FUSION OF FINGERPRINT AND AGE BIOMETRIC FOR GENDER CLASSIFICATION USING FREQUENCY AND TEXTURE ANALYSIS

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ABSTRACT

Classification of gender from fingerprints is one of the important steps in forensic anthropology. This forensic anthropology is used to identify the gender of a criminal in order to minimize the suspects list of search. A very few researcher have worked on gender classification using fingerprints and have gain the competitive results. In this work we are trying to fuse the fingerprint and age biometrics for gender classification. The real fingerprints were collected from different age groups such as 15-20 years and 20-60 years of the rural and urban people. According to this experimental observation soft biometric information can be used significantly to improve the recognition performance of biometric system. The overall performance of the proposed method is found to be satisfactory and more competitive.

KEYWORDS

Gender classification, frequency domain, texture analysis, soft biometrics and hard biometrics traits.

1. INTRODUCTION

Generally for any person identification or verification for official documentation fingerprints science can be used. There are many masses of biometric techniques which are available nowadays, which are used in this stage of research (e.g., odour analysis) and also biometric technologies are mature and available commercially. The behavioural physical and human adhered characteristics of soft biometric traits are giving information about person like gender, beard, age, ethnicity, glasses, skin colour, eye hair, length of legs, and arms, skin hair colour, weight, height, gestures and gait, ear shape, accent, etc., To distinguish humans peers some natural ways are created using soft biometrics instances. The major part of the advantages of biometrics and endorse of its own assets is inherited by soft biometric. Even these are some advantages which include non obtrusiveness, efficiency of time for computations and also for person observance. In future, enrolment of person not even consent or co-operation of the subject matter is not required. Generally the permanent and unique characteristics of a person include such has face, retina, fingerprint, voice iris etc., are indistinct or indistinguishable physically and behaviour and the information is not distinctive or permanent.

Therefore soft biometric traits very easy to capture and does not require any co-operation from subjects. The performance of biometric recognition system can be improved by verifying but they can provide robust authentication [1], [2], [23]-[25, 26]. In biometric techniques fingerprints

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identification is one of oldest technique. In forensic anthropology gender classification or recognition using fingerprints is one used to minimize the criminals suspect list.

All the methods proposed in the literature are basically on ridges of fingerprints and ridge parameters insight given but the methods of parameter measurement are failed to give the accuracy. Because it may due to inked fingerprints impression measurement and measurement of parameters done manually where recklessness and human errors are bound to happen poor fingerprint impressions cannot be avoidable because of one or more reasons in the following finger if foreign substances, unclear and smear fingerprints due to slip or slip of finger while enrolling, problems of inking apparatus and also even co-operation of the subject is poor. The pressure applied also depends on thickness may also leads to provide false results for gender identification. But frequency domine an analysis and ridge related parameters are the traditional methods use for gender detection.

A very few researcher have worked on fingerprints for gender classification and have dig up the competitive results [3]-[7]. In this work we are trying to fuse the fingerprint and age biometrics for gender classification. In general the things accomplished for classification bring into being with competitive and acceptable results were observed and it is used by forensic anthropology.

2. RELATED WORK

Integrating faces, soft biometric traits for recognition has been carried out by Anil k Jain et al., (2004) for the recognition and results are 96.3% and 89.6% for ethnicity and gender classification respectively.

Ahmed Badawi, et. al., (2006) have proposed a method for gender classification from fingerprints. 2200 persons image has been taken to create the data base of each 10-fingerprint each under 2 equal sub classification of both the genders and different age groups. Ridge count, ratio of ridge to valley thickness, white lines count and ridge count asymmetry are the main parameters extracted for the analysis. Linear Discriminate Analysis, Fuzzy C Means and Network were used mainly for the classification. Subsequently obtained result is 90.39%, 88.5% and 86.5% for FCM, NN and LDA methods respectively.

Shimon K. Modi et. al., (2007) worked on impact of age groups on fingerprint recognition performance. Features were extracted from fingerprints of different quality levels, for minutiae count, to test the performance of a minutiae-based matcher. A dataset of 18-25years, 26-39 years, 40-62 years and 62 years and above, in all 1620 samples was collected. Difference of age group has confirmed different quality of finger print image. The statistical result produced through the work indicates that the fingerprint image quality is not similar between age groups because the quality score was not within a reasonable tolerance to be similar [9].

