CHAPTER I:INTRODUCTION

The long story of that inescapable mark of identity has been told and retold for many years and in many ways. On the palm side of each person's hands and on the soles of each person's feet are prominent skin features that single him or her out from everyone else in the world. These features are present in friction ridge skin which leaves behind impressions of its shapes when it comes into contact with an object. The impressions from the last finger joints are known as fingerprints. Using fingerprints to identify individuals has become common place, and that identification role is an invaluable tool worldwide.[11]

A fingerprint is formed on any opaque surface and is the impression of the friction ridges on the finger of a human. The matching of two fingerprints is among the most widely used and most reliable biometric techniques. Fingerprint matching considers only the obvious features of a fingerprint. A fingerprint classification system groups fingerprints according to their characteristics and therefore helps in the matching of a fingerprint against a large database of fingerprints. Early classification systems were based on the general ridge patterns, including the presence or absence of circular patterns, of several or all fingers. This allowed the filing and retrieval of paper records in large collections based on friction ridge patterns alone. Fingerprint classification systems included the Roscher System, the Juan Vucetich System and the Henry Classification System. The Roscher System was developed in Germany and implemented in both Germany and Japan. The Vucetich System was developed in Argentina and implemented throughout South America. The Henry Classification System was developed in India and implemented in most English-speaking countries. In the Henry Classification System there are three basic fingerprint patterns: loop, whorl, and arch, which constitute 60–65 per cent,30-35 per cent, and 5 per cent of all fingerprints respectively.

There are also more complex classification systems that break down patterns even further, into plain arches or tented arches, and into loops that may be radial or ulnar, depending on the side of the hand toward which the tail points. Ulnar loops start on the pinky-side of the finger, the side closer to the ulna, the lower arm bone. Radial loops start on the thumb-side of the finger, the side closer to the radius. Whorls may also have sub-group classifications including plain whorls, accidental whorls, double loop whorls, peacock's eye, composite, and central pocket loop whorls.[12]

Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, and it remains an extremely valuable tool for law enforcement. One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person. Fingerprint identification also helps investigators to track a criminal’s record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions.[13]

The recovery of partial fingerprints from a crime scene is an important method of forensic science. Moisture and grease on a finger result in fingerprints on surfaces such as glass or metal. Deliberate impressions of entire fingerprints can be obtained by ink or other substances transferred from the peaks of friction ridges on the skin to a smooth surface such as paper. Fingerprint records normally contain impressions from the pad on the last joint of fingers and thumbs, though fingerprint cards also typically record portions of lower joint areas of the fingers. Human fingerprints are detailed, nearly unique, difficult to alter, and durable over the life of an individual, making them suitable 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 identification, known as dactylscopy or hand print identification, is the process of comparing two instances of friction ridge skin impressions, from human fingers or toes, or even the palm of the hand or sole of the foot, to determine whether these impressions could have come from the same individual.[12]

The two underlying premises of fingerprint identification are uniqueness and persistence (permanence). To date, no two people have ever been found to have the same fingerprints—including identical twins. In addition, no single person has ever been found to have the same fingerprint on multiple fingers. Persistence, also referred to as permanence, is the principle that a person's fingerprints remain essentially unchanged throughout their lifetime. As new skin cells form, they remain cemented in the existing friction ridge and furrow pattern. In fact, many people have conducted research that confirms this persistency by recording the same fingerprints over decades and observing that the features remain the same. Even attempts to remove or damage one's fingerprints will be thwarted when the new skin grows, unless the damage is extremely deep, in which case, the new arrangement caused by the damage will now persist and is also unique·[13]

Analysts use the general pattern type (loop, whorl or arch) to make initial comparisons and include or exclude a known fingerprint from further analysis. To match a print, the analyst uses the minutiae, or ridge characteristics, to identify specific points on a suspect fingerprint with the same information in a known fingerprint. For example, an analyst comparing a crime scene print to a print on file would first gather known prints with the same general pattern type, then using a loop, compare the prints side-by-side to identify specific information within the minutiae that match. If enough details correlate, the fingerprints are determined to be from the same person.[13]

Fingerprints can be used in all sorts of ways:

- Providing biometric security (for example, to control access to secure areas or systems)
- Identifying amnesia victims and unknown deceased (such as victims of major disasters, if their fingerprints are on file)

Figure1: Fingerprint collection

- Conducting background checks (including applications for government employment, defence security clearance, concealed weapon permits, etc.).

