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Fingerprint Based Gender Classification Using Minutiae Extraction

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Abstract: In crime complication court of law has accepted fingerprints verification is most believable and trustworthy proof for gender classification. For the identification and verification fingerprints are very crucial, considering this fact comparatively less no of mission vision methods suggested for gender recognition and identification. Identifying the gender using fingerprint is one of the most important steps in forensic anthropology. But only few researchers have worked for gender classification using fingerprints competitive results are gained. In this work minutia features are extracted for gender classification. The real fingerprints were collected according to different age groups and conducted experiments on internal database of 600 samples (300 male and 300female) by considering the minutiae details like intersecting points, ridge counts, number of blobs, terminating points and ridge counts. In general this work is found to be acceptable and spirited results were observed which are helpful and practically applicable in forensic anthropology.

Keywords: Fingerprint based classification, Minutia Extraction, Feature Extraction, Transform based extraction methods

I. INTRODUCTION

For any official documentation of person identification and verification the science of fingerprint are used. There are different masses of biometric techniques are nowadays available. But only few techniques are in the research stage (e.g. the iris analysis) and also much number of technologies is commercially available which are mature already. But the oldest biometric techniques for identification are fingerprint. The important step in forensic anthropology is to recognize the gender using fingerprint in order to reduce the list of suspects search. All proposed methods in the literature are mainly based on fingerprint ridges and given insight about ridge parameter mentioned about fails to give accurate method for parameter measuring. This might be due to the manual measurements and inked fingerprint impression. The parameter leads to human errors and recklessness is inevitable [11], [12], [24].

The good quality of fingerprint image input leads to increase in the performance of fingerprint features extraction and algorithm matching are critically dependent. At the same time it is difficult to measure the 'quality' of the fingerprint, it is more or less corresponds to ridge structure clarity in fingerprint images. Consequently to improve the clarity structure of fingerprint, maintain their integrity, avoid introduction of forged structures or artefacts, connectivity of ridges should be retain while partition between ridges. The distance variation by own deformation is minimized when the distance between minutiae is normalized by ridge frequency. The non linear deformation are less affected by positions are less affected by positions and ridge orientation of minutiae which are located near region in view of the fact that non linear deformation in some local areas and changes regularly [16], [20].

Gender classification performance is very much depends on pre-processing in which several distinguishable features are extracted and which can be applied among classes. In order to facilitate the large fingerprints management database and speed up the fingerprint matching is proposed by fingerprint based classification due to increase in the database manual identification become tedious and automate methods are widespread. Identification of the person using fingerprint and algorithm for identification are classified into categories: Minutiae based and image based. Image based methods include optical correlation and transform-based features.[11-12],[14-15],[17], [19-20]. Fingerprint identification are depends on other aspects like orientation, core points detection, segmentation [2], [4], [16], [24]. The most common characteristics of ridges in fingerprint image is shown in below figure-1

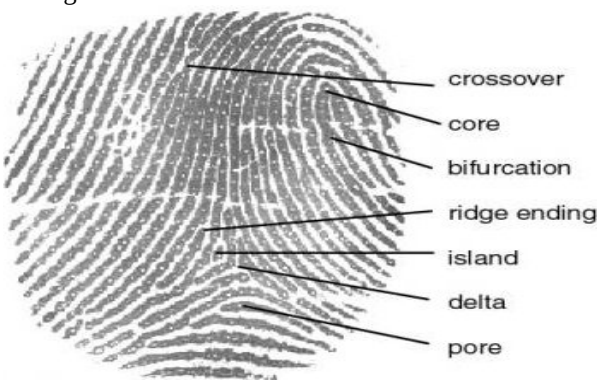

Figure-1: Common ridge characteristics

In the research field gender classification using minutiae extraction is very much significant. Using minutiae extraction only few researchers have worked on fingerprints

and have dig up competitive results.[1],[3-7], [9-10], [21], [25]. In this research work an attempt has made for gender classification using minutiae points. The real fingerprints are collected and experiments were conducted on internal database of 600 samples (300 male and 300 female). The intersecting points, blobs, ridge counts and termination points are the minutiae details extracted and classified. The rest of the paper is organized as follows: the section-2 gives the outline of the related work. Section-3 will give the current issues and challenges related to the problem. Section-4 will gives the discussion and analysis of the experiment work followed by the conclusion and future work.

