM LEVEL DESIGN

A fingerprint based gender identification system constitutes of digital images of fingerprint as its input which is then transformed into frequency domain, compared with the predetermined thresholds

and finally, gender is declared. The figure below shows the block diagram of the proposed gender identification system by frequency domain analysis of fingerprints.

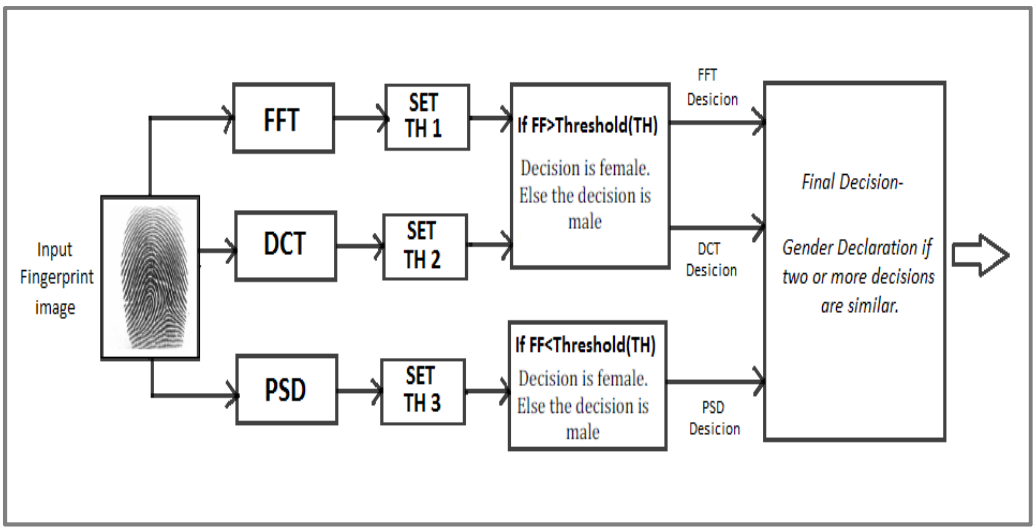

Figure-1: Block Diagram of the proposed Gender identification scheme.

The proposed gender identification system follows the following steps:

1. Input from the database is given to the gender identification system.
2. FFT transforms the given input and generates the output. Threshold is set to TH1. Rule is set in such a way that if the fundamental frequency (FF) is greater than TH1 the decision is female and if the FF is less than TH1 the decision will be male.
3. DCT transforms the given input and generates the output. Threshold is set to TH2. Rule is set in such a way that if the fundamental frequency (FF) is greater than TH2 the decision is female and if the FF is less than TH2 the decision will be male.
4. PSD transforms the given input and generates the output. Threshold is set to TH3. Rule is set in such a way that if the fundamental frequency (FF) is less than TH3 the decision is female and if the FF is greater than TH3 the decision will be male.
5. Comparing the decisions by all the transforms, if two decisions are male, the result is announced as male and if two decisions are female, the result is announced as female.

V. EXPERIMENTAL RESULTS

5.1 Data Set

The database is basic requirement for any research work An internal dataset of fingerprints (left and right forefinger) for 220 persons of different ages and gender (110 males, and 110 females) were obtained from different colleges that used biometric fingerprint sensor for marking the attendance and were analysed using frequency domain analysis. The internal database is of 8 bit gray level with a size of 109 x 108 each. The developed algorithm has been tested using the MAT LAB 7.1 image processing tool.

Figure- 2: Sample Fingerprint images from our database

5.2 Threshold Setting

Setting the threshold for each transform is an important part of the gender identification process. Initially 50 fingerprints of both male and female are examined with FFT, DCT and PSD and the fundamental frequencies were obtained for each case. After the manual analysis, proper threshold was set for the gender classification. Table below gives the details of the transform, threshold and the threshold condition for the identification of gender.

Table-1: Threshold setting of FFT, DCT and PSD

Gender	Transforms and Threshold		
	FFT	**DCT**	**PSD**
Male	FF<1500000	FF<17000	FF>9000000000
Female	FF>1500000	FF>17000	FF<9000000000

5.3 Results

Table-2 shows the FFT, DCT and PSD transform results of fingerprints of 10 female subjects. The proposed system performs well and successfully classifies the subjects as females. Few readings were found to have deviations from the desired results.

