Analysis of the Color Contrast Between Ridges and Furrows of Latent Fingermarks Within a Small Population

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Introduction

Establishing a method for age determination will be important to general processes involving fingermarks. This correlates into assisting in analyzing prints within a population. Previous research has explored possible ways of estimating time of deposition of latent fingermarks. This project focused on differences in fingermark color contrast within a population of donors. This research will be the foundation to standardizing a technique that will strengthen fingermark identifications in the near future.

The aims of this research:

- Test the reliability of color contrast (between ridges and furrows) examination as a technique for detecting sensitivities of conditions within a population of donors
- Detect differences in color contrast between sexes (male/female)
- Investigate the effect of powder used (white/black) for visualization and substrate type (plastic/tile) on latent fingermark color contrast
- Investigate the effect of the generation (first/second impression) and type of deposition (flat/rolled) on inked print color contrast
- Validate previous studies conducted on the effects of environmental conditions such as substrate type and light level

Materials and Methods

- The original 240 JPEG images were obtained from a library of prints, coded and randomized to prevent bias during data collection on color contrast.
- Color contrast values depicted in the histogram are shown from brightness levels 0-255, 0 being pure black and 255 being pure white. The y-axis represents the frequency of pixels within the selected tonal range.

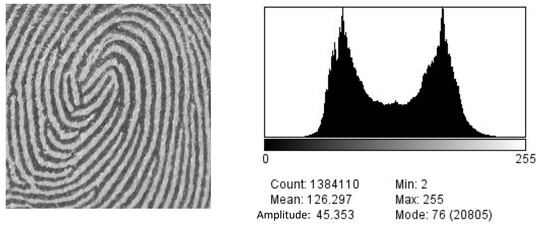


Fig. 1: Example of an edited image fingermark paired with its histogram taken from ImageJ

- These images were modified to greyscale, converted to 3000 pixels per inch and resized to 1 cm x 1 cm. The scale label in the image was standardized to a value of 180 by adjusting the midtone of the image using the Levels function in Adobe® Photoshop®.
- The mean intensity, intensity amplitude (range of colors) and other histogram data was recorded for each image using Adobe® Photoshop® and ImageJ and transferred into Microsoft Excel and IBM® SPSS® Statistics for statistical analyses.
- A total of three replicates were performed along with a validation protocol titled “Old Run”.

Table 1: Experimental variables

					Latent				Inked			
Subject		Finger			Powder		Substrate		Deposition		Generation	
Male	Female	Index	Middle	Ring	White	Black	Plastic	Tile	Flat	Rolled	First	Second

Results and Discussion

Statistical analyses were run on the data using IBM® SPSS® Statistics and the following tests were performed: One-Way and Two-Way ANOVA, T-Test for Equality of Means and Kruskal-Wallis H tests. The results are found in Tables 2 and 3.

The technique of color contrast examination was found to be reproducible both within and between investigators as well as over different conditions. There was no significant difference between sexes; however, a significance was detected between powder type as well as between substrates. This can be attributed to the nature of the black and white powders in that they are opposite colors. The difference between substrate may be caused by an interaction between the print and the substrate. No significant difference was detected between deposition types. This can be due to the technique not being sensitive enough to distinguish differences between flat or rolled prints. A significant difference was detected between generation as the first impression after inking is darker than a second impression without re-inking. This results in a noticeable decrease in contrast.

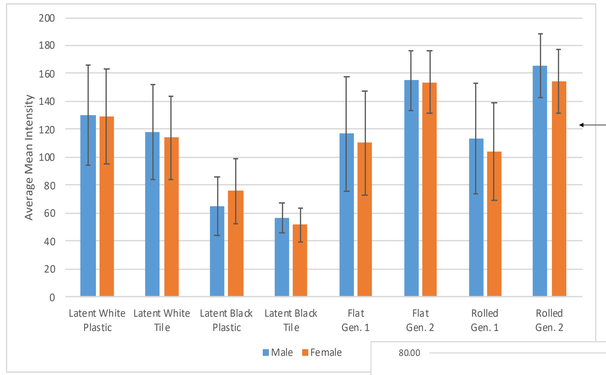
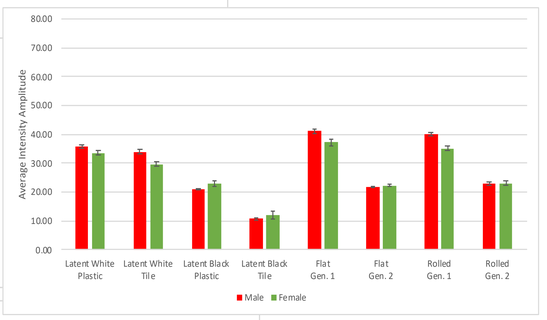