II. RELATED WORK

Ahmed Badawi, et. al., (2006) have proposed a method for Gender classification from fingerprints. A dataset of 10-fingerprint images for 2200 persons of different ages and gender (1100 males and 1100 females) was analyzed. Features like ridge count, ridge thickness to valley thickness ratio (RTVTR), white lines count, and ridge count asymmetry, and pattern type concordance were extracted. Fuzzy- C Means (FCM), Linear Discriminate Analysis (LDA) and Neural Network 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 [3].

Shimon K. Modi et. al., (2007) have worked on Impact of Age groups on Fingerprint Recognition Performance. Features extracted fingerprints from different quality levels, minutiae count, and 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 were collected. The results confirm a difference in fingerprint image quality across age groups. The statistical result produced through the work indicates that the fingerprint image quality is not similar between age groups because the quality score were not within a reasonable tolerance to be similar [4].

Sudesh Gungadin et. al., (2007) have carried out a research work whose goal is to set up a correlation among sex and fingerprint ridge density. The fingerprints were collected from 500 persons (250 males and 250 females) within the age group of 18-60 years. The parameter used by them is ridge density. By counting the ridges in the upper segment of all ten fingers and calculating the mean value, it is illustrated that a finger print ridge of < 13 ridges/25 mm2 is probably of male origin and finger print ridge of > 14 ridges/25 mm2 is perhaps of female origin. It has been a great achievement to sustain the hypothesis that women be likely to comprise a statistically imperative greater ridge density than men [5].

Manish Verma, et. al., (2008) have proposed a method for gender classification from fingerprints. Features like; ridge width, ridge thickness to valley thickness ratio (RTVTR), and ridge density were extracted. This method is experimented with the internal database of 400 fingerprints in which 200 were male fingerprints and 200 were female fingerprints Support Vector Machine (SVM) was used for the classification and achieved 91% correct classification for male and female classes [6]

Jen feng wang, et al., (2008) worked on gender determination using finger tip features. The fingerprints from 115 normal healthy adults in which 57 were male fingerprints and 58 were female fingerprints have been considered for research work. They used ridge count, ridge density, and finger size features were used for classification. However, the ridge count and finger size features of left little fingers were also be used to achieve a classification. The best classification result of 86% accuracy is obtained by using ridge count and finger size feature together [7].

Angela Bell et.al., have Proposed a method in contrast to Acree's M method of comparing ridge densities. This work compares fingerprint loop ridge counts from data set of 40 male and 40 female fingerprints. The analysis revealed no significant mean difference in the loop ridge counts across gender represented by these eighty fingerprints, $F(1, 78) = .308$, $p > .05$, $MSE = 7.946$. There is no difference in the number of loop ridge counts that males have (13.18, SD = 2.735) then did females (13.53, SD = 2.900). The work concluded that there were no significant differences in loop ridge counts between male and female [1],[25].

Nithin et. al., (2011) have proposed a study using baye's theorem on the rolled fingerprint images belonging to south Indian population. The objective is to identify the gender depending upon the finger ridge count contained by a definite region. A set of database of 550 persons (275 men and 275 women) all of them possess the age range of 18-65 years. The experimental results illustrated that women have an appreciably greater number of ridge count than men. Furthermore it is established that fingerprint having ridge density < 13 ridges/25 mm2 is almost certainly to be of male origin and ridge count > 14 ridges / 25 mm2 are probably to be of female [9].

