Determination of Sex from the latent palm prints present on documents

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Abstract

In field of forensic science, to determine the sex of suspect from latent prints found at crime scene is often suspicious. Identification of an individual's sex is being possible from the latent palm prints present on documents. To determine the sex from the latent palm print can be done with minutiae details of developed prints from the documents, which will be helping for the investigators in nabbing the suspects.

For this study, 60 samples including male and female from villages of Uttar Pradesh, India were taken for the determination of sex of an individual through the development of latent palm prints present on documents. The Obtained 12 parameters (radius of curvatures, Angle of curvature from line of writing, Inter distance between centre of curvatures, and Distance of centre of curvatures from line of writing), their mean values and standard deviations from this study not only gives the significant of sex at 95% confidence level of difference but also considered statistically significant ($p<0.05$). On behalf of which determination of sex can be done. It also can increase the evidential value of such lateral palm prints. These evidences can be helpful for reducing the pool of potential suspects in investigations, and also can be placed at par with the fingerprints in court of law on the top of all other scientific evidences.

Keywords: latent palm prints, determination of sex, Documents, Statistically significant,

Introduction

Patterns (Finger & Palm) which are genotypically determined (Dennis E.O. Eboh, 2014) and Being unique and permanent by nature, these are considered one of the best mean of absolute identification of an individual (S. Kumar Ajay, 2013). The palm prints which are highly Individualistic (Kaushal N., 2009) and encountered at crime scene and on questioned documents also. A few works has been carried out to determine the writer, but not to determination of gender of an individual. In forensic Science, to estimate the sex of suspect from latent palm prints is challenging (Barros M. Rodrigo, 2013) and no work has been carried out yet related to this. Identification of individual through palm prints is infallible (Kumar Lalit & et.al. 2013), and if the determination of gender could done from latent palm prints then it will be helping for forensic experts and Investigator's to nab a suspect (Agarwal Sandeep, 2013).

It must be remembered that while writing or preparing the works of art, etc. one cannot help touching or holding the surface, part of the hand (Palm and Finger) resting on the writing surface to give support and facilitating the movement of the hand. Since the finger/Palm has raised lines and furrows having sweat pores which keeps the ridges moist, and hence as it touches the writing surface, it is expected to leave their impression (prints) in latent form on the writing surface or papers. Especially when we signed, the lower part of the palm (Hypothenar area) comes in the contact of the surface. Since sweat is apparently a colorless fluid, the prints so left behind are not visible to the naked eye; the visibility of the prints (Kumar Shen & et al. 2002) are enhanced by various methods.

In this work, the inherent relation of the signatures with the lateral palm prints is leading the determination of sex of the suspect, and also increasing the reliability of questioned documents examination. By carefully examination of the developed palm prints and obtained parameters (Radius of curvature, Distance of curvature from line of writing, Angle of centre of curvature from line of writing, and inter-distance of curvatures) of minutiae details gives the statistically significant values ($P<0.05$). These results indicate that the determination of sex is possible (Chaudhary R. & et al. 2004).

Material and Methods

Samples

For this study, 60 samples including 30 male and 30 female were considered from the villages Ramala, Kirthal, Barout, Sarurpur, Kishanpur Baral, Baoli, Bijwara, of Districts Baghpat & Meerut of Uttar Pradesh, North part of India in March 2013. The selection of the subjects was done randomly. After taking the consent of subjects, the subjects were asked to put their signature on white paper sheet of good quality (bond paper) with ball pen. For the development of fresh latent prints, Black powder was used, which is usually considered best developer for fresh samples.

Methods

All the subjects were selected randomly, and the consent was taken. The primary information about the subjects such as Age, sex, Address, occupation and their educational qualification were noticed. The subjects were asked to sit on the chair at ease. After giving a blank white paper sheet and blue ball pen to the individuals, were asked to sit on chair and to put the paper on a table which was up to the height of elbow. The subjects were spoke to put their signatures on the sheet at calm and congenial atmosphere (Chaudhary R & at al, 2004).

When the individual was asked to stop to writing, according to the "Mutual Exchange principle" (B.R. Sharma, 1984) the print in latent form was also transferred on papers and below to the signature. By carefully handling, the sheets were put at the room temperature for 5-6 hours.

