CHAPTER - 1

INTRODUCTION

A fingerprint is an impression left by the friction ridges of a human fingertip, able to be used for identifying individuals from the unique pattern and lines on the fingertips. Human fingerprints are detailed, unique, difficult to alter, and durable over the life of an individual. So the fingerprints are considered as long-term markers of human identity. They may be employed by police or other authorities to identify individuals who wish to conceal their identity, or to identify people who are incapacitated or deceased and thus unable to identify themselves, as in the aftermath of a natural disaster.

Fingerprint is the unique identity of any person in the world. It takes place in pregnancy and lives for whole span of life of a person. Though finger of a person is injured, burned, the prints damages for little period of time after getting well, it occurs as usual. Means there is no changes in the fingerprints. In judicial matters law also believes and accepts the fingerprints due to its most reliability in criminal study also fingerprints are most valuable. There are no exactly same fingerprints of two persons though they are twins. It can be classified gender wise, which narrows the suspects. If we want to find suspicious person from 100 or1000 of employees of industry, and if there are 50% of female and 50 % of male employees, this classification reduces the50% of data automatically.

Identification of gender plays an important role in forensic and medico legal investigations. Fingerprints are considered to be most precise and reliable indicators for personal and gender identification. Many researches are conducted on the topic of gender identification from fingerprints and it has been proved that ridge density is more in female (13 to 20 ridges/ 25mm^2) and less in male (11 to 16 ridges/25mm^2). Ridge density is the ridge count corresponding to a defined fingerprint area. In the present scenario transgender are considered as a gender category other than male and female. Transgender are the people who are having gender identity or gender expression that differs from their sex assigned at the birth.

Gender determination is one of the significant aspects of fingerprint identification science having extensive applications in diverse scientific fields. Apart from forensic science it has applications in human biology and anthropological sciences to study various traits among different populations and cultures. Apart from all these, fingerprints are valued

forensically because of their frequent presence at scene of crime and help in the identification of the suspect. Identifying the difference in transgender fingerprints will helps to distinguish them from male and female. If the sex of the individual could be established with certainty, the burden of the investigator would be reduced by half.

For this study I have collected the thumb prints of transgender. Thumb prints are of distinct importance. They are even used in lieu of signature in India in many documents like wills, bank cheques, property documents, sale deed etc. Thumb prints are often considered in civil and criminal cases as prominent evidence. Whenever a person touches, holds or lift any objects like pen, paper, knife, glass, firearms etc there is more chance to transfer the thum print on to the object.

The study has conducted based on the parameter ridge density in a specified area. Previous studies in this topic had been proved that transgender fingerprints are most similar to male fingerprints. In this study I am trying to identify the difference in transgender fingerprints.

CHAPTER-2

LITERATURE REVIEW

2.1. Acree M. has 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. Application of Baye's theorem suggests that a given fingerprint possessing a ridge density of 11 ridges/ 25mm²or less is most likely to be of male origin. Likewise a fingerprint having a ridge density of 12 ridges/25mm² or greater is most likely to be of female origin, regardless of race.

2.2. Dr. S. Gungadin, Principal police medical officer, Police medical division, Port Louis, Mauritius has conducted a study entitled Sex determination from fingerprint ridge density. The study was conducted on 500 subjects (250 males and 250 females) in the year 2000-2002. In this study the subjects were chosen randomly in the age group of 18-60 years from the state of Karnataka. The plain fingerprints of all fingers were collected. The height and weight of each individual also recorded to know whether extremes of height and weight have any impact over ridge density. The upper portion of the each print was chosen as an area for analysis, because all. In this selected area of fingerprints epidermal ridges if both males and females were counted within a square of 5mm x 5mm. Specific comparison of the means they were made and various calculations were performed on this using some software. The results shows the ridge density ranges from 11-15 ridges/25mm² in male and 12-16 ridges/25mm² in females was found. It shows that males have lesser ridge density than females. The mean value of ridge count for male is 12.8 and that of female was 14.8 as per this study.