Manish V. et. al., (2008) have proposed a method for gender classification from fingerprints. Ridge densities, ratio of ridge valley to thickness, ridge width are the main features extracted for the analysis. The internal database of 400 fingerprints was collected in which 200 of each gender were taken for internal database. SVM method has yield 91% right classification for each gender classes [10].

Gender classification from Hand shape has been proposed by Gholamreza Amayah et al., in 2008. The geometric features like region and boundary features based on Zernike moments and Fourier descriptors were extracted. A dataset of 125 male hand image and 125 female hand images were collected. They have obtained classification results of 98% using score-level fusion and LDA (Linear Discriminate Analysis) [11].

Jen feng wang, et. al., (2008) have worked on gender determination using finger tip features. For this research work 57 male and 58 female fingerprint totally 115 healthy adults fingerprint has been taken. They used ridge count, ridge density, and finger size features were used for classification. It has accurately obtained the result about 86% through both finger size and ridge count feature. [12]

A is method is proposed against Acree's to compare densities of ridge by Angela Ball et al., This work compares fingerprint loop ridge counts from data set of 40 male and 40 female subjects. No considerable mean difference in the top ridge count across gender has been explores and indicated by these 80 subjects F (1.78) = 308, p> 0.5, MSE = 7.946. The number of loop ridge count that males having (13.18, SD= 2.735) and females having (13.53, SD = 2.900) is also similar to the previous analysis. The work concluded that there were no significant differences in loop ridge counts between genders [13].

Alliance of finger print distribution, blood group and gender had presented by Prateek Rastogi et al., A database of 100 male and 100 female of age group range between 18 to 25yrs were analysed. Finger print loops and arches are the most and least common recurring fingerprint pattern according to the revealed result. Incidence of whorls is higher in males whereas incidence of loops in female is higher as analysed by result. In blood group Rh + or –ve of A, B, AB and O except O-ve loops were predominated. The result finalised that was a relationship between fingerprint pattern, blood group and gender distribution[14].

Gender identification using fingerprint through FDA has been proposed by Gnanaswami P et al., (2011) to estimate gender by analyzing fingerprints using FFT, DCT and PSD. A dataset under different age group and different gender of 400 people is collected as internal data base and determination is compared with predetermined and identification of gender is done. The work is resulted in 92.88 % and 94.85 % accuracy for male and female respectively [4].

Shrikant Tiwari et. al.,(2012) have proposed a method for the recognition of the newborn using Fusion of Ear and Soft-Biometrics. A dataset of the newborn includes 2100 images from 210 subjects with 10 images per person. Extraction of feature is done by PCA, KPCA. FLDA, ICA and HAAR and got the result of 90.7% accuracy.

The classification of gender using fingerprint is based on Discrete Wavelet Transform and Singular Value Decomposition has proposed by Gnanaswami P et al., (2012). It is analyzed with 1980 male and 1590 female of totally 3570 internal database fingerprints. For the left hand little fingers of female obtained result is 95.46% whereas it is 95.46% for left hand index finger for male person. Gender classification for any fingerprint of male persons tested is obtained as 91.67% and 84.69% for female persons respectively [3].

Fingerprint based gender identification using fingerprint domain analysis has been worked by Ritu Kaur at al., (2012) and classification is done by fingerprint analysis using FFT, DCT and PSD. 220 persons dataset of different age and gender is collected. Predetermined threshold is used for frequency domine calculation and finally determined the gender. The overall recognition rate of 90%, and 79.07% for female and male respectively [16].

Estimation of age based on fingerprint has been proposed by T Arulkumaran at al., (2013), in which extraction of features via 2D Discrete Transforms and Principal Component Analysis has been done. A dataset of 400 fingerprints of the age of 12-60 was collected and the overall success rate of classification in age estimation was around 68% [17].

Fingerprint based gender identification through FDA method has been proposed by Rijo Jackson Tom et al., (2013) to find by analysing fingerprints using 2D Discrete Wavelet Transforms and Principal Component Analysis. 400 persons dataset of different gender and age was collected as internal database. Their overall success rate in gender classification is around 70%[18].