Ramanjit and Rakesh (2011) have proposed a research work and revealed that there is a considerable variation in epidermal ridge density among males and females. The research conducted to scrutinize ridge density variations in two Northern Indian populations (Sikh Jat and Bania). The experimental results exposed that 92% of Sikh Jat females comprise a mean ridge density above 13, while 76% of Sikh Jat males comprise (a mean ridge density) below 13, while in Bania, 100% of females possess mean ridge density above 14 and 80% of males – below 14. And hence it was concluded that there are considerable variations in epidermal ridge density amongst males and females within each of the two populations, and also considerable variations amongst the two populations [10].

S. Sudha Ponnarasi et. al., (2012) have proposed Gender Classification System Derived from Fingerprint Minutiae Extraction. The study was carried out over 500 public people (250 male & 250 female) belonging to the various age groups between 1 - 90. Features extracted were; ridge count, ridge thickness to valley thickness ratio (RTVTR), white lines count, and ridge count asymmetry, and pattern type concordance. Support Vector Machines (SVM) was used for the classification using the most dominant features and achieved the competitive results [16].

Ravi Wadhwa et.al.,(2013) have proposed a gender classification based on age and gender of a person from finger print impression. The novelty in the solution lies in the fact that the identification of age and sex is independent from the pressure i.e. finger prints thickness or ridge/valley thickness. The age and gender finger prints are classified on the basis of ridge to valley area, entropy and RMS value of DCT coefficients and achieved the competitive results [22].

T.Arulkumaran, et al., (2013) have proposed a method for fingerprint based age estimation method used for extracting the features through 2D Discrete Wavelet Transforms and Principal Component Analysis. A dataset of 400 fingerprints age of 12-60 were collected and the overall success rate in age estimation in around 68% [17].

Lidong Wang et al. (2014) proposed the testing and frequency distribution analysis of African American fingerprint patterns (loop, whorl, and arch) was conducted. It was shown that loops are the most common, whorls are the second most common, and arches are the least common with a very small percentage (4.33%). Most loops are ulnar loops while only 4.47% loops are radial loops. Of the total arches, 61.54% arches are plain arches and 38.46% arches are tented arches. A comparative study of gender difference in African American fingerprint patterns was conducted using a non-parametric method based on the *U* test. The *U* test results show that there is no significant gender difference in fingerprint patterns between African American males and females at the 0.05 level of significance [23].

From, literary it was observed that few researchers have worked on gender classification by different approaches and predicted some promising results but still there is a scope for developing the robust algorithm using different parameters like age group demographic characterization based on rural, urban people and different robust features are required to be extracted for gender classification which will bring be more accurate and suitable for all types of applications to increase the classification rate[2],[15],[20],[21].[27].

III. CURRENT ISSUES AND CHALLENGES

In fingerprint recognition system numerous challenging troubles are faced. Such as recognition of fingerprints, based on the tip of the finger, which leads to difficulties to recognize the fingerprint deformities in ridge patterns due to cuts, dirt or even tear and wear. One of the complicated task in acquiring high quality images with distinct fingerprint ridges and minutiae. Few people like surgeons, chemist there will be few or no minutiae points as they often wash their hands with strong detergents and also the people like builders have special skin conditions in their fingerprints due to their rough work, therefore it is difficult to enrol or use the system to detect minutiae points. But minutiae points are limiting factor for algorithm security. The system results were confusing due to false recognition of minutiae points due to low quality enrolment imaging or difficulties to notice the fingerprint ridge details. The lack of robustness is one of the important open issues against quality degradation in image. The quality of the fingerprint is heavily affected the performance of fingerprint recognition system. Numerous factors are involved foe determining the quality of fingerprints. Such as skin conditions like dryness, wetness, dirtiness, temporary or permanent cuts and buries sensor conditions like dirtiness, voice and size and also user co-operation for enrolling to give the fingerprints. Therefore this spurious and missed feature results in poor quality images and degrades the overall performance of the system. Therefore it is very important to estimate the quality and validity of the fingerprint recognition system of captured fingerprint images. [8], [13],[18].