In addition, fingerprints can link a perpetrator to other unsolved crimes if investigators have reason to compare them, or if prints from an unsolved crime turn up as a match during a database search. Sometimes these unknown prints linking multiple crimes can help investigators piece together enough information to zero in on the culprit. Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions. Fingerprints have crucial role in establishing the identity of an individual.

In the past, there is no study present related to graphical representation of ridge count of fingerprints. In the present study graphical representation of ridge count of fingerprints is done. The significance of this topic is that, presently fingerprint matching is done based on the minutiae features of fingerprints, so if a method where the fingerprints of individuals can be represented in the form of a graph (based on ridge count) is developed then the process of fingerprint matching can be simplified in future.

CHAPTERII: LITERATURE REVIEW

D.K.Isenor et.al (1985) studied fingerprint identification using graph matching. A new algorithm for automated fingerprint encoding and matching is presented. A fingerprint is represented in the form of a graph whose nodes correspond to ridges in the print. Edges of the graph connect nodes that represent neighbouring or intersecting ridges. Hence the graph structure captures the topological relationships within the fingerprint. The algorithm has been implemented and tested using a library of real-life fingerprint images.

H.Choi et.al (2011) studied fingerprint matching incorporating ridge features with minutiae. Fingerprint pre-processing and ridge feature extraction is performed initially followed by fingerprint matching. The ridge feature vectors between the minutiae in the ridge coordinate system can be expressed as a directional graph whose nodes are minutiae and whose edges are ridge feature vectors. Thus, we can adopt graph matching methods to utilize the ridge feature vectors in fingerprint matching.

H Deng et.al (2005) studied minutiae matching based fingerprint verification using Delaunay triangulation and aligned-edge-guided triangle matching. Using Delaunay triangulation, each fingerprint is represented as a special connected graph with each node being a minutia point and each edge connecting two minutiae. Such a graph is used to define the neighbourhood of a minutia that facilitates a local-structure-based matching of two minutiae from input and template fingerprints respectively. The possible alignment of an edge in input graph and an edge in template graph can be identified efficiently. A global matching score between two fingerprints is finally calculated by using an aligned-edge-guided triangle matching procedure.. The effectiveness of the proposed approach is confirmed by a bench mark test on FVC2000 and FVC2002 databases.

A Eshera et.al (2006). An image comparison arrangement uses an electronic computer to compare digitized fingerprint minutia maps of fingerprints of an unknown fingerprint set with corresponding maps of reference. Fingerprint sets which are stored in memory, in order to identify unknown fingerprints or to match fingerprints. The matching is performed by converting all the fingerprints to attributed relation graphs (ARGs) including nodes and branches, to which attributes are appended. The number of elements in the match core indicates the degree of match of the unknown to each reference fingerprint.

N.K Ratha et.al (2000) studied robust fingerprint authentication using Local structural similarity. Using the fingerprint minutiae features, a labelled and weighted graph of minutiae is constructed for both the query fingerprint and the reference fingerprint. In the first phase, we obtain a minimum set of matched node pairs by matching their neighbourhood structures. In the second phase, we include more pairs in the match by comparing distances with respect to matched pairs obtained in first phase. An optional third phase, extending the neighbourhood around each feature, is entered if we cannot arrive at a decision based on the analysis in first two phases. The proposed algorithm has been tested with excellent results on a large private live scan database obtained with optical scanners.

Raffaele Cappelli et.al (2010) studied Minutia Cylinder-Code: A New Representation and Matching Technique for Fingerprint Recognition. The Minutia Cylinder-Code (MCC): a novel representation based on 3D data structures (called cylinders), built from minutiae distances and angles. The cylinders can be created starting from a subset of the mandatory features (minutiae position and direction) defined by standards like ISO/IEC19794-2(2005), fixed-length, and bit-oriented coding, some simple but very effective metrics can be defined to compute local similarities and to consolidate them into a global score. Extensive experiments over FVC2006 databases prove the superiority of MCC with respect to three well-known techniques and demonstrate the feasibility of obtaining a very effective (and inter operable) fingerprint recognition implementation for light architectures.