Development of latent Prints:

Black Powder

The powder, which reacts with the lipid materials present in the prints (finger and palm) residue and enhance the visibility of latent prints. All the samples were put at room temperature for 6 hours. All the samples containing sheets were treated with Black Powder, which is considered the best developer for fresh Samples on papers. It was seen that latent prints were successfully developed on all the sheets. The developed prints shown in figure (1-4) were clear and having enough information about the identification of an individual.

Figure, (1-2) developed prints by Black powder

Statistical Analysis

The purpose of the study is to determine the sex of an individual from the obtained aggregate information of developed palm prints (Ashbaugh D. 1999). Firstly, we have to allocate three centers of curvatures in the developed palm prints and to correlate them with the line of writing, where signatures were put on. It is expected that the latent image of palm prints (Jain A. 1999) will come below that signature or in the line of writing.

For the centre of curvatures, First of all two tangentional lines (Keegan J.F. 1977) were drawn, where the lines intersects each other in developed print from that point a corresponding line is also drown. Now from the corresponding line up to the deepest point A, it will be the radius of centre of curvatures A. Thus all three centers (A, B, C) and the radius of respective centers were allocated. Now a straight line along with the signature (baseline) was drawn, which will correlate the palm prints with the signatures. For all of three centers A, B, C and their radius, r_a, r_b, r_c, were measured, the angle of the centre of curvature from the line of writing θ_a, θ_b, and θ_c were taken. The inter-distance of three centers AB, BC, CA was measured, and the normal distance from the line of writing of the centers of curvatures la, lb, lc was determined (Chaudhary, R. & et al. 2004). The correlation of these points (Wu Xiagqian & et al. 2003) with respect of writing's line is cumulative and was measurable. It was seen that all the parameters for each individual were unique. The position of latent palm print was below the signature. It is considered that all the obtained parameter's details Ra, Rb, Rc (radius of curvatures), La, Lb, Lc (Normal distance of centre of curvature from line of writings) and θa, θb, θc (angle of centre of curvature from line of writing)& AB, BC, CA (Inter-distance between centre of curvatures) were having enough information for the determination of sex of an individual.

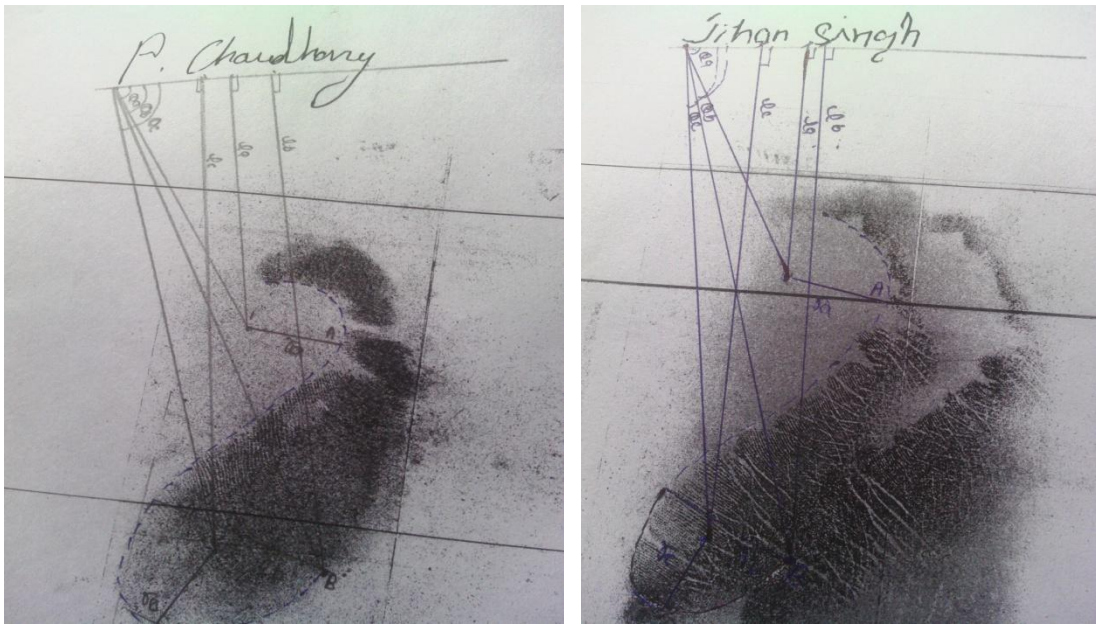


Figure (3-4) of the analysis palm prints.