2.3. M.D. Nithin, B. Manjunatha, D.S. Preethi, and B.M. Balaraj has presented a study to determine the gender based on finger ridge count within a well-defined area. Rolled fingerprints were taken from 550 subjects (275 men and 275 women) belonging to South

Indian population all within the age range of 18–65 years. Results show that women have a significantly higher ridge count than men. Application of Baye's theorem suggests that a fingerprint possessing ridge density <13 ridges/25 mm2 is most likely to be of male origin. Likewise, a fingerprint having ridge count >14 ridges/25 mm2 are most likely to be of female origin. These results are helpful as a tool for fingerprint experts as they can be used as a presumptive indicator of gender based on the degree of ridge density.

2.4. Ramanjit Kaur, Rakesh K. Gargin had conducted a study on gender classification from fingerprints using ridge density. 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.

2.5. Dr. Gangandeep Singh conducted a study which aims to determine the difference in male and female fingerprints of two northern Indian population of Chandigarh region (Khatri and Bania).The samples for the present study consist of fingerprints from 50 khatri and 50 Banias (25 males and 25 females in both populations) aged between 18–40 years. Rolled fingerprints of all ten fingers were collected. Epidermal ridges in each fingerprint sample were counted within a 5 mm ´ 5 mm square. This value represents the epidermal ridge density. After calculating the epidermal ridge density of all ten fingers, the mean is calculated for it. This value represents the single data point for that individual. The means of 25 data points were calculated for both the populations. And various calculations were done on it. The result shows that ridge density of Khatri males ranged from 10.6 to 14.1 ridges/25 mm and for females from 12.8 to 15.5 ridges/25 mm². In Bania population the ridge density value ranges from 11.4 to 15.6 ridges/ 25 mm² for males and from 14.1 to 20.5 ridges/25 mm² for females The magnitude of difference between the means of Khatri males and females is 2.1 ridges/25 mm and between Bania males and females is 2.6 ridges/25 mm².1)

2.6. Ponnarasi SS and Rajaram M. 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 10-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. Application of Bayes' theorem suggests that a given fingerprint possessing a ridge density of 11 ridges/25 mm2or less is most likely to be of male origin. Likewise, a fingerprint having a ridge density of 12 ridges/25 mm2 or greater is most likely to be of female origin, regardless of race.

2.7. Dr.Amit Patil, Dr. Amrit Mascen and Dr. TrezaShirole conducted a study entitled "fingerprint ridge density as tool of gender determination" The study was conducted on 170 subjects at Dr D Y Patil Medical College and Hospital, Nerul, Navi Mumbai. The samples for the present study consist of fingerprints of 70 males and 100 females aged between 18 to 65 years of age. The rolled fingerprints were collected and epidermal ridges in each fingerprint sample were counted within a 5 mm X 5 mm square drawn on a transparent film in the chosen area of 25 square mm using magnifying glass. And statistical analysis was done on it. The results showed that in male subjects, the ridge density ranged from 8.0 to 12.90 ridges/25 mm2with a mean of 10.62 ridges/25 mm2 and in females from 10.20 to 15.00 ridges/25 mm2 with a mean of 12.69 ridges/25 mm2. Mean ridge density was higher in females than males. Fingerprint possessing >13 ridges/25 mm2 has a higher probability of being from female ($p = 0.99$). The probability of fingerprint of < 11 ridges/25 mm2 of being from a male origin is very large.

2.8. Ganesh B. Dongre and S.M Jagad presented a study aims to determine the difference in transgender fingerprints from male and female fingerprints. The set of features for this study is minutiae patterns like bifurcation, fridge ending, core, delta, sweat pores etc. The demographic composition of sample population represents 10 trans genders, 10 males and 10 females The fingerprints are collected by using fingerprint scanners and stored in the database. The various methods like singular value decomposition, discrete wavelet transform can used for the extraction of feature from the finger print image. Singular Value Decomposition is used to get eigen vector and 2D Discrete Wavelet Transform is

useful for energy vector determination. Unless the finger print image is used as input, it is very difficult to obtain the feature vector. 2D - Discrete Wavelet Transform will decompose and image into the sub bands. That some bands are localized in frequency and orientation. Mainly in high frequency sub band images, this process is further used to isolate small changes in an image. Thus 2D - Discrete Wavelet Transform is more suitable tool which can be used for the designing of gender classification system. After extraction of features by various methods the feature vector are combined with the help of combined vectors, singular value decomposition, discrete wavelet transform and the histogram for comparison purpose. Through this study they have found that the features of the transgender fingerprints mostly tending towards male fingerprint characteristics.