Jianjiang Feng et.al (2005) studied Fingerprint Indexing Using Ridge Invariants. They conducted experiments on DB1_A from FVC2002 databases. The image size is 388×374, and their solution is 500dpi. An efficient fingerprint indexing algorithm is proposed in this paper, which is based on ridge invariants. Compared to minutiae triplets based indexing algorithm, our algorithm carries more information. The discrete nature of ridge invariants makes binning of invariants unnecessary

Tsai Yang Jea et.al (2006) studied a minutia-based partial fingerprint recognition system. An approach that uses localized secondary features derived from relative minutiae information. A flow network-based matching technique is introduced to obtain one-to-one correspondence of secondary features. Since the minutia-based fingerprint representation is an ANSI-NIST standard [American National Standards Institute, New York, 1993], their approach has the advantage of being directly applicable to existing databases.

R.S.Germain et.al (1997) studied Fingerprint matching using transformation parameter clustering. Flash, a similarity-searching algorithm akin to geometric hashing, proves suitable for one-to-many matching of fingerprints on large-scale databases.

.A.Wahab et.al (1998) studied Novel approach to fingerprint recognition. An enhanced fingerprint recognition system consisting of image pre-processing, feature extraction and matching that runs accurately and effectively on a personal computer platform. The image pre-processing includes histogram equalisation, modification of directional codes, dynamic. Only features extracted are stored in a file for fingerprint matching. The matching algorithm presented is a modification and improvement of the structural approach. Experimental results acquired for matching are accurate, reliable and fast for implementation using a PC and a fingerprint scanner.

CHAPTER III: AIM AND OBJECTIVES

AIM

To study the graphical representation of ridge count of fingerprints.

OBJECTIVES

- To determine the difference in the graphs for ridge count of fingerprints for the age group from 15to30yrs.
- To determine whether these graphs can be used for fingerprint matching.
- To determine the differences in the graphs obtained for both the sex.

CHAPTER IV: MATERIALS AND METHODOLOGY

MATERIALS REQUIRED

1. Fingerprint collection slip
2. Ink
3. Graph paper
4. Magnifying lens
5. Needle
6. Inkpad

Figure2: Inkpad

METHODOLOGY

Fingerprints were collected onto the fingerprint collection slip from 50 males and 50 females within the age group 15 to 30yrs. Then the ridge count from core to delta of each individual fingerprints were taken. While taking the ridge count of whorl pattern, ridge count from both the deltas to the core were taken. The ridge count for arch pattern was taken as fixed value zero. Based on the obtained ridge count, graphs were being drawn by taking ridge count along Y-axis and fingers along X-axis. After plotting the ridge count with respect to each fingers for each individual, graph was drawn for all ten fingers. In case of whorl patterns, the average of the ridge count from both the deltas were taken for plotting them in the graph. The graphs obtained were then compared with each other in the following ways:

The graphs obtained for males were compared with that of females. Lastly individual graphs of each individual were compared among each other.

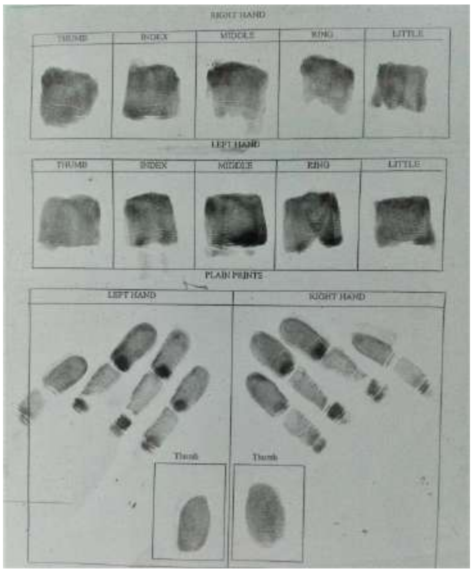

Figure3: Fingerprints collected on fingerprint collection slip.