A method for gender identification by means of combined feature have been proposed by S. S. Gornale et al., (2013) using FFT, Major Axis Length on the dataset combination of 450 male and 550 female samples of total 1000 numbers. Analysis of left thumb impression of each sample has been done for internal database. Optimal threshold was chosen to get promotable result. The algorithm produces accurate classification of 80% of male and 78% of female [19].

From the literature it was understood that there is limited study has been done in developing the robust algorithm using different algorithm such as age group demographic characterization of various strong features of urban and rural people are necessary to explore for gender classification. This will be more precise and appropriate for most of implementation to increase the rate of classification [19]-[22].

3. CURRENT ISSUES AND CHALLENGES

There are numerous challenging problems in fingerprint recognition system such as recognition of fingerprint based on the tip of the finger similarly recognition of fingerprint in light of deformities in ridge patterns due to cuts, dirt, or even wear and tear. One of the major complicated tasks is to acquire high-quality fingerprint images with distinctive ridges and minutia points.

The people with less number or no minutia points like surgeons because wash their hands with strong detergents, builder and special skin conditions of people, these are difficult to enrol and cannot use the system. But one of the limiting factors of algorithm for security is number of minutia points in fingerprints. Results were confusing due to false recognition of minutia points (areas of obfuscation that appear due to low-quality enrolment, imaging, or fingerprint ridge detail).

Another open issue is the lack of robustness against image quality degradation. The performance of a fingerprint recognition system is heavily affected by fingerprint image quality. Several factors are involved determining the quality of a fingerprint they are like: skin conditions (e.g., dryness, wetness, dirtiness, temporary or permanent cuts and bruises), sensor conditions (e.g., dirtiness, noise, size), user cooperation, etc.

Due to poor quality of fingerprints feature are missed and gives the false results which results in decomposing overall performance of the system. Therefore in order to estimate quality and validity of fingerprints images is a very important task of fingerprint recognition system [1] [2].

4. PROPOSED METHODOLOGY

The general steps for gender classification system is as shown in figure 1.

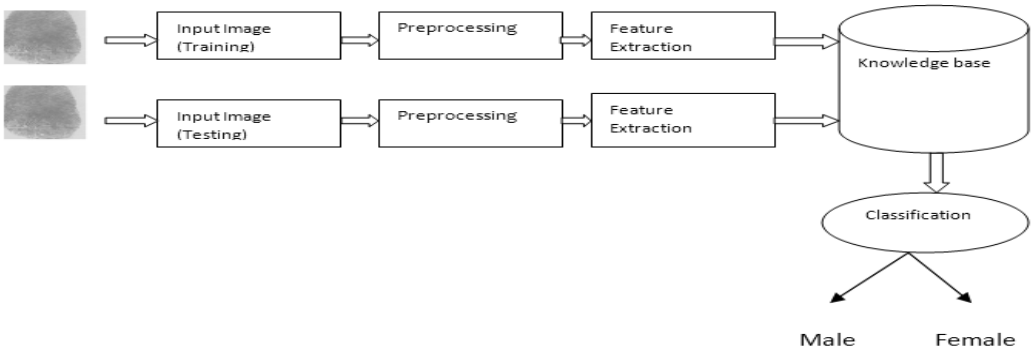


Figure-1: General steps of classification system

4.1 Fingerprint acquisition:

As per our knowledge there is no separate standard database for male and female fingerprints. In the aim of attempting deep research in this field we have collect fingerprint database the acquisition of the fingerprint was made by "Fingkey hamster 2nd scanner manufacture by nitgen biometric solution [30 with interface USB 2.0]". The resolution of the captured images is of 512 DPI in gray scale of 200x200 pixels.

4.1.1 Database used in Research

The database is constituted for gender classification based on fingerprints. The dataset is categorized into different age classes and samples were chosen from urban and rural area. A 45 samples of Male and 46 samples of female for rural and 65 Samples of Male and 60 samples of female for rural for the age group 15-20 years and for the age group 21-60 years respectively. The samples of fingerprints for the same age groups from the urban areas are collected and the overall data set is near about 4320 fingerprint samples (10 samples of each person) are shown in Table-1.

Sr No	Area	Age Group	Male	Female
01	Rural	15-20 Years	450	460
		21-60 Years	650	600
02	Urban	15-20 Years	450	460
		21-60 Years	650	600
Total			**4320**	

Table-1: Dataset Used in the Research

4.2. Pre-processing

After collecting fingerprint samples in bitmap format are pre-processed such as background elimination, cropping, converting colour image into binary image etc. For computer efficiency, the colour image is converted into binary image.

