Fingerprint Based Gender Classification using multi- class SVM

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Abstract

Gender identification from fingerprints is an imperative footstep in forensic science in order to deliver fact-finding hints for finding anonymous persons. Fingerprint verification is unquestionably the most honest and satisfactory substantiation till date in the court of law. Due to the massive potential of fingerprints as an effective technique 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 and we have proposed a technique for gender classification which will use some features of finger such as ridge thickness, ridge density to valley thickness ratio (RTVTR) and ridge measurement for gender detection. Proposed methodology uses Multi Class SVM as classifier which overcome the problem of SVM (Binary Classifier).

Keywords: - RTVTR, LDA, Ridge, Density, SVM

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. [2].

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 [2]. 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 [9].

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 [10]. 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.

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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. [11] 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 t he 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, et al, (2006) [9] 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 Discr iminant 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% [7].

Jen feng wang, et al, (2008) worked on gender determination using finger tip 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 [8].

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 (Sikh 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 [5] , 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 [4].

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% [1].

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III. COMPARISON

S. No .	Author/ Title	Method	Classification Method	Result
1	Acree, M. "Is there a gender difference in fingerprint ridge density?" [11] 1999.	On the basis of ridge density	-	-
2	A. Badawi, M. Mahfouz, R. Tadross, and R. Jantz "Fingerprint - based gender classification"[9] 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 Discr iminant 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.''[7] 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". [8] 2008.	Rridge 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 Ridge Density In Two Northern Indian Populations" [6] 2011.	Epidermal ridge density.		
6	Dr. Prateek Rastogi, Ms. Keerthi R Pillai "A study of fingerprints in relation to gender and blood group" [5] 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" [4] 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"[1] 2013.	Frequency domain analysis.	2D Discrete Wavelet Transforms (DWT) and Principal Component Analysis (PCA).	70%.

IV. PROPOSED SYSTEM DESIGN

As we have seen various methods for gender identification from fingerprint in above comparison table. In earlier approach SVM used as classifier. Support Vector Machines (SVM) are binary classifiers, and as such, in their original form, they can only decide between two classes at once. Suppose we have to decide between three classes, A, B, and C. Now, suppose all we have are binary classifiers, i.e., methods which can automatically decide only between two classes using SVM. Hence accuracy will be getting reduce in identification.

To overcome the disadvantage of SVM (Binary Classifier) we will use Multi Class SVM. Suppose we have to decide between three classes, A, B, and C. Now, suppose all we have are binary classifiers, i.e., methods which can automatically decide only between two classes. A possible approach in order to use our binary classifiers in a multi-class classification problem would be to try to divide our multi-class problem into a set of binary problems.

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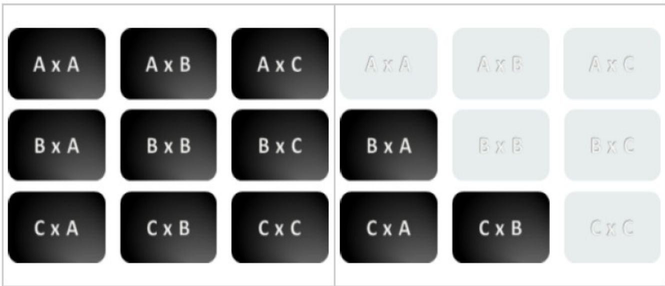

Fig. 1 Multi-class Problem

In fig. 1 the left matrix above shows all possible combinations of binary decision problems which can be formed by taking our three classes. The left matrix below shows all possible combinations of binary decision problems which can be formed by taking our three classes. Notice that the left matrix includes some redundant scenarios. For example, it is pointless to compute the decision between A and A. It is also inefficient to compute both B x A and A x B, when computing only one and taking the opposite would suffice. Discarding the redundant options, we are left with the matrix on the right. As it can be seen, a typical decision problem between n classes can always be decomposed in a small subset of n (n-1)/2 binary problems.

i.e n (n-1)/2 = 3(3-1)/2= 3

Now the decision is reduced to only three options. Now the class which having highest score will be winner. Fig. 2 is our proposed architecture in which Multi class SVM classifier used for gender identification based on features of fingerprint. In ***Normalization*** we standardize the intensity values of an image by adjusting the range of its grey-level values so that they lie within a desired range of values e.g. zero mean and unit standard deviation. Let I(i,j) denotes the gray-level value at pixel (i,j), M & VAR denote the estimated mean & variance of I(i,j) respectively & N(i,j) denotes the normalized gray-level value at pixel (i,j). ***Orientation*** of a fingerprint is estimated by the least mean square orientation estimation algorithm given by Hong. In which Firstly, a block of size wXw (25X25) is centred at pixel (i, j) in the normalized fingerprint image. For each pixel in this block, compute the Gaussian gradients x(i, j) and y(i, j), which are the gradient magni- tudes in the x & y directions respectively. After orientation image fingerprint features (Ridge Density, Ridge Width, Valley Width) estimated. Ridge Width R is defined as thickness of a ridge. It is computed by counting the number of pixels between consecutive maxima points of projected image, number of 0's between two clusters of 1's will give ridge width.

e.g. **11110000001111**
In above example, ridge width is 6 pixels.