CHAPTER V: OBSERVATION TABLE

		Ridge Count									
S.No	**Samples**	**RT**	**RI**	**RM**	**RR**	**RL**	**LT**	**LI**	**LM**	**LR**	**LL**
1	Sample 1	22	16	10.5	20.5	18	21	8	17	19.5	12
2	Sample 2	21.5	19	16	15.5	14	19.5	15	18	18.5	14
3	Sample 3	21	20	17	20	10	20	15	15	16	14
4	Sample 4	24	14.5	21	18	12	17	17.5	14.5	16	15
5	Sample 5	16	16.5	18	17	15	12	14	17	17	19
6	Sample 6	21	13	11	16	7	12	10	0	15	10
7	Sample 7	25	15	22	17.5	11	19	12	18	19.5	12
8	Sample 8	19	0	11	10	14	18	4	7	10.5	13
9	Sample 9	22	17.5	17	19.5	14.5	16.5	21	19.5	17	21
10	Sample 10	21	5	9	10	7	19	4	14	10	10
11	Sample 11	33	29.5	30	33.5	24.5	33.5	21	29.5	35.5	22.5
12	Sample 12	36.5	30	16	24.5	21	33.5	31	23.5	20.5	18
13	Sample 13	25	27.5	18	28	14	18	30.5	21	22	15
14	Sample 14	18	0	14	11	12	15	11	15	15	13
15	Sample 15	21	18.5	18	17	14	17	16	18	17.5	17
16	Sample 16	15	15	13	12	11	19	15	17	19	15
17	Sample 17	22	18	17	16	15	12	0	18	13	13
18	Sample 18	20	14	19	15	16	22	15	23	17	20
19	Sample 19	32	26	25	29	18	30.5	23	30.5	24	16
20	Sample 20	11	13	10	13	17	28	10	10	9	12

21	Sample 21	24	15	20	27	23	29	24	28.5	17	15
22	Sample 22	28.5	26	22	31	16	24	27	20.5	24	16
23	Sample 23	33	21.5	23.5	27.5	18.5	26	23.5	19	23.5	16
24	Sample 24	28.5	13	10	15	9	21.5	8	13	15	11
25	Sample 25	21.5	18	14	20	17	22.5	13	17	16	17
26	Sample 26	20	19.5	22.2	28.5	25.5	28.5	22.5	28	22	23.5
27	Sample 27	32	16	17	19	13	28	8	20	21	17
28	Sample 28	20	15	14	25.5	11	0	12	16	16	16
29	Sample 29	20	8	5	10	14	14	11	12	14	13
30	Sample 30	29.5	17	18	24	19	30.5	17	19	28	16
31	Sample 31	27	30	16	32.5	18	37	29	26.5	32	22
32	Sample 32	23	28	19	24	17	26	32	24	23	14
33	Sample 33	15	11	17	22	8	10	14	17	23	9
34	Sample 34	36.5	9	0	0	7	25	13	10	17	12
35	Sample 35	31	11	14	15.5	12	21	12	15	18	13
36	Sample 36	19	6	13	16	10	17	8	10	20	15
37	Sample 37	16	0	0	5	11	14	0	0	7	9
38	Sample 38	26	16	13	12	13	14	0	12	11	10
39	Sample 39	30	24	27.5	27.5	18	29.5	23	27	27.5	13
40	Sample 40	12	0	13	9	10	8	0	12	13	0
41	Sample 41	0	9	12	25.5	16	8	19	18.5	19.5	14
42	Sample 42	24	20	20	18	16	18	19	18	15	20
43	Sample 43	18	14	16	20	17	14	17	13	17	16
44	Sample 44	21	10	9	12	8	19	14	9	14	8
45	Sample	21	19	13	16	5	20	14.5	15	12	11

