A Short Assessment on Male-Female Categorization Derived From Fingerprints

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Abstract---Gender classification from fingerprints is an important step in forensic science in order to provide investigative leads for finding unknown persons. Fingerprint verification is certainly the most trustworthy and acceptable evidence till date in the court of law. Due to the enormous prospective of fingerprints as an effective method of identification an attempt has been made in the present work to analyze their correlation with gender of an individual. Due to the immense potential of fingerprints as an effective method of identification an attempt has been made in the present work to summarize all the recent techniques related to the field.

Keywords: RTVTR, LDA, Ridge, Density

I. INTRODUCTION

Recently, there has been an increased interest in biometric technologies that is human identification based on one's individual features. The various identification data used are fingerprints, handwriting, bite marks, DNA fingerprinting etc. Fingerprints are constant and individualistic and form the most reliable criteria for identification [8].

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 [8]. 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 [2].

Fingerprint identification algorithms are well established and are being implemented all over the world for security and person identity. Very few attempts have been made to classify the gender from an obtained fingerprint. This is helpful for anthropologists for classifying gender from the fingerprints they obtain from excavated articles and for crime investigators

for minimizing the rage of the suspects. The gender of the person can be judged using the fingerprint of that concern person based upon the count of the ridges of the fingerprint. The average ridge count is slightly higher in males than in females, with high standard deviation among subjects of both genders.

Gender classification is an important problem with a variety of practical applications. For example, a robust gender classification system could provide a basis for performing passive surveillance using demographic information or collecting valuable consumer statistics in a shopping center. It could also be used to improve the performance of biometric systems such as face authentication and recognition [2]. In computer vision, the majority of studies on gender classification are based on face since visual information from human faces provides important cues for gender classification. Based on the varieties of the information available from the fingerprint we are able to process its identity along with gender, age and ethnicity.

The performance of a fingerprint feature extraction and matching algorithm depends critically upon the quality of the input fingerprint image. While the 'quality' of a fingerprint image cannot be objectively measured, it roughly corresponds to the clarity of the ridge structure in the fingerprint image [6]. Direct binarization using standard techniques renders images unsuitable for extraction of fine and subtle features such as minutiae points. Therefore it is necessary to improve the clarity of ridge structures of fingerprint images, maintain their integrity, avoid introduction of spurious structures or artifacts, and retain the connectivity of the ridges while maintaining separation between ridges. As the distance between minutiae is normalized by ridge frequency at each minutia, the distance variation by nonlinear deformation is minimized. The positions and ridge orientations of minutiae that are located in near region also are less affected by nonlinear deformations since nonlinear deformation appears in some local areas and changes gradually. The remainder of this paper is organized as follows: Section 2 provides a brief review of the researches in the fingerprint classification finally we concluded our work.

II. LITERATURE SURVEY

Fingerprint identification and classification has been extensively researched in times past, however very few researchers have studied the fingerprint gender classification problem.

Acree, M. [1] in 1999 presented a study whose aim is to determine if women have significantly higher ridge density, hence finer epidermal ridge detail, than men by counting ridges that occur within a well-defined space. If significant gender differences do exist then the likelihood of inferring gender from given ridge densities will be explored. Their study focused on 400 randomly picked ten - print cards representing 400 subjects. The demographic composition of this sample population represents 100 Caucasian males, 100 African American males, 100 Caucasian females and 100 African American females all within the age range of 18 - 67. Results show that women tend to have a significantly higher ridge density than men and that this trend is upheld in subjects of both Caucasian and African American descent ($F = 81.96$, $P < 0.001$). Application of Bayes' theorem suggest s that a given fingerprint possessing a ridge density of 11 ridges/25 mm 2

or less is most likely to be of male origin. Likewise a fingerprint having a ridge density of 12 ridges/25 mm 2 or greater is most likely to be of female origin, regardless of race.

Ahmed Badawi, Mohamed Mahfouz, Rimon Tadross, Richard Jantz [3] in 2006 proposed a Gender classification from fingerprints, which is an important step in forensic anthropology in order to identify the gender of a criminal and minimize the list of suspects search. A dataset of 10 - fingerprint images for 2200 persons of different age s and gender (1100 males and 1100 females) was analyzed. Features extracted were; ridge count, ridge thickness to valley thickness ratio (RTVTR), white lines count, and ridge count asymmetry, and pattern type concordance. Fuzzy - C Means (FCM), Linear Discriminant Analysis (LDA), and Neural Network (NN) were used for the classification using the most dominant features. They obtained results of 80.39%, 86.5%, and 88.5% using FCM, LDA, and NN, respectively.

Manish Verma, et al, (2008) proposed a met hod for Gender classification from fingerprints. Features extracted were; ridge width, ridge thickness to valley thickness ratio (RTVTR), and ridge density.SVM is used for the classification. This method is experimented with the internal database of 400 fingerprints in which 200 were male fingerprints and 200 were female fingerprints. They found male - female can be correctly classified up to 91% [4].