2.9. Pinki Kumari, Aman Kumar, Sanjeev Kumar, Saroj Kumar Ranjan, Nikhil Goel, Sanjay Kumarhas presented a study on gender classification from fingerprint ridge density. The study was conducted on 500 healthy people (250 male and 250 female) between ages of 18 and 60 years. Fingerprints were taken using Glass slab inking roller method. The type of fingerprint pattern and ridge density in these patterns was analyzed for sex identification. They found that the loop pattern of fingerprint was seen in majority (61.20%) of cases. This study also revealed that fingerprint ridge density in female is 13.42 in comparison to male 11.97. Ridge density in female is more than male.

2.10. S. F. Abdullah, A. F. N. A. Rahman and Z. A. Abas presented a study on gender classification using fingerprint ridge density in the population of Northern part of Malaysia. The sample of this study consists of 50 participants coming from the age group of 18-60 year old and consists of 25 males and 25 females. Fingerprint images that taken manually will be going through the image pre-processing phase using a MATLAB software before the ridge of the fingerprint from two topological areas, radial and ulnar can be counted and the mean can be calculated. The results show that fingerprint ridges of less than 12 ridges/25mm² is more likely belong to a male respondent while fingerprint ridges of more than 14 ridges/25mm² is more likely to be from a female respondent. From the result, we can conclude that in Malaysia too, woman tends to have a greater ridges density compared to man. The result shows that the male respondents tends to have lower number of ridges density with a maximum number of 14 ridges density compared to female respondents with maximum of 16 ridges density. In terms of percentage, 40% of the male respondents tend to have 11 ridges while for female respondent, majority of the group have 16 ridges, which accumulate 40%.

CHAPTER - 3

AIM AND OBJECTIVES

3.1. **Aim**

- Comparison of Trans gender fingerprints with Male and Female fingerprints

3.2. **Objectives**

- Collecting fingerprints of Male, Female & Trans gender
- Determining the ridge count and calculating the mean ridge density.
- Comparing transgender fingerprints with male and female based on ridge density

CHAPTER-4

MATERIALS AND METHODOLOGY

4.1. **Materials required:**

- Samples
- Fingerprint inkless pad
- Ink pad
- Fingerprint collection slip
- Magnifying lens
- Transparent sheet
- Scale

4.2. **Collection of samples**

In this study 10 transgender, 10 Males and 10 Females were chosen, aged between 22 to 32 years. The purpose of this study was explained and verbal consent to the subjects individually. Subjects with any evidence of diseases or injury in fingertips were excluded. The subjects were asked to clean their hands. The ink pad and the slip have placed on edge of table. The recommended height for taking fingerprints is 39 inches from floor. The subjects were asked to stand in front of the table by keeping one arm distance. The subjects were asked to roll their thumb on the pad from one side of the nail to other side and from the crease of the first joint to tip of the finger and imprint it on the fingerprint collection slip by rolling the thumb towards the fingers away from the center of the individual's body.