	45										
46	Sample 46	17	0	13	20	13	15.5	0	12	17	9
47	Sample 47	19	15	16	18	20	14	10	13	17.5	18
48	Sample 48	16	16.5	18	17	15	12	14	17	17	20
49	Sample 49	24	16	24	15.5	12	0	13	18	20	0
50	Sample 50	28	16.5	16	19	20	22	0	17	13	18
51	Sample 51	22.5	14	16	17	16	18	16.5	17	18	14
52	Sample 52	17	11.5	18	13	16	15	0	13	16	12.5
53	Sample 53	18	16	14	17	15	15	16	17	15.5	17
54	Sample 54	18.5	16.5	16	18	18	18.5	16.5	16	14	19
55	Sample 55	14	11	10	9.5	8	12	11	9	11.5	9.5
56	Sample 56	0	16	17	19	21	0	18	21	22	12
57	Sample 57	12	15	11	10	6	12	0	8	13	15
58	Sample58	25.5	18	14.5	18	20	22.5	19	17.5	16	19
59	Sample 59	20.5	26.5	19.5	20.5	17.5	20	19.5	21	20.5	17
60	Sample 60	23	11	0	14	20	20	17	18	13	19
61	Sample 61	16.5	16.5	18	20.5	19.5	0	18	18	22	21
62	Sample 62	13.5	16	19	16	16	13.5	14.5	17	22	18
63	Sample 63	6	7	4	12	8	0	0	5	8	12
64	Sample 64	17	17.5	15	20	17	17	21	16	21	19
65	Sample 65	21	5	9	10	7	19	4	14	10	10
66	Sample 66	18	9	9	8.5	13	21	9	12	10	13
67	Sample 67	23	14	14	21	8	16	12	23	16.5	19
68	Sample 68	14.5	21	18	6	0	5	28	15	12	18.5
69	Sample 69	22.5	19.5	15	14.5	16	19.5	17	21	27	8

70	Sample 70	10	12.5	16	4	11	13	19	15	15	17
71	Sample 71	20.5	5	0	11	11	17	18	16	20	21.5
72	Sample 72	27	13	14.5	11	18	16.5	12	12	10	0
73	Sample 73	16	13	8	15	18.5	18	14	16.5	12.5	19
74	Sample 74	12	14	21	25	15	13	11.5	14	9	18
75	Sample 75	16	14	12	18	20	16	16	14	21	18
76	Sample 76	22.5	19	15	19	15	10	8	16	0	20
77	Sample 77	13	17.5	17.5	14.5	18	13.5	16	10	0	0
78	Sample 78	19	16	13	17	16.5	10	17	14	18	19
79	Sample 79	5	11	15	12	13	8	6	10	16	11
80	Sample 80	18	13	16	19	14	22.5	19.5	16.5	16.5	21.5
81	Sample 81	26	22.5	13	17	0	18.5	17	18	10	22.5
82	Sample 82	15	16	16	18.5	23.5	22.5	13	16	16.5	20
83	Sample 83	0	19	14	16	0	10	15.5	16	19	17
84	Sample 84	18	23	16.5	23	14	15	118.5	11	15.5	20
85	Sample 85	16.5	14	13.5	10	18	12	16.5	19	17	17
86	Sample 86	21	17	17	0	22.5	19	13.5	21.5	16	18
87	Sample 87	17	0	18.5	19	15	18	16	10	14	12
88	Sample 88	16	17.5	19	16.5	18	17.5	17	18	16	0
89	Sample 89	19.5	21	18	24	16	18	18	17	15	21.5
90	Sample 90	21.5	19.5	23.5	22.5	18.5	16.5	17.5	21.5	22.5	18.5
91	Sample 91	6.5	13	18.5	14	17.5	22	19	0	15	18
92	Sample 92	18	15	15.5	18	22	17	17.5	10	18	15
93	Sample 93	23.5	10	9.5	15.5	25	22	18	19	12	16

94	Sample 94	12	11	22	19	18	12	0	19	19.5	19
95	Sample 95	18	14	8	17	14	16.5	17	19	18.5	16
96	Sample 96	15	20	13	22	18	17.5	18	16	18	18
97	Sample 97	10	17	28	16	18.5	19	15.5	19	17	10
98	Sample 98	15	13	26.5	15	17	16	19.5	18	16	17.5
99	Sample 99	16.5	14.5	22	17	18	18.5	18	15	14.5	17.5
100	Sample 100	14	18	15	0	21.5	12.5	22	17	14.5	16