Result and Discussion:

Parameters for male Subjects

Subject	Radius of Curvature(Cm.)			Normal distance of curvature from Line of Writing (cm.)			Angle of centre of curvature from line of writing			Inter-distance of centre of curvature (cm.)		
	R_a	r_b	r_c	la	lb	lc	θ_a	θ_b	θ_c	AB	BC	CA
M	1.2	2.4	1.5	4.7	8.5	8.0	75	76	87	3.8	1.4	4.3
M	1.5	3.0	1.6	5.5	7.2	8.1	76	85	92	4.3	2.5	4.0
M	3.0	3.8	2.0	6.6	10.6	11.0	80	75	83	5.0	2.2	4.4
M	2.5	2.6	1.4	8.1	13.0	12.5	73	77	80	5.1	1.9	5.4
M	1.3	2.7	1.6	7.4	11.3	11.0	80	82	95	4.0	1.8	4.2
M	1.7	2.6	1.6	6.6	10.5	10.2	68	72	75	4.3	1.6	3.7
M	2.1	3.1	2.0	6.7	10.6	10.7	75	69	77	4.7	2.0	4.2
M	2.0	2.8	1.5	7.2	11.5	11.2	85	86	89	4.8	1.9	3.9
M	1.8	3.2	1.7	7.0	11.3	11.0	82	84	88	4.2	1.8	3.7
M	2.2	3.3	1.5	5.6	9.9	9.6	75	73	90	4.5	2.0	4.7
M	1.9	2.8	1.7	5.3	9.5	9.6	70	74	78	4.6	1.9	4.3
M	2.2	3.5	1.9	5.1	10.0	10.4	72	71	85	4.1	2.5	3.9
M	1.6	3.0	1.8	5.4	9.2	9.4	74	72	83	4.4	2.0	3.8
M	1.7	3.6	1.8	6.0	11.2	10.6	71	76	85	5.3	2.1	4.6
M	1.5	3.4	1.4	5.5	10.3	9.8	70	80	88	4.9	1.9	4.5
M	2.2	3.3	1.7	5.8	10.9	10.3	75	89	91	5.0	1.7	4.6
M	2.0	2.4	1.6	5.8	13.1	11.0	83	86	93	5.1	1.9	5.6
M	1.5	3.2	1.6	6.8	11.8	11.0	78	83	91	5.0	1.8	4.7
M	1.6	3.8	2.0	6.0	11.2	10.8	66	73	80	5.3	1.8	5.3
M	1.5	3.1	2.0	3.7	7.6	7.2	64	68	64	4.7	1.5	3.6
M	2.2	2.9	2.0	5.4	10.8	10.3	78	79	87	5.4	1.9	4.8
M	1.8	3.1	1.9	5.9	10.3	10.1	78	83	96	3.7	2.3	5.3
M	2	3.4	1.8	6.5	11.2	10.7	70	75	82	5.1	1.7	4.6
M	2.3	3.2	1.9	6.2	10.8	10.4	67	73	87	4.8	2.4	4.3
M	2.1	3.1	2	5.9	10.5	10.7	67	70	89	5	1.7	4.8
M	1.8	3.5	1.9	6	10.5	9.9	68	65	90	5.1	2.1	4
M	1.6	3.2	1.9	5.9	10.5	10.1	70	72	77	5	1.7	4.7
M	1.1	2.7	1.7	4.5	11.9	11.1	70	84	89	5.2	1.6	5.2
M	2	2.9	1.9	6.7	12	10.8	66	86	90	5.7	2.2	5.4
M	2.1	2.5	1.6	7	13.7	11.1	80	79	86	4.7	1.8	4.1
Mean	1.86	3.07	1.68	6.02	10.70	10.28	73.6	77.23	85.23	4.76	1.93	4.57
S.D.	.39	.38	.19	.91	1.42	1.05	5.82	6.37	6.85	.48	.27	.77

