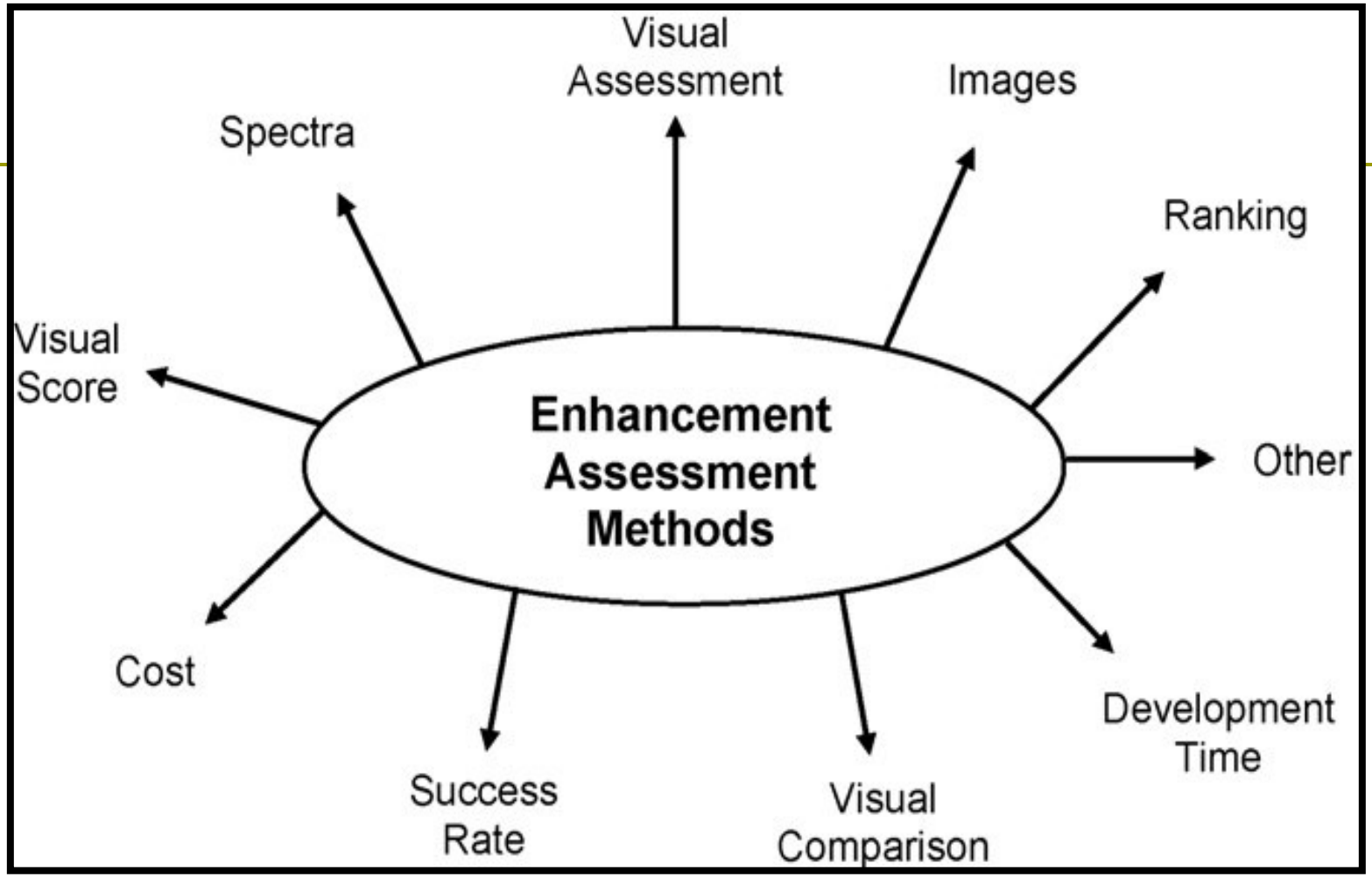
The investigation of a relative contrast index model for fingerprint quantification

การตรวจสอบโดยรูปแบบดัชนีเปรียบเทียบความคมชัดสำหรับการระบุปริมาณลายนิ้วมือ

By

YUWARESS SAIKAEW

Introduction



วิธีการต่าง ๆในปัจจุบันที่ช่วยเพิ่มรูปร่างลักษณะของลายนิ้วมือ

Results from literature survey regarding methods of articulating fingermark enhancement results.