Table 1: Ridge count of individuals

GRAPHICAL REPRESENTATION OF RIDGECOUNT OF FINGERPRINTS

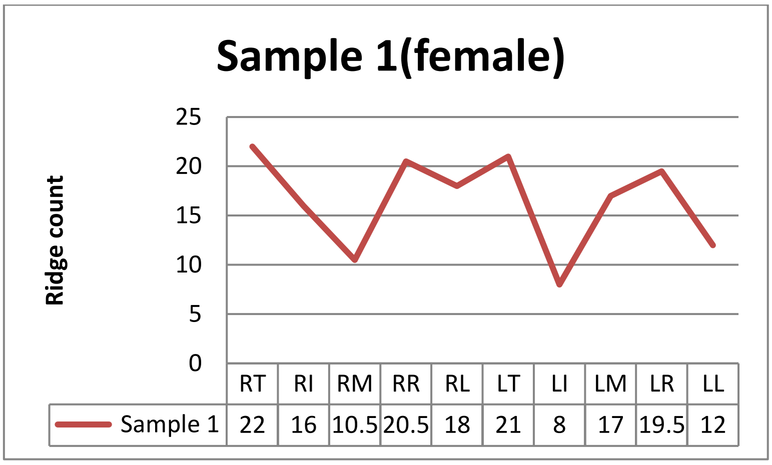

Fig1: Graph obtained for sample1

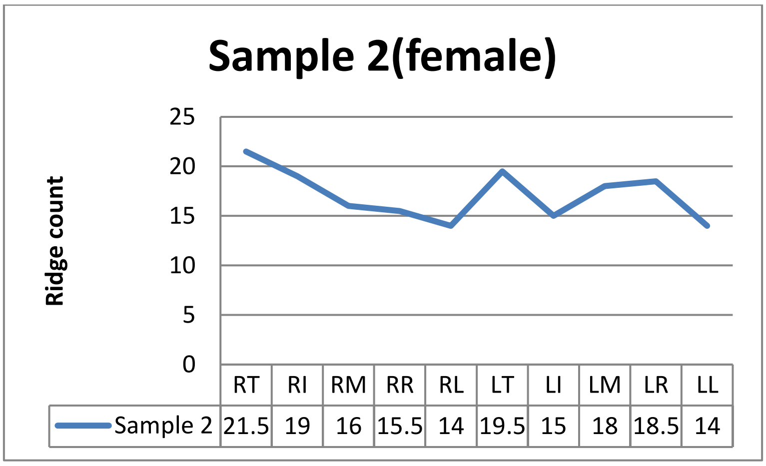

Fig1.1: Graph obtained for sample2

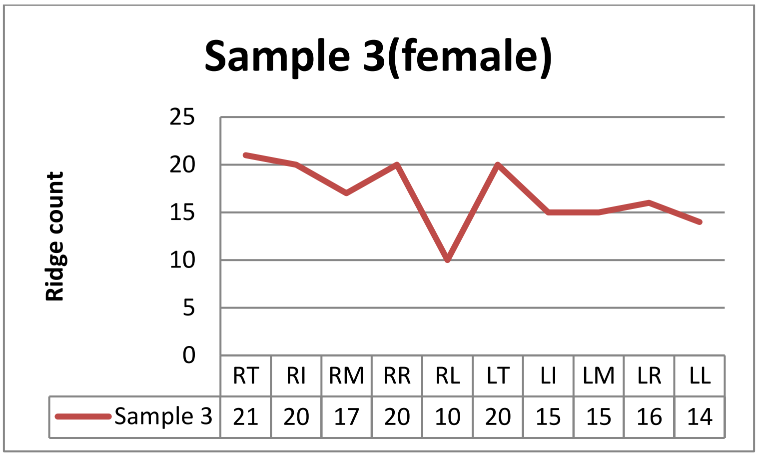

Fig1.2: Graph obtained for sample3

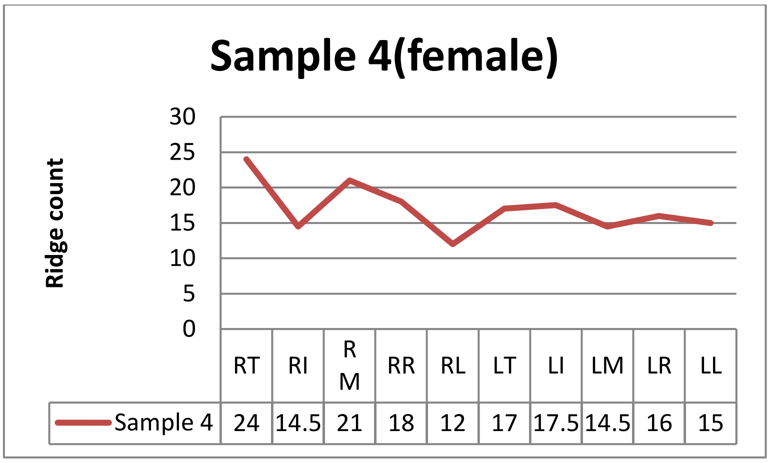

Fig1.4: Graph obtained for sample4

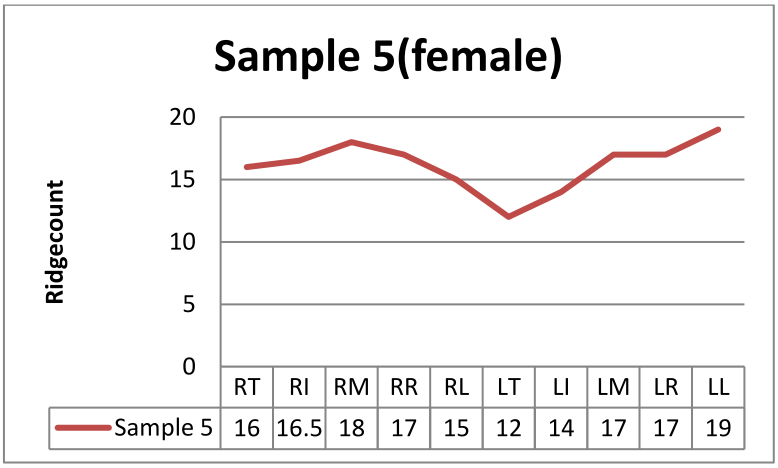

Fig1.5: Graph obtained for sample5

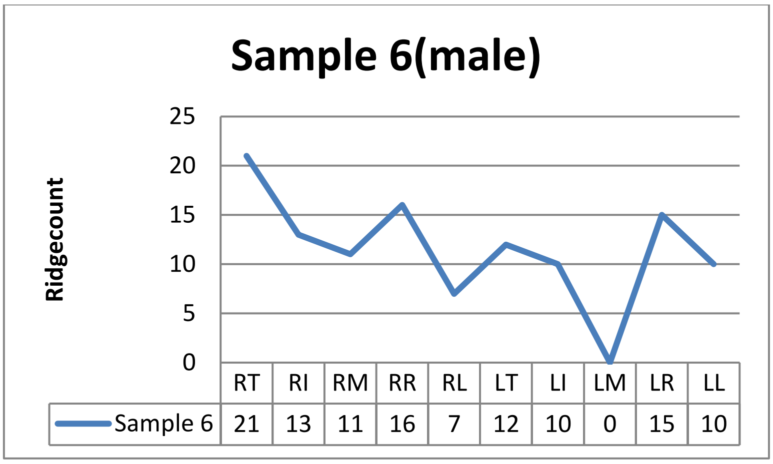

Fig1.6: Graph obtained for sample6

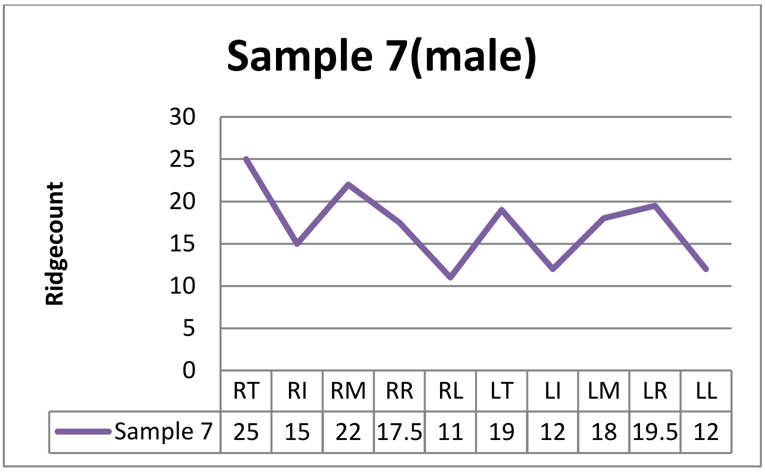