Figure 4.1: Inking of thumb

Figure 4.2: Inked thump

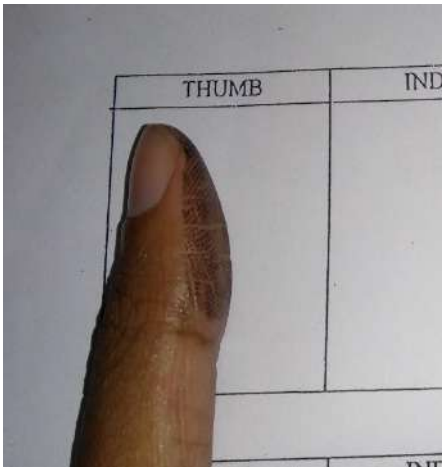

Figure 4.3: Imprinting on fingerprint slip

Methodology

On a transparency sheet two straight lines bisecting each other were drawn. This bisecting point was placed at the core or center of the print. 5 mm above this, another transverse line was drawn. Two squares of 25 mm^2 each were drawn on both sides (left and right). These were our chosen areas for analysis. Ridge counting was performed in these designated areas and the values were tabulated. At the time of counting the number of ridges, this transparency sheet was superimposed on the print so that the lower intersection lies on the core/center of the print, in cases of Whorls and Loops. In Arches the intersection was kept on the lowest ridge which flows continuously from one side to the other side of the print. The epidermal ridges from one corner of the square to the diagonally opposite corner were

counted. Dots were not counted. Forks were counted as two ridges excluding the handle and a lake was counted as two ridges.

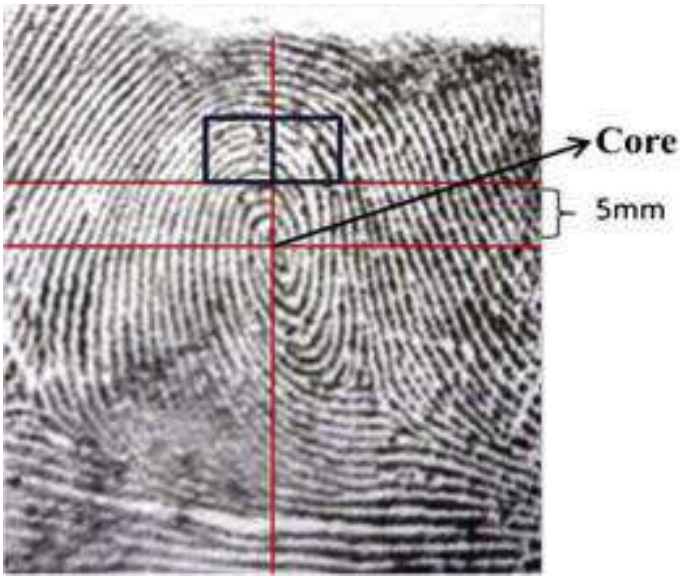

Figure 4.4: Areas for analysis (left side of center (LoC) and right side of center (RoC)

Ridge counting was done on male, female and transgender fingerprints using above method. The value of ridges density represented in the number of ridges/ 25mm² square areas is calculated by using the formula.

Ridge density = Mean of number of ridges in Left side of the Center (LoC) + Right side of the Center (RoC)/ 25mm²

After finding the ridge density transgender fingerprints were compared with male and female to identify the difference.

CHAPTER-5

CALCULATIONS AND OBSERVATION TABLES

Trans gender

The ridge count of transgender Thumb prints are been tabulated and given in the following table.

Sample	Left Thumb			Right thumb			Total
	LoC	RoC	Mean	LoC	RoC	Mean	Left+Right/2
1	14	13	13.5	12	14	13	13.25
2	11	13	12	12	13	12.5	12.25
3	13	12	12.5	12	11	11.5	12
4	11	12	11.5	11	13	12	11.75
5	14	11	12.5	12	13	12.5	12.5
6	14	15	14.5	13	14	13.5	14
7	12	11	11.5	11	14	12.5	12
8	13	11	12	12	10	11	11.5
9	13	13	13	12	14	13	13
10	12	13	12.5	14	12	13	12.75

Table 5.1

Mean Ridge density in the left thumb = Sum of the mean of LoC + RoC in left thumb/ Total Number of participants

= 125.5/10

= 12.55 ridges/ 25 mm²

Mean Ridge density in the right thumb = Sum of the mean of LoC + RoC in right thumb/ Total Number of participants

= 124.5/10

= 12.45 ridges/ 25mm²

The total mean Ridge density of both Right thumb and left thumb = (12.55+12.45)÷2

= 12.5ridges/25mm²

Female

Ridge count of Female thumb prints are been tabulated and given in the following table