Fig. 2: A graph depicting the relationship of mean intensity between sexes and different conditions. Sample size is 5 males, 5 females. Each replicate was 240 prints, for a total of 720 prints.

Fig. 3: A graph depicting the relationship of intensity amplitude between sexes and different conditions. Sample size is 5 males, 5 females. Each replicate was 240 prints, for a total of 720 prints.



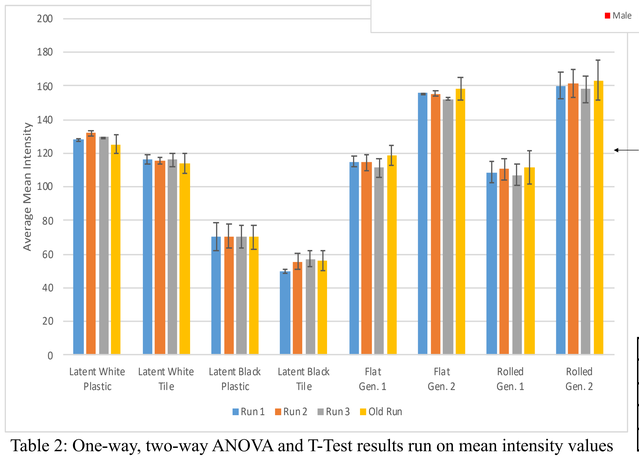


Fig. 4: A graph depicting the reproducibility of this technique. *The Old Run was performed by an investigator at a previous institution.

KEY	
PW – Latent White/Plastic	F1 – Flat/Gen. 1
PB – Latent Black/Plastic	F2 – Flat/Gen. 2
TW – Latent White/Tile	R1 – Rolled/Gen. 1
TB – Latent Black/Tile	R2 – Rolled/Gen. 2

Table 2: One-way, two-way ANOVA and T-Test results run on mean intensity values

Conditions	Tile	White	Rolled	Gen. 2	Conditions	Substrate	Powder	Interaction	Conditions	Deposition	Generation	Interaction
Plastic	0.005	--	--	--	PW	0.000	0.000	0.510	F1	0.985	0.000	0.002
Black	--	0.000*	--	--	PB				F2			
Flat	--	--	0.994*	--	TW				R1			
Gen. 1	--	--	--	0.000	TB				R2			

*T-Test for Equality of Means

Table 3: Kruskal-Wallis H test results run on intensity amplitude values

Conditions	Mean Rank	Kruskal-Wallis H	P-value	Conditions	Mean Rank	Kruskal-Wallis H	P-value
PW	57.55	43.067	0.000	F1	59.58	53.905	0.000
PB	23.45			F2	21.43		
TW	60.50	59.26	0.000	R1	60.15	57.203	0.000
TB	20.50			R2	20.85		
PB	58.33	47.071	0.000	F1	43.83	1.638	0.201
TB	22.68			R1	37.18		
PW	45.75	4.083	0.043	F2	38.40	0.653	0.419
TW	35.25			R2	42.60		
PW	122.80	115.421	0.000	F1	122.65	111.656	0.000
PB	66.58			F2	40.58		
TW	109.95			R1	115.58		
TB	22.68			R2	43.20		

Conclusions

- No significant difference within or between sexes was found.
- This technique of analyzing color contrast is insensitive to method of deposition.
- This technique is sensitive enough to detect differences between generation.
- This technique is reproducible both between and within investigators across different conditions.

Future Work

This research will be continued as part of a senior capstone project. The results will be used in conjunction to test a method for age determination of latent fingermarks.

References

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