4.3. Feature Extraction

Feature extraction of pre-proposed fingerprint images through texture analysis like DWT(Discrete wavelet transform), DCT(Discrete Cosine Transform), FFT(Fast Fourier Transform) and Region

Properties like major axis length, area, eccentricity, minor axis length, convex area, solidity, perimeter, extent, Euler number and filled area.

4.4. Feature Matching

Several approaches have been developed for automatic fingerprint classification. These approaches can be broadly put into four main categories:

- Knowledge-based: To classify the fingerprints knowledge based technique uses location of singular points like core and delta points.
- Structure-based: To classify fingerprint structure based technique uses estimation of orientation field in a fingerprint.
- Frequency-based: This classification technique uses the frequency spectrum of the fingerprints for classification.
- Syntactic: This classification technique uses a formal grammar to represent and classify fingerprints.

5. EXPERIMENT ANALYSIS AND DISCUSSION

The experiment is carried out on real fingerprints which are collected from different age groups. A 45 samples of Male and 46 samples of female for rural and 65 Samples of Male and 60 samples of female for rural for the age group 15-20 years and for the age group 21-60 years respectively. The samples of fingerprints for the same age groups from the urban areas are collected and the overall data set is near about 4320 fingerprint samples (10 samples of each person). Different analytical trails were conducted using Discrete Cosine Transform, Fast Fourier Transform and Texture feature life area, minor axis length, orientation, eccentricity, major axis length, Euler number, convex area, equivalent diameter, perimeter, extent, solidity and filled area therefore using these features reliable results are obtained. But considering results some dominant features life eccentricity, major axis length, and Fast Fourier Transform used for gender classification in this paper. The algorithm-1 is for gender classification.

Algorithm-1:

Input: Fingerprint image

Output: Male or female finger print images

1. Computations of texture features, FFT features and DCT features has done by inputting the database i.e., fingerprint to the gender identification.

2. The generation of the output after the input transformation by FFT and TH1 is set as threshold. The greater values of fundamental frequency (FF) than the threshold is considered as female were as lesser value will be of male.

3. Eccentricity computation of given input and its output generation.TH2 is set as threshold. The greater values of fundamental frequency (FF) than the threshold considered as female were as lesser value will be of male.

4. Major axis length computation of given input and its output generation.TH3 is set as threshold. The greater values of fundamental frequency (FF) than the threshold considered as female were as lesser value will be of male.

5. Result comparison and decision making by all three features, the result is announced as male if two decision are male and it is announced as female if two decision are female.

In the experiment no specific classifier are used to classify the data. An optimal threshold is set for each feature for FFT 55000 and samples having defined fundamental frequency less than the threshold is considered as male and if it is greater than threshold is declared as female. For eccentricity, the threshold is fixed as 0.6 and having fundamental frequency less than the threshold is considered as male and if it is greater than threshold is declared as female and the recognition rate is calculated. For major axis length, the threshold is fixed as 250 and having fundamental frequency less than the threshold is considered as male and if it is greater than threshold is declared as female and using the formula recognition rate is calculated.

$$Classification\ Rate(\%) = \frac{\text{Total Number of Correctly Classified samples}}{\text{Total Number of fingerprint Samples}}$$

The performance/results of the algorithm for combined features are showed in Table-2 to Table-5 for the age group of 15-20 years and 21-60 years for rural and urban people with graph representation.

Table-2: Urban for the Age group 21-60 years

	FFT: Threshold =550000	Eccentricity Threshold= 0.6	Major axis length Threshold =250
Male	77.14%	75.5%	66.6%
Female	78.18%	69.09%	78.18%

Table-3: Rural for Age group 21-60 years

	FFT Threshold =550000	Eccentricity Threshold= 0.6	Major axis length Threshold =250
Male	73.30%	88.50%	68.23%
Female	75.76%	48.26%	51.87%