Sample	Left Thumb			Right thumb			Total
	LoC	RoC	Mean	LoC	RoC	Mean	Left+Right/2
1	14	13	13.5	13	13	13	13.25
2	14	15	14.5	13	14	13.5	14
3	15	14	14.5	16	15	15.5	15
4	14	15	14.5	14	13	13.5	14
5	14	13	13.5	13	13	13	13.25
6	15	14	14.5	12	14	13	13.75
7	14	13	13.5	15	14	14.5	14
8	13	12	12.5	12	14	13	12.25
9	12	13	12.5	11	13	12	12.25
10	14	12	13	15	14	14.5	13.75

Table 5.2

Mean Ridge density in the left thumb = Sum of the mean of LoC + RoC in left thumb/ Total Number of participant

= 136.5/10

= 13.65 ridges/25mm²

Mean Ridge density in the right thumb = Sum of the mean of LoC + RoC in right thumb/ Total Number of participants

= 135.5/10

= 13.55ridges/25mm²

The total mean Ridge density of both Right thumb and left thumb = (13.65 + 13.55) ÷2

= 13.6ridges/25mm²

Male

Ridge count of Male thumb prints were tabulated and given in the following table

Sample	Left Thumb			Right thumb			Total
	LoC	RoC	Mean	LoC	RoC	Mean	Left+Right/2
1	13	10	11.5	13	12	12.5	12
2	12	9	10.5	10	11	11.5	11
3	13	12	12.5	11	13	12	12.25
4	14	12	13	11	13	12	12.5
5	12	11	11.5	12	10	11	11.25
6	9	12	10.5	12	11	11.5	11
7	13	12	12.5	11	12	11.5	12
8	11	12	11.5	13	12	12.5	12
9	14	15	14.5	14	13	13.5	14
10	12	14	13	11	13	12	12.5

(Table 3)

Mean Ridge density in the left thumb = Sum of the mean of LoC + RoC in left thumb/ Total Number of participant

= 121/10

=12.1ridges/25mm²

Mean Ridge density in the right thumb = Sum of the mean of LoC + RoC in right thumb/ Total Number of participants

= 120/10

= 12 ridges/25mm²

The total mean Ridge density of both Right thumb and left thumb = (12.1 + 12)÷2

=12.05 ridges/25mm²

CHAPTER - 6

RESULTS

Descriptive statistics of ridge densities in male female and transgender are shown in the tables. In Transgender the ridge density ranges from 10-14ridges/ 25mm² at both left side of the center (LoC) and right side of the center (RoC) with a mean ridge density of 12.5 ridges/25mm².In the left thumb the mean ridge density is 12.55ridges/25mm².In the right thumb the mean ridge density is 12.45ridges/25mm².When combining the left thumb and right thumb ridge density it is 25. The total mean ridge density is 12.5 ridges/25 mm².

In females the ridge density ranges from 11-16ridges/25mm². The mean ridge density in left thumb is 13.65ridges/25mm². The mean ridge density in right thumb is 13.55ridges/25mm². The total mean ridge density is 13.6ridges/25mm².

In males the ridge density ranges from 9-14 ridges/25mm². The mean ridge density in left thumb is 12.1ridges/25mm². The mean ridge density in right thumb is 12ridges/25mm². The total mean ridge density is 12.05ridges/25mm².

While comparing the transgender fingerprint with male and female fingerprints transgender fingerprints are mostly tending towards male origin. So the result of the study shows that transgender fingerprints are mostly similar to male fingerprints.

CHAPTER - 7

CONCLUSION

Fingerprint evidence is undoubtedly the most reliable and acceptable evidence till date in the court of law. Due to the immense potential of fingerprints as an effective method of identification of gender, an attempt has been made in the present work to analyze the transgender fingerprints to find the difference in their fingerprint from male and female based on ridge density.

The present study empirically tested and confirmed the hypotheses of sexual differences in the ridge density of transgender with male and female and that shows that the transgender fingerprints are mostly tending towards male fingerprints. This study is confirming the findings of previous studies on this topic.

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