Jen feng wang, et al, (2008) worked on gender determination using fingertip features. He obtained fingerprints from 115 normal healthy adults in which 57 were male fingerprints and 58 were female fingerprints. They have used ridge count, ridge density, and finger size features for classification. However, the ridge count and finger size features of left little fingers are used to achieve a classification. The best classification result of 86% accuracy is obtained by using ridge count and finger size feature together [5].

Ramanjit Kaur, Rakesh K. Garg [6] in 2011 with their study provided an aid for the fingerprint examiner in analyzing fingerprint samples as it shows that there is a significant difference in epidermal ridge density between males and females of the two populations. Their study has been carried out to examine ridge density differences in two Northern Indian populations (Sik h Jat and Bania). In their study it has been found that 92% of Sikh Jat females have a mean ridge density above 13, whereas 76% of Sikh Jat males have (a mean ridge density) below 13, while in Bania, 100% of females have mean ridge density above 14 and 80 % of males – below 14. The study suggested that there are significant differences in epidermal ridge density between males and females within each of the two populations, and also significant differences between the two populations.

Dr. Prateek Rastogi, Ms. Keerthi R Pillai [7] in 2011, presented that there is an association between distribution of fingerprint patterns, blood group and gender. This prospective study was carried out over a period of 2 months among 200 medical students (100 male & 100 female) belonging to the age group 18 - 25 of Kasturba Medical College, Mangalore, India. Results show that each finger print is unique; loops are the most commonly occurring fingerprint pattern while arches are the least common. Males have a higher incidence of whorls and females have a higher incidence of loops. Loops are predominant in blood group A, B, AB and O in both Rh positive and Rh negative individuals except in O negative where whorls are more common. Thus, they concluded that there is an association between distribution of fingerprint patterns, blood group and gender and thus prediction of gender and blood group of a person is possible based on his fingerprint pattern.

Ritu Kaur et.al, (2012) have worked on fingerprint based gender identification using frequency domain analysis. The classification is achieved by analyzing 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. Frequency domain calculations are compared with predetermined threshold and gender is determined. They obtained results of 90%, and 79.07% for female and male samples respectively [10].

Rijo Jackson Tom, et al, (2013) have proposed a method for Fingerprint Based Gender Classification through frequency domain analysis to estimate gender by analyzing fingerprints using 2D Discrete Wavelet Transforms (DWT) and Principal Component Analysis (PCA).A dataset of 400 persons of different age and gender is collected as internal database. They have used minimum distance method for classification and achieve overall success rate in gender classification of around 70% [11].

III. COMPARISON

S. No	Author/ Title	Method	Classification Method	Result
1	Acree, M. "Is there a gender difference in fingerprint ridge density?"[7] 1999.	On the basis of ridge density	-	-
2	A. Badawi, M. Mahfouz, R. Tadross, and R. Jantz "Fingerprint - based gender classification" [5] 2006.	Features extracted were; ridge count, ridge thickness to valley thickness ratio (RTVTR), white lines count, and ridge count asymmetry, and pattern type concordance.	Fuzzy - C Means (FCM), Linear Discriminant Analysis (LDA), and Neural Network (NN).	Results of 80.39%, 86.5%, and 88.5% using FCM, LDA, and NN, respectively.
3	Manish Verma and Suneeta Agarwal.'' Fingerprint Based Male - Female Classification.''[8] 2008.	Features extracted were; ridge width, ridge thickness to valley thickness ratio (RTVTR), and ridge density.	SVM	91%

4	Jen feng wang, et al, "Gender Determination using Fingertip Features". [10] 2008.	ridge count, ridge density, and finger size		86% accuracy is obtained by using ridge count and finger size features together.
5	Ramanjit Kaur, Rakesh K. Garg "Determination Of Gender Differences From Fingerprint Ridg e Density In Two Northern Indian Populations"[3] 2011.	epidermal ridge density		
6	Dr. Prateek Rastogi, Ms. Keerthi R Pillai "A study of fingerprints in relation to gender and blood group"[9] 2011.	association between distribution of fingerprint patterns, blood group and gender		
7	Ritu Kaur and Susmita Ghosh Mazumdar, "Fingerprint Based Gender Identification using Frequency Domain Analysis" [11] 2012.	frequency domain analysis	Fast Fourier transform FFT), Discrete Cosine Transform (DCT) and Power Spectral Density (PSD).	Results of 90%, and 79.07% for female and male samples respectively.
8	Rijo Jackson Tom, T.Arulkumaran "Fingerprint Based Gender Classification Using 2D Discrete Wavelet Transforms and Principal Component Analysis" [12]2013.	frequency domain analysis	2D Discrete Wavelet Transforms (DWT) and Principal Component Analysis (PCA).	70%.

IV. Conclusion

Gender identification can help effectively reduce the search time by limiting the subsequent searching stage to either male database or female database. Once a person is identified as male or female, then any suitable biometric trait can be used for further classification. Identification of gender can also provide an important clue in various security and surveillance based applications. Hence, an attempt has been made to put just another small brick into the wall of research on gender classification using fingerprints.

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