IV. PROPOSED METHODOLOGY

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

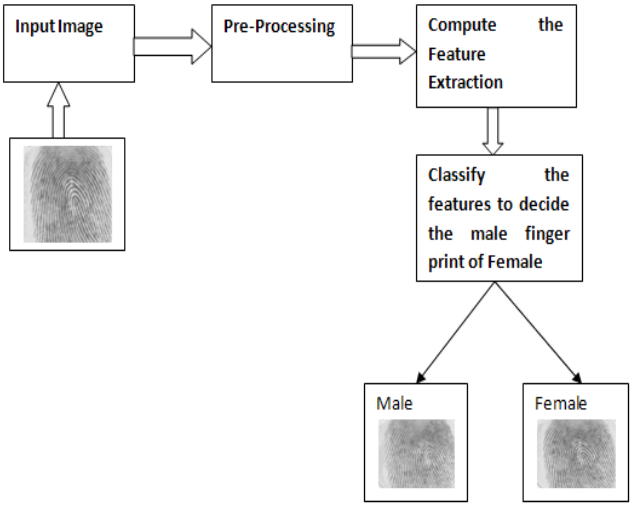

Figure: 2

A. Fingerprint acquisition:

We have created our own database with "Fingkey hamster 2nd scanner manufactured by Nitgen biometric solution [30 with interface USB 2.0]" and captured images are with a resolution of 512 DPI and a size of 200 x 200 pixels in gray scale.

a. Database used in Research:

Fingerprints are used for gender classification which is constituted on the database. According to different age groups real fingerprints were collected and different experiments are conducted on the internal database of 600 samples (300 male and 300 female).

B. Pre-processing:

The fingerprints collected were in bitmap format for the computer efficiency fingerprints are pre-processed by removing of noise such as background elimination, cropping and converting colour image into binary image etc,.

C. Feature Extraction:

In order to assess the fingerprint similarities several representations are used. Representations of fingerprints are broadly characterized into two types they are Global and Local. Overall attribute of the finger is represented but only single representation is valid for entire fingerprint which is typically determined for examination is known as Global representation. In local representation consists of numerous components in fingerprint which is derived typically from spatial restricted region of fingerprint.

D. Feature Matching:

For the automatic fingerprint based classification numerous approaches are developed. Considering many approaches it is broadly classified into four main categories:

a. Knowledge-based: In this technique classification is done by considering location of singular points such as core and delta for fingerprint classification.

b. Structure-based: In this structure-based technique orientation field is estimated in the fingerprint image to classify the fingerprints.
c. Frequency-based: In this technique frequency spectrum of fingerprints used for classification.
d. Syntactic: In this technique a formal grammar is used to represent and classify fingerprints.

V. EXPERIMENT ANALYSIS AND DISCUSSION

As real fingerprints were collected on different age groups different experiments are conducted on fingerprints internal database of 600 samples (300 male and 300 female) minutiae details life intersecting points, ridge counts, number of blobs and terminating points in the fingerprint image were extracted. The following gives the steps involved in minutia processing.

Step-1: Input the fingerprint image.
Step-2: Pre-process the input image i.e. removal noise, image resize, etc
Step-3: Convert the gray image to binary image.
Step-4: Compute the intersecting points, number of blobs, ridge counts and terminating points.
Step-5: Select the optimal threshold value to classify the gender
Step-6: Output: Male or female finger print images

The performance/results of the algorithm for combined features are showed in the form of graph which are shown in Figure-1 to Figure-5

VI. CONCLUSION AND FUTURE WORK

The experiment is carried on different age groups of fingerprints internal database of 600 samples (300 male and 300 female) minutiae details life intersecting points, ridge counts, number of blobs and terminating points in the fingerprint image were extracted.