Fig1.7: Graph obtained for sample7

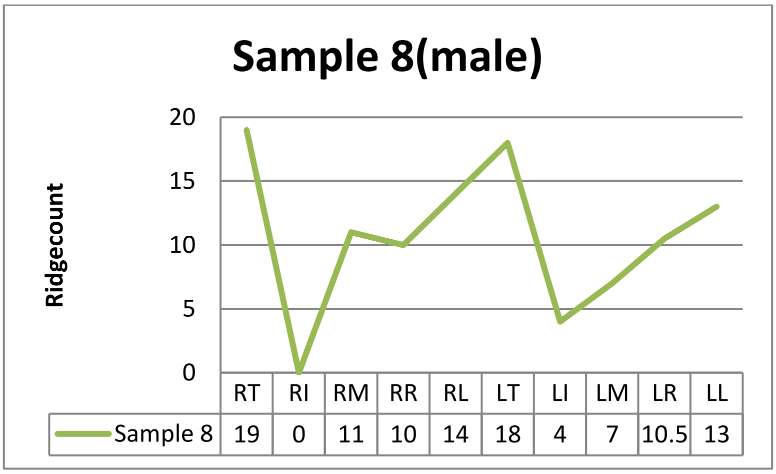

Fig1.8: Graph obtained for sample8

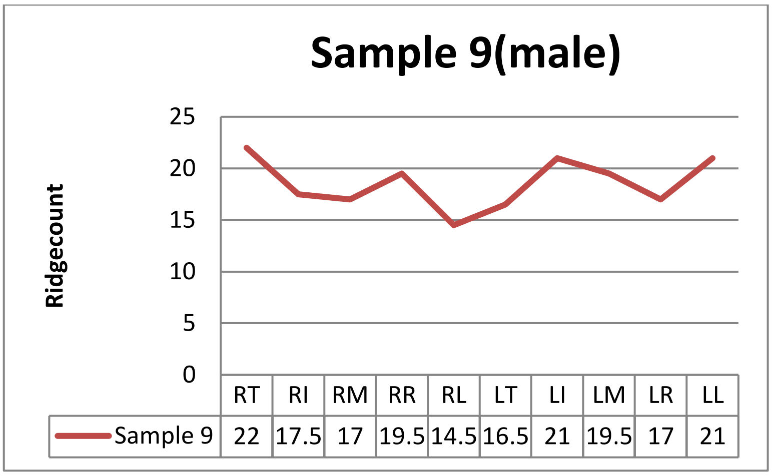

Fig1.9: Graph obtained for sample 9

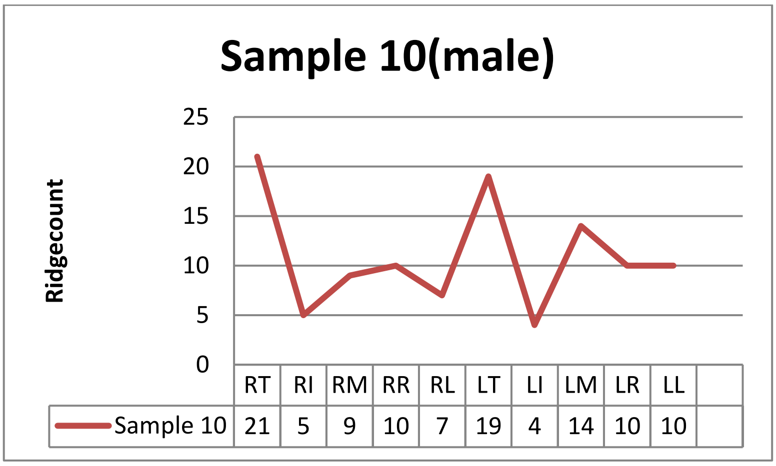

Fig1.10: Graph obtained for sample10

CHAPTER VI: RESULTS AND CONCLUSION

RESULTS

Different graphs are obtained for each individual. The graphs obtained for males and females varies among them.

CONCLUSION

The graphs for each individual are different from each other. But for individuals with arch pattern in all individual fingers will be getting a straight line along the X-axis. So, using these graphs which are based on ridge count for fingerprint matching is only limited to fingerprint pattern other than arch pattern. It can be concluded that, this method of using graphical representation of ridge count of fingerprints for fingerprint comparison is applicable to individuals who are not having arch patterns in all their fingers.

In future, this method of graphical representation using ridge count of fingerprints can be applied for ridge density in order to determine whether they can be used for fingerprint comparison and identification.

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