Parameters for female Subjects

Subject	Radius of Curvature (cm.)			Normal distance of curvature from Line of Writing (cm.)			Angle of centre of curvature from line of writing			Inter-distance of centre of curvature (cm.)		
	R_a	R_b	R_c	la	lb	lc	θ_a	θ_b	θ_c	AB	BC	CA
Fe	2.0	3.6	2.7	3.7	8.8	9.0	60	62	70	6.2	2.2	4.6
Fe	2.1	3.2	2.4	3.0	7.2	7.5	50	55	68	5.0	1.6	4.1
Fe	2.0	4.1	1.9	4.8	9.7	9.2	69	84	91	4.2	1.8	4.8
Fe	2.0	2.9	1.8	5.9	9.7	9.9	81	74	84	4.5	2.3	3.7
Fe	1.8	2.8	1.6	5.7	10.0	10.2	86	80	90	4.5	1.7	4.4
Fe	1.6	3.0	2.3	6.0	10.3	10.1	75	70	78	4.7	1.9	4.0
Fe	2.0	2.7	1.6	6.0	10.1	10.0	68	72	78	4.7	1.8	4.2
Fe	1.8	3.4	1.8	5.5	10.3	9.6	77	69	86	3.9	1.7	4.1
Fe	1.2	3.0	1.6	4.4	7.8	8.2	45	50	58	4.4	1.6	3.5
Fe	2.0	2.8	1.7	5.2	9.3	9.4	65	62	70	5.1	1.8	4.3
Fe	1.7	2.8	1.7	4.8	8.6	8.3	60	62	68	4.4	1.5	3.9
Fe	1.9	2.6	2.0	7.1	13.8	11.3	95	90	93	5.0	1.4	4.4
Fe	2.1	3.4	1.8	6.1	7.9	10.0	78	86	93	4.7	2.0	4.1
Fe	1.1	3.0	1.5	4.3	8.4	8.0	52	59	65	4.7	1.8	4.0
Fe	1.3	3.3	2.1	4.6	9.7	8.3	65	60	70	5.6	1.9	4.4
Fe	1.4	2.6	1.9	5.1	8.3	8.5	62	67	79	4.9	2.3	4.2
Fe	1.6	2.7	1.6	4.6	8.3	8.4	60	62	70	4.4	2.0	3.8
Fe	1.3	3.2	2.0	5.3	9.8	10.2	60	65	75	5.0	1.8	4.7
Fe	1.0	2.8	1.9	5.5	9.1	8.9	83	75	90	3.9	1.9	3.7
Fe	1.3	1.8	1	4.8	8.1	8.2	72	74	79	3.5	1.4	3.4
Fe	1.6	1.9	1.3	4.2	7.4	7	76	72	79	3.6	1.1	3
Fe	1.9	3.1	1.8	5.2	9.8	9.1	67	79	88	5,3	1.7	4.7
Fe	1.6	2.2	1.3	4.6	8	7.7	68	70	75	4	1.3	3.3
Fe	1.5	2.8	1.6	5.2	9.1	9	68	70	78	4.3	1.6	3.6
Fe	1.3	3.6	2.7	6.8	11.4	10.7	83	80	91	5.2	2.1	4.2
Fe	1.2	3	2	6.5	12.6	12	66	80	86	6.1	1.6	4.9
Fe	1.8	3.1	1.9	5.9	10.3	10.1	78	83	91	3.7	2.1	4.6
Fe	2	3	1.8	6.5	11.2	10.7	70	75	82	5.1	1.7	4.6
Fe	1.1	4.3	1.8	8	11	12.3	105	110	102	4.8	1.6	4.3
Fe	1.8	2.7	3.1	6.7	11.9	12.8	75	80	87	5.5	2.1	4.8
Mean	1.63	2.94	1.87	5.4	9.59	9.48	67.73	72.25	80.46	4.69	1.76	4.14
S.D.	.34	.53	.43	1.06	1.55	1.42	12.75	11.93	10.24	0.67	.26	.48

Parameters Details	Characteristics	S.D.		P-Value	S.E.
		Male	female		
Radius of Curvature	R_a	.39	.34	**.0180**	.094
	R_b	.38	.53	.2794	.199
	R_c	.19	.43	**.0308**	.086
Normal distnace of curvature from line of writing	l_a	.91	1.06	**.0182**	.255
	l_b	1.42	1.55	**.0054**	.384
	l_c	1.05	1.42	**.0160**	.322
Angle of centre of curvature from line of writing	θ_a	5.82	12.75	**.0254**	2.599
	θ_b	6.37	11.93	**.048**	2.469
	θ_c	6.85	10.24	**.0382**	2.249
Inter distance of centre of Curvature	**AB**	.48	.67	**.0101**	.50
	BC	.27	.26	**.0159**	.068
	CA	.77	.48	**.0119**	.166