	Enhancement research	Fingermark image\s	Visual assessment	Visual comparison	Visual score assigned	Side-by-side comparison	Development time	Production cost	Number of marks developed	Quantification attempted	Type of quantification
Reagent	[2]	0	U	●							
	[3]	5	U	●			●				
	[4]	2	U	●	●	●	●		●		
	[5]	3	U	●						●	Spectra
	[6]	5	U	●		●				●	Spectra
	[7]	6	U	●		●		●		●	Spectra, amino acid test
	[8]	0	U	●						●	Spectra, NMR spectra
	[9]	0	U						●	●	Spectra, fluorescence intensity
	[10]	12	U	●		●				●	Spectrum
	[11]	13	U	●		●				●	Amino acid test
	[12]	0	U		●						
	[13]	6	U	●	●						
	[14]	12	U	●	●	●					
	[15]	25	NC	●		●		●	●		
MD	[16]	9	U	●		●	●	●			
	[17]	5	U							●	Deposition (ICP-MS)
	[18]	22	U	●							
	[19]	7	U							●	Deposition (Densitometry & ICP-MS)
	[20]	15	U	●		●					
	[21]	12	U	●		●	●	●			
Powder	[22]	11	U	●		●				●	Spectra
	[23]	3	U	●						●	Weight and volume percent
	[24]	16	U	●						●	Spectra
	[25]	8	NC	●		●				●	Spectra, fluorescence intensity, lifetime
	[26]	17	U	●							

	Enhancement research	Fingermark image\s	Visual assessment	Visual comparison	Visual score assigned	Side-by-side comparison	Development time	Production cost	Number of marks developed	Quantification attempted	Type of quantification
Blood	[27]	8	D	●		●				●	Minutiae counted
	[28]	5	D	●	●	●	●	●	●	●	% Success rate
	[29]	6	U	●	●	●					
	[30]	0	U	●		●					
	[31]	22	U	●		●		●		●	Spectra
Other	[32]	2	U								
	[33]	2	U		●					●	Cyanoacrylate deposition
	[34]	6	U							●	Spectra
	[35]	0	U								
	[36]	16	U								
	[37]	8	U						●	●	Spectra
	[38]	5	NC	●							
	[39]	4	NC		●		●				
	[40]	10	U								
	[41]	34	U	●		●					
	[42]	3	U	●						●	Sputter time, spectra, surface analysis
	[43]	2	D								
	[44]	18	U	●		●					
	[45]	21	D	●		●			●	●	pH testing, Ca spectra, % success rate
	[46]	16	NC								

Visual assessment key, D = Defined, U = Undefined, NC = Not clear.

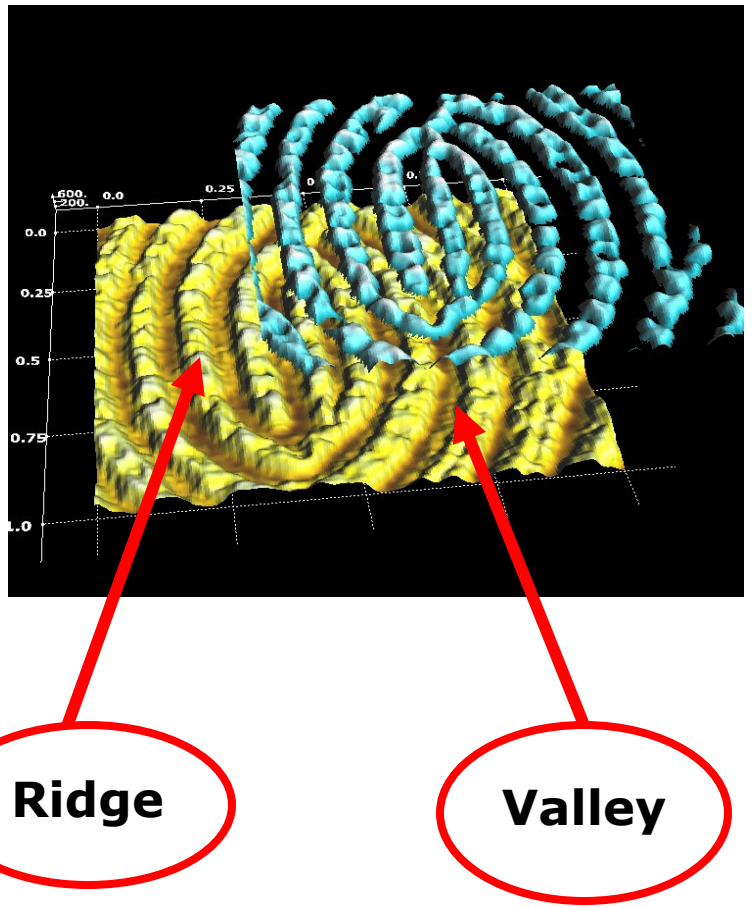
Fingerprint

น้ำ 98.5%

สารประกอบต่าง ๆ 1.5%

สารประกอบอินทรีย์ 1%

สารประกอบอนินทรีย์ 0.5%



Relative contrast index model (RCI)