Valley Width V is defined as thickness of valleys. It is computed by counting the number of pixels between consecutive minima points of projected image, number of 1's between two clusters of 0's will give valley width.

e.g. 000011111111000
In above example, valley width is 7 pixels.

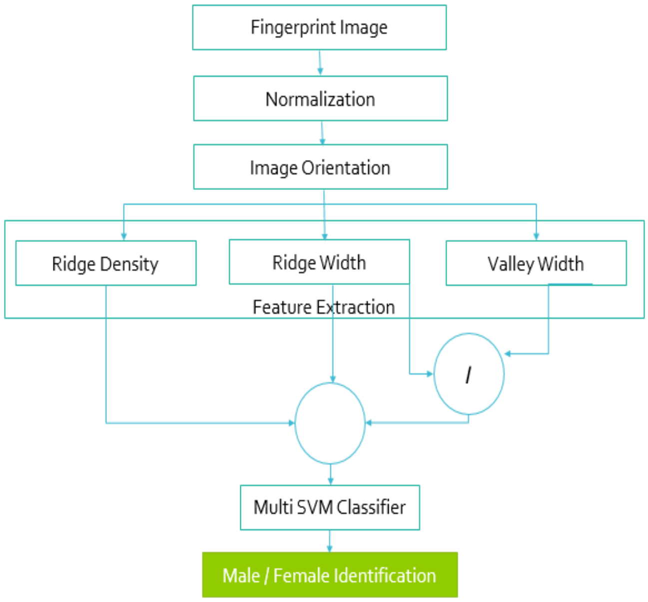

Fig. 2 Proposed Architecture

Ridge Density is defined as number of ridges in a given block. e.g. 001111100011111011 Above string contains 3 ridges in a block. So ridge density is 3. Ridge Thickness to Valley Thickness Ratio (RTVTR) is defined as the ratio of ridge width to the valley width and is given by RTVTR = R/V. Multi class SVM will work as shown in fig 3.

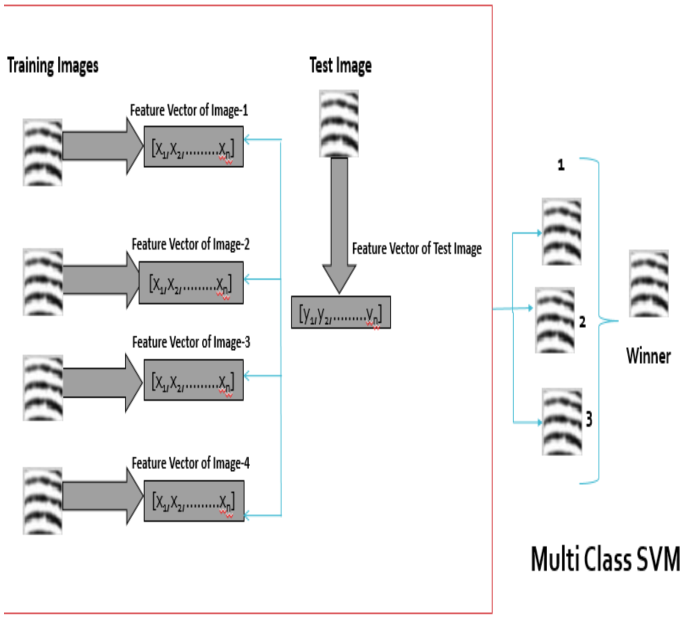

Fig.3 Multi Class SVM

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V. EXPERIMENTAL EVALUATION

For implementation of my project we have used MATLAB 7.0 and we have taken 300 samples of female and male both for training. Fingerprint samples has been taken from http://www.unilorin.edu.ng/ website.