The identification of individual (Kaur Ms. Ritu & et. Al., 2012) with absolute certainty has become a necessity. Palm prints, undoubtedly are most reliable and accepted evidence in court of law. The present work was carried out to determine the sex (Badawi Ahmed &et. al., 2007) of an individual from latent palm prints on documents. It's very rare that the latent palm prints are not occurring on documents and very hard to believe that when we are writing, our hand/part of or palm do not rest on paper. No occurrence of latent prints on papers can be because of wearing gloves in hands. Once the signatures or any material have written on a document, then along with the writing the individual also left their identity in form of latent palm print. The results of this study conclusively differentiate the gender. By studying the developed palm prints shown in (figure 5-8) and their inherent relation with the signatures are leading to determination of the sex of suspect (Alston J & et al. 1987).

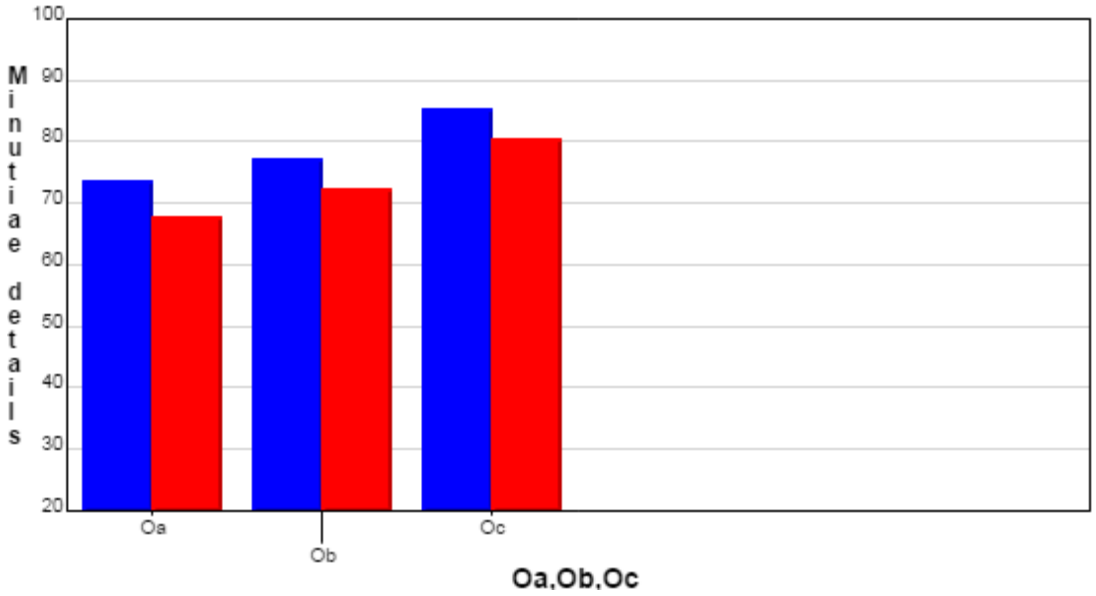
After application of T-test, during the observation of parameters of minutiae details, it is noted that the variation in the parameters of both (Male & Female) are clear. If the suspect is male, then the angle of centre of curvature from line of writing (θ_a, θ_b, θ_c), are higher than female parameters which lies up to ($\pm 6^0$). After the application of t- test the obtained Standard deviation for angle of centre of curvature from line of writing (θ_a) is (male 5.82, female 12.75) gives P- Value (0.0254), which is statistically significant ($P<0.05$). The standard error is (2.599). For θ_b the S.D. (male 6.37, female 11.93) gives P-Value (0.048), which is considered statistically significant ($P<0.05$). The standard error is (2.469), And for θ_c the S.D. (Male 6.85, Female 10.24) and the P- Value is (0.0382) which indicates the significance ($P<0.05$).The standard error is (2.249). In observation of male, the radius of curvature r_a, r_b, & r_c are too higher than the comparison of female. The observations of radius of Curvature Ra, standard deviation (Male 0.39,

female 0.34) and the P- Value (0.0180), which is statistically significant that (P<0.05). The standard error is (0.094). For observation standard deviation of Rb (male 0.38, female0.53) and the P-Value (0.2794), which is not statistically significant (P>0.05) and standard error is (0.199) In observation of Rc (Male0.19, female 0.43) & the P-Value (0.0308), which is statistically significant (P<0.05). The standard error is (0.086)