But from this experiment we concluded that it is very difficult to consider all five features for gender classification, hence we are considering the most dominant features like intersecting points and terminating points for concluding the decision of male and female fingerprints. By the graphical representation of intersecting points and termination points in fingerprint are more in male fingerprints when compared to female fingerprints.

Therefore 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.

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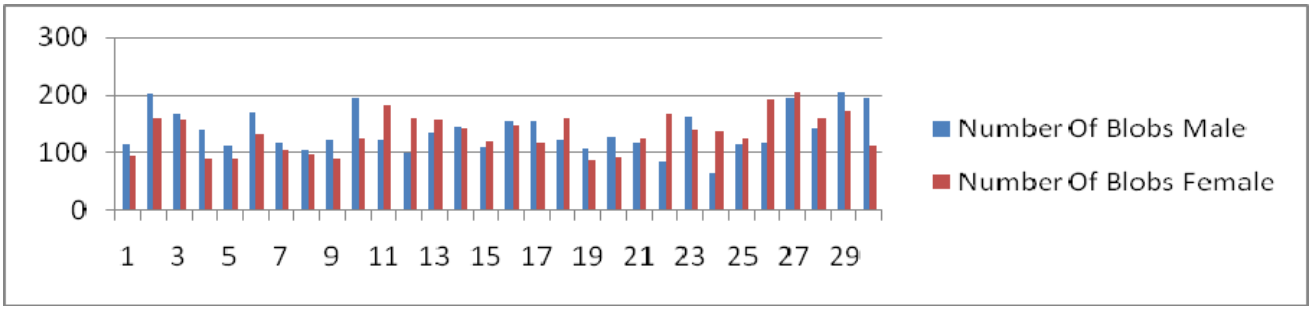

Figure-1: Graphical representation based on number of blobs in the male and female fingerprints.

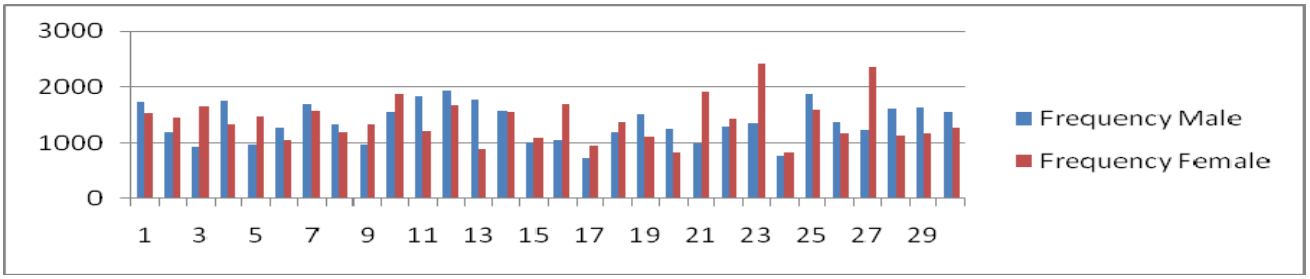

Figure-2: Graphical representation based on frequency in the male and female fingerprints.