Table 2: Results of FFT, DCT and PSD for female samples

Fingerprint Sample	FFT Threshold> 150000	DCT Threshold> 17000	PSD Threshold<9000000000
1	2279661	21010.92356	16050830074
2	1570108	14471.19513	7648114668
3	1454314	13403.958	6569115014
4	2330334	21477.96078	16606900769
5	2258674	20817.49294	15758103976
6	1580512	14567.08555	7749077120
7	2284175	21052.52769	16114143245
8	2000917	18441.82716	12248922996
9	2182986	20119.90027	14578942394
10	1848986	17041.52657	10583366169

Table-3 shows the FFT, DCT and PSD transform results of fingerprints of 10 male subjects. The proposed system performs well and successfully classifies the subjects as males. Few readings were found to have deviations from the desired results.

Table 3: Results of FFT, DCT and PSD for male samples

Fingerprint Sample	FFT Threshold<150 000	DCT Threshold< 17000	PSD Threshold>9000000000
1	1720734	15859.46794	9059365136
2	1010376	9312.320079	3124565177
3	1817095	16747.59719	10097352413
4	1447936	13345.17396	6512066008
5	2249503	20732.96669	15480756894
6	1736023	16000.38188	9337090299
7	1666175	15356.61467	8489722112
8	1246556	11489.11739	4838737388
9	1369293	12620.34599	5737451302
10	1777807	16385.49196	9665436481

Of the total samples tested, the performance efficiency of the proposed system was found to be 90% for female (99 samples identified exactly out of 110female samples) and 79.09% (87 samples identified exactly out of 110male samples) for male.

VI. CONCLUSIONS

In this paper, instead of traditional ridge related analysis, we proposed a frequency domain analysis of fingerprint to identify the gender. From the internal database, 110 male samples and 110 female samples were tested. Optimal threshold for each transform is chosen for better results. It is found that the proposed algorithm produces an accurate decision of 90% for female and 79.07% for male. The performance can be enhanced further by using good quality fingerprint images. In future, more work can be done in frequency domain to find different parameters and different transforms that can be applied in gender identification which will more accurate and suitable for all types of applications. Gender identification results using frequency domain analysis showed that this method could be considered as a prime candidate for use in forensic anthropology in order to minimize the suspects search list and give a likelihood probability value of the gender of a suspect.

REFERENCES

[1.] M.D. Nithin, B. Manjunatha, D.S. Preethi and B.M. Balaraj, "Gender differentiation by finger ridge count among South Indian population," Journal of Forensic and Legal Medicine, vol 18 (2), pp. 79-81, Feb 2011.
[2.] Dr. SudeshGungadin MBBS, MD "Sex Determination from Fingerprint Ridge Density," Internet Journal of Medical Update, Vol. 2, No. 2, Jul-Dec 2007.
[3.] G. G. Reddy, Finger dermatoglyphics of the Bagathas of Araku Valley (A.P.), American Journal of Physical Anthropology Volume 42, Issue 2, pages 225-228, March 1997.
[4.]Yvonne K. Dillon, Julie Hayne S and Macie J Hennerberg [8]," The relationship of the number of Meissner's corpuscles to dermatoglyphic characters and finger size," journal of anatomy, vol 199, pp. 577-584, November 2001.
[5.] KRALIK M., NOVOTNY V. 2003. Epidermal ridge breadth: an indicator of age and sex in paleodermatoglyphics. Variability and Evolution, Vol. 11: 5-30, Adam Mickiewicz University, Faculty of Biology, Institute of Anthropology, Poznan.
[6.] Acree, M. Is there a gender difference in fingerprint ridge density? Forensic Science International 1999 May; 102 (1): 35-44.
[7.] A. Badawi, M. Mahfouz, R. Tadross, and R. Jantz.Fingerprint-based gender classification.The International Conference on Image Processing, Computer Vision, and Pattern Recognition, June 2006.
[8.] Dr. A.Bharadwaja , Dr.P.K.Saraswat, Dr.S.K.Aggarwal, Dr.P.Banerji, and Dr.S.Bharadwaja, "Pattern of finger prints in different ABO blood groups." Journal of Indian Academy of forensic medicine, vol 26(1), pp 6-9, March 2004.
[9]. Anil K. Jain, Sarat C. Dass, and KarthikNandakumar "Soft Biometric Traits for Personal Recognition Systems" Proceedings of International Conference on Biometric Authentication, LNCS 3072, pp. 731-738, Hong Kong, July 2004
[10]. S.M.E. Hossain , G. Chetty "Next Generation Identity Verification Based on Face-Gait Biometrics" 2011 International Conference on Biomedical Engineering and Technology IPCBEE vol.11 (2011) © (2011) IACSIT Press, Singapore
[11]. Michael D. Frick, Shimon K. Modi, Stephen J. Elliott, Ph.D., and Eric P. Kukula, Member IEEE "Impact of Gender on Fingerprint Recognition Systems" 5th International Conference on Information Technology and Applications ICITA 2008 ISBN: 978-0-9803267-2-7

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