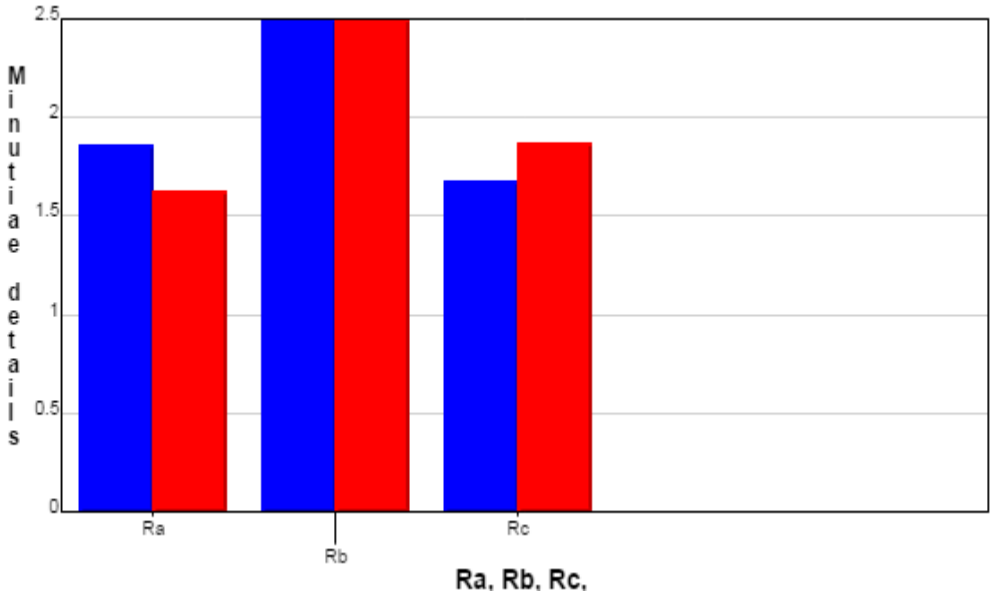
Now, in the normal distance of centre of curvature (l_a , $l_{b,}$ $l_{c,}$), the observations of male suspects also differ from the female. For Normal distance of curvature from line of writing (la), the standard deviation (Male 0.91, female 1.06) and the P-Value is (0.0182), which is statistically significant (P<0.05) and standard error is (0.255). Now for lb the S.D. (Male 1.42, Female 1.55) and the P-Value are (0.0045), which is considered statistically significant (P<0.05) and standard error is (0.384). For the lc, the S.D. (Male 1.05, female 1.42) and the P- Value is (0.0160), which is significant (P<0.05). The standard error is (0.322)

In parameters of inter distance between centre of curvatures AB, BC & CA that it also gives the significant difference between the genders. Now for the inter distance of centre of curvatures (AB), the standard deviation (Male 0.48, female 0.67) and the P-Value (0.0101), which is considered statistically significant (P<0.05) and S.E. is (0.50). At centre of curvatures the inter distance (BC), the standard deviation (male 0.27, female 0.26) and the p-Value is (0.0159), which indicates the statistically significant (P<0.05) and S.E. is (0.068). And for the CA the standard deviation (Male 0.77, female 0.48) and the P- Value is (0.0119), which is considered strongly significant (P<0.05). The Standard error is (0.166).