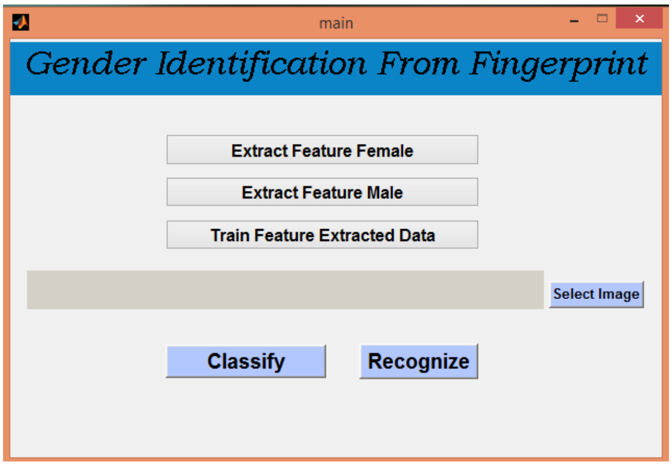

Fig. 4 Main GUI Interface for Gender Identification

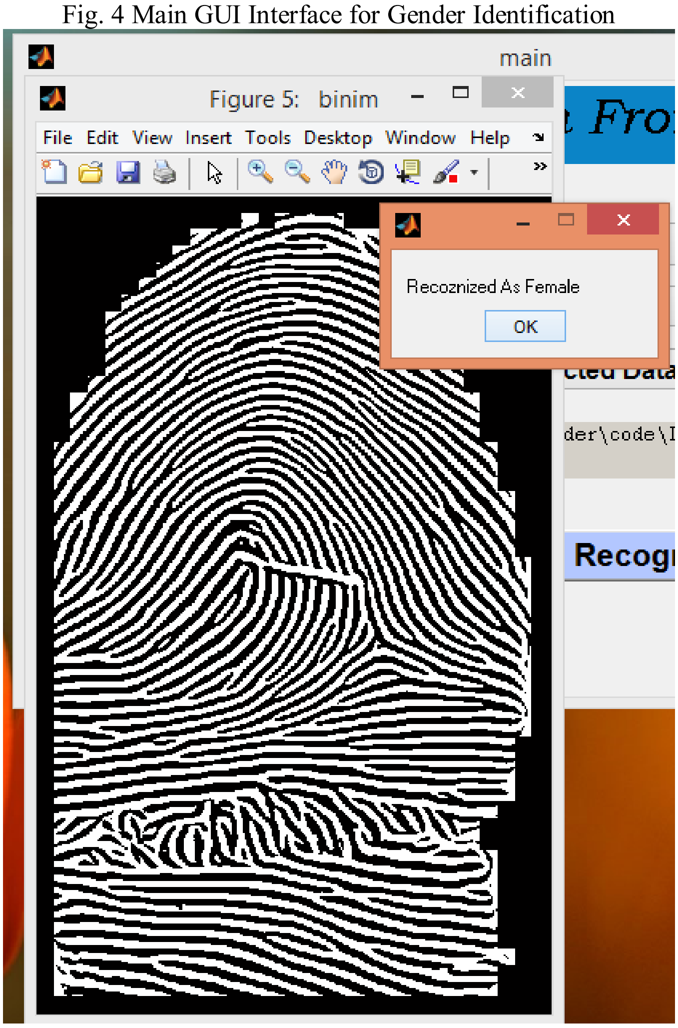

Fig. 5 Identified Gender

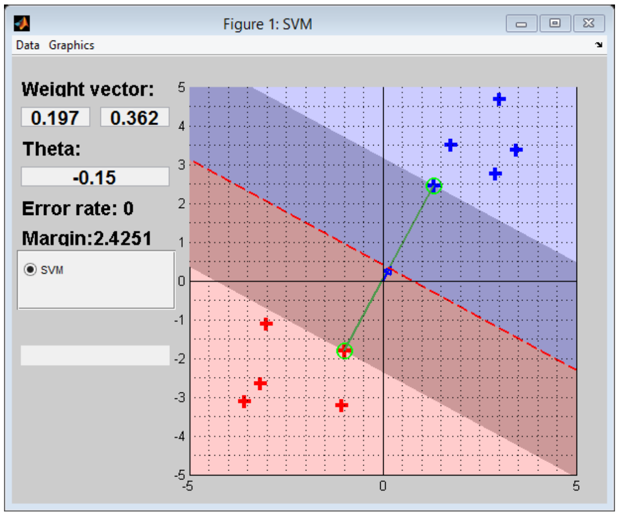

Fig. 6. Multi Class SVM Classification

S. No.	Number of Sample	Gender	Success Ratio
1	150	Female	81%
2	150	Male	81%
3	300	Female	91%
4	300	Male	91%

As we are seeing in above table if we increase in number of sample then our success ratio will increase.

VI. 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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