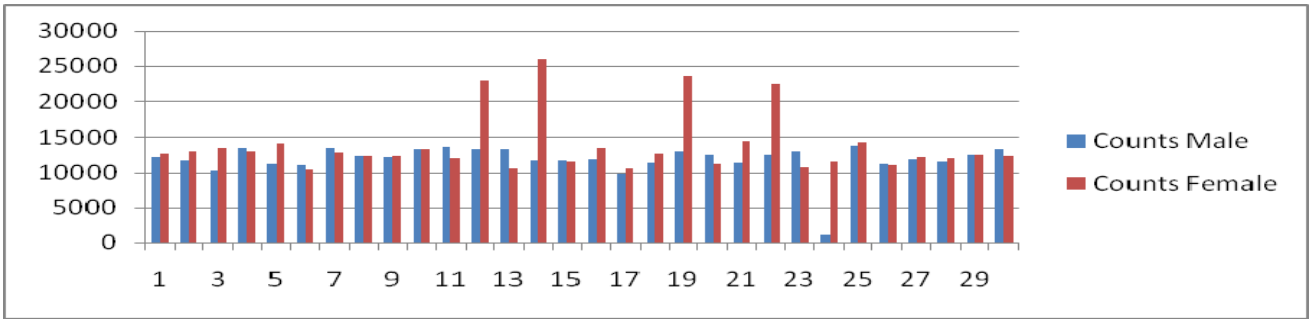

Figure-3: Graphical representation based on count in the male and female fingerprints.

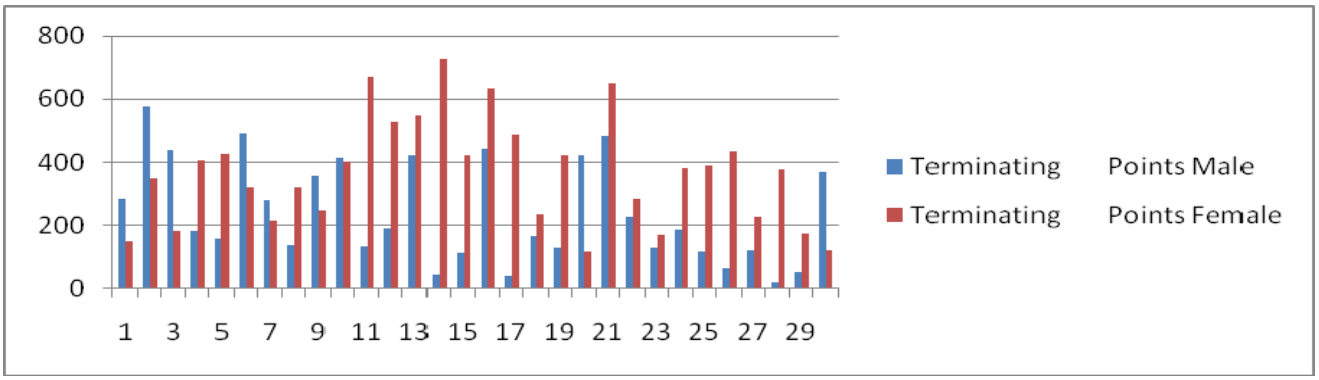

Figure-4: Graphical representation based on terminating points in the male and female fingerprints.

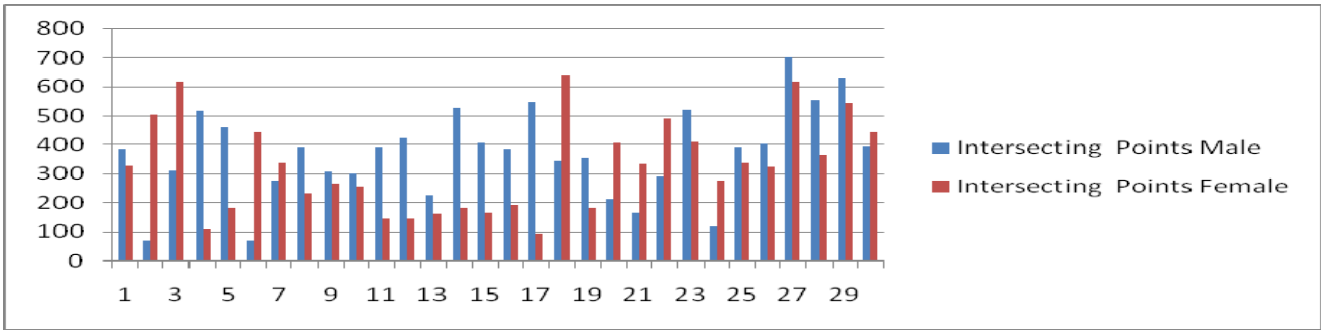

Figure-5: Graphical representation based on intersecting points in the male and female fingerprints

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