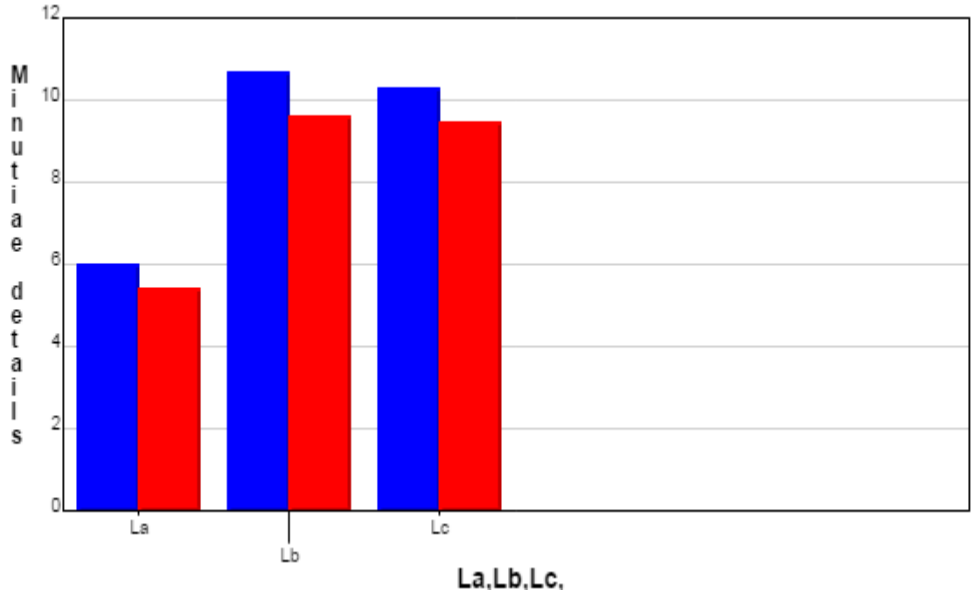
These variations in the minutiae details between male and female are the significant of sexing (Gutierrez-redomero Esperanza & et al. 2011), which in term allows the conclusive determination of sex of an individual. The graph between the details of male and female sex determination significantly shows variations-



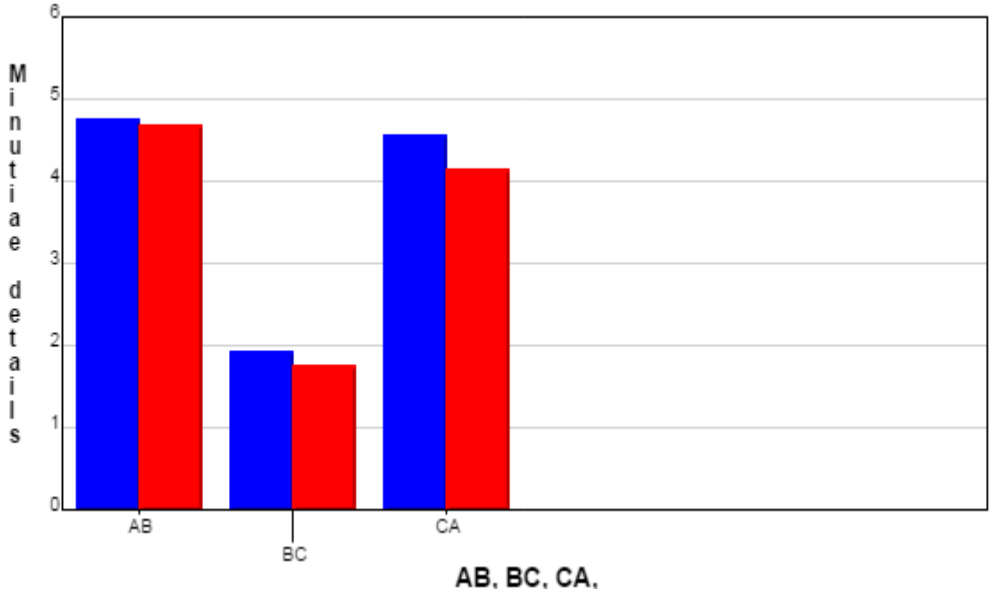
Graph 1.is showing the difference between male and female on basis of angle



Graph 2. Is showing the difference between male and female in radius of curvature



Graph 3. Is showing the normal distance of curvature's difference between male & female



Graph 4. Is showing the difference in Inter-distances of centre of curvatures.

In the given graph (1,2,3,4) the difference between genders can be easily seen. The error in the measured distance is within the limits of (±0.2cm), and in the angles it is up to the limits of ($\pm 2^0$) which can be attributed to the instrumental error/constant error and are due to natural variation.

Determination of sex also provides an important clue about the suspect during investigation, which decrease the decision time and its identical role. From the results of the study it is seen, that it can be utilized in order to minimize suspects list by getting similar values for suspects sex.