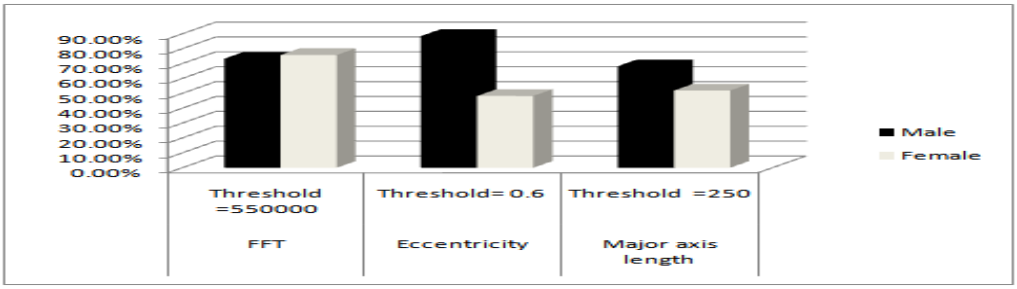
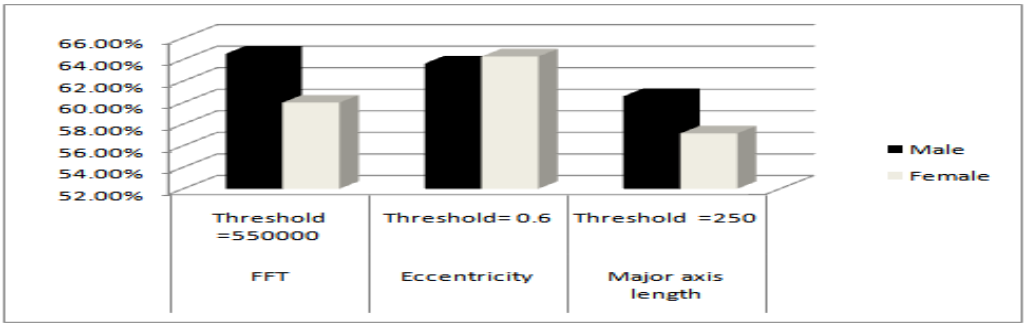


Table-4: Urban for the Age group 15-20 years			
	FFT Threshold =550000	Eccentricity Threshold= 0.6	Major axis length Threshold =250
Male	62.00%	79.5%	76.00%
Female	66.66%	52.00%	61.00%

Table-5: Rural for the Age group 15-20 years			
	FFT Threshold =550000	Eccentricity Threshold= 0.6	Major axis length Threshold =250
Male	64.54%	63.63%	60.60%
Female	60.00%	64.28%	57.14%



For urban people recognition rate of 62.00%, 79.50% and 76.60% for male; and 66.66%, 52.00% and 61.10% for female for the features FFT, eccentricity and major axis length respectively for the age group 15-20 years. A recognition rate of 77.14%, 75.50% and 66.60% for male and 78.18%, 69.09% and 78.10% for female for the features FFT, eccentricity and major axis length respectively for the age group 21-60 years.

For Rural people recognition rate of 64.54%, 63.63% and 60.60% for male; and 60.00%, 64.28% and 57.14% for female for the features FFT, eccentricity and major axis length respectively for the age group 15-20 years. A recognition rate of 73.30%, 88.50% and 68.23% for male and

75.76%, 48.26% and 51.87% for female for the features FFT, eccentricity and major axis length respectively for the age group 21-60 years.

6. CONCLUSION AND FUTURE WORK

The main objective of this paper is to combine the soft biometrics such as age with the fingerprint of a person for the gender classification. Different analytical trails were conducted on 4320 fingerprint samples using Discrete Cosine Transform, Fast Fourier Transform and Texture feature life area, minor axis length, orientation, eccentricity, major axis length, Euler number, convex area, equivalent diameter, perimeter, extent, solidity and filled area therefore using these features reliable results are obtained. The results which are predicted in this work are only by some prevailing features like FFT, eccentricity and Major axis length. According to this experimental observation soft biometric information can be used significantly to improve the recognition performance of biometric system. The overall performance of the proposed method is found to be satisfactory and more competitive.

In future, the work will be extended to build hybrid biometric system for gender classification that uses the face and fingerprint as the primary characteristics and ethnicity, height, skin colour, hair colour etc., and other parameters as the soft biometric parameters. The classification rate may be increased by extracting the features using wavelets, wavelet packets and multi-wavelets and also by using some standard classifiers like SVM, K-NN, Neural Networks, Fuzzy Sets, etc.,

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