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References

1. A. Jain, R. Bolle, S. Pankanti (1999); Biometrics: Personal Identification in Networked Society. Kluwer Academic Publishers.
2. Alston, J., Taylor, J.(1987); Handwriting theory, Research and pratice, Beckenhan, Kent, pp, 80-93.
3. B. R. Sharma (1984); Bank fraud prevention and detection, Surmeroo pub., Chandigarh, pp. 50-84.
4. Badawi Ahmed , Mahfouz Mohamed, Tadross Rimon, Jantz Richard (2007-2013.);fingerprint based gender classification, The Pennsylvania State University,
5. Barros, M. Rodrigo, Faria E. F. Bruna, Kuckelhaus A. S. Selma ; Morphometry of latent palmprints as function of time, forensic science international accepted in 2013.
6. Cummins H., Midlo C. (1943) ; Finger Prints, Palms and Soles. An introduction to Dermatoglyphics. The Blankson Company, Philadephia. p. 9.
7. D. Ashbaugh (1999); Quantitative-qualitative friction ridge analysis: An introduction to basic and advanced ridgeology. CRC Press,
8. Eboh Dennis E.O. (2013);Fingerprint patterns in relation to gender and blood group among students of delta state University, Abraka, Nigeria, Journal of experimental and clinical Anatomy , Vol. 12 (2), pp. 82-86.
9. Gutierrez-Redomero Esperanza, Alonso-Rodriguez Concepcion, Hernandez-hurtado Luis E., Rodriguez-Villalba Jose L. (2011) ; Distribution of minutiae in the fingerprints of a sample of the Spanish population. Forensic Science international 208, pp. 79-90.
10. J. F. Keegan (1977), How can you tell if two line drawings are the same, Comput. Graph. Image Process. Vol. 6 . Pp. 90–92.
11. Kaur Ms. Ritu, Mazumdar Ghosh Mrs. Susmita, Bhonsle Mr. Devanand (2012); A study on various methods of gender identification based on fingerprints, International journal of emerging technology and advanced Engineering, Vol. 2(4).
12. K.G. Asano, K.C. Bayne, M.K. Horsman, V.M. Buchanan (2002) ;Chemical composition of fingerprints for gender determination, Journal of Forensic Sciences, Vol. 47(4), pp. 805-807.
13. Kaushal, N., (2009) ; Fingerprints historical background and future trends. The Internet journal of Forensic Science, Vol. 4(2).

14. Kumar Lalit, Agarwal Sandeep, Garg Rajesh, Pratap Amit, Mishra V.K. (2013); Gender determination using fingerprints in region of Uttarakhand, Journal of Indian Academy forensic Medicine, Vol. 35 (4).
15. M.A. Acree (1999); Is there a gender difference in fingerprint ridge density? Forensic Science International, .Vol 102, pp. 35-44.
16. Nayak V.C., Rastogi P., Kanchan T., Yoganarasimha K., Kumar G.P., (2010); Sex differences from finger print ridge density in Chinese and Malaysian populations. Forensic Science International, Vol. 197, pp. 67-69.
17. Prateek R., Keerthi R.P. (2010); A study of fingerprints in relation to gender and blood group. Journal of Indian Academy of Forensic Medicine,Vol. 32 (1), pp. 11-4.
18. Ramesh Chaudhary , Sarat Kumar pant (2004); Identification of authorship using lateral palm print –a new concept., Forensic Science international, 141, pp 49-57.
19. S. Ajay Kumar (2013) ; determination of sex from fingerprint ridge density among south Indian population-A one year cross sectional study, KLE University, Belgaum, Karnataka.
20. Singh, Dr. Gagandeep (2012); Determination of Gender differences from Finger prints Ridge density in two Northern Indian population of Chandigarh Region, Journal of Forensic research,
21. Tsuchihashi Y.; Studies on personal identification by means of lip prints. Forensic Science , 1974(3), pp. 233-48.
22. Vahanwala S. (2005) ; Study of lip-prints as an aid for sex determination. Med Leg Update,(5), pp. 93-98.
23. Xiagqian Wu, David Zhang, Kuanquan Wang (2003); Fisherpalms based palmprint recognition. Elsevier pattern recognition letters. Vol 24 pp. 2829-2838.
24. http://easycalculation.com/statistics/standard-deviation.php, for standard deviation, on 18/08/2014, 3:40pm.