Relative contrast index = log10 $\frac{\text{Valley intensity}}{\text{Ridge intensity}}$

- Difference in contrast between fingerprint ridges and valleys
- The same specimen when using different instruments
- These values are consistent ?

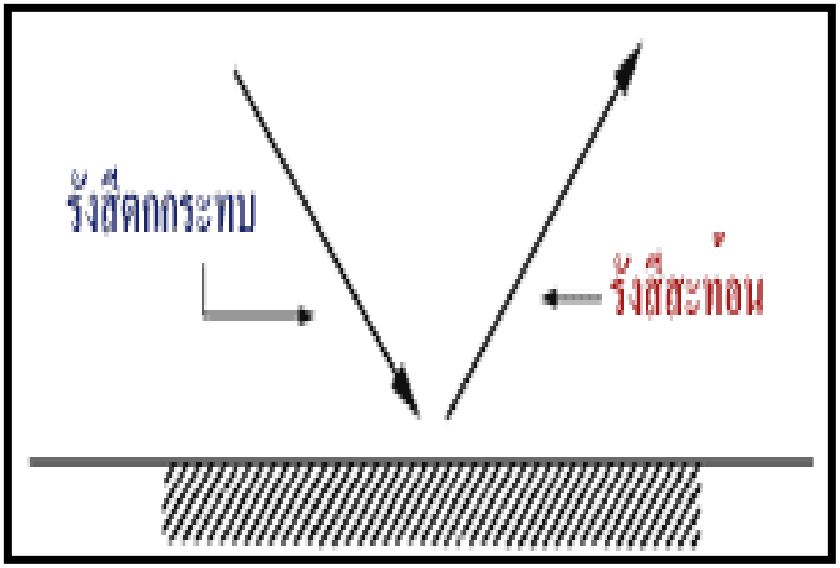
Materials and methods

Measurement mode

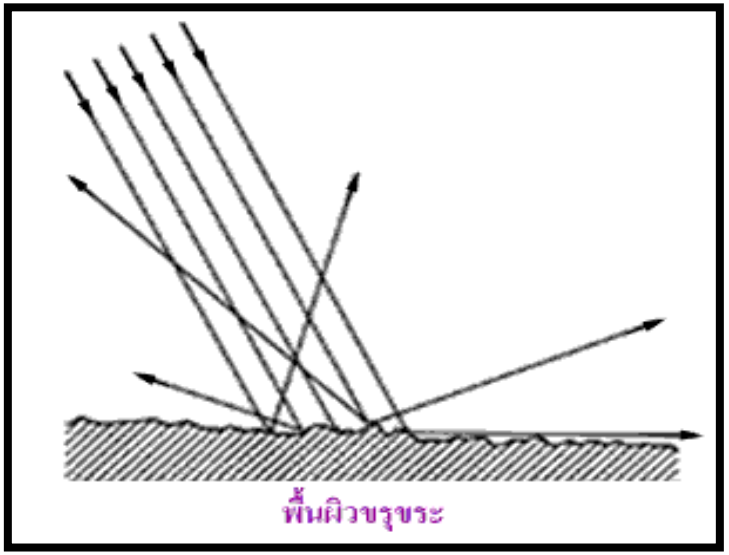
Microspectrophotometer

- Scope mode
- Transmission mode
- Reflective mode

- Reflective mode



การสะท้อนแบบปกติ



การสะท้อนแบบกระจาย

Materials and methods (cont.)

Microspectrophotometer

- *1. Leica DMR และ Ocean Optics HR2000*
- *2. Leica Aristomat and Leitz MVP SP*
- *3. CRAIC QDI 2010*

Leica DMR และ Ocean Optics HR2000

Leica DMR

Ocean Optics HR2000

- Linked an Ocean Optics HR2000 spectrophotometer

- Spectrophotometer by a coaxial probe to the camera mount of the Leica DMR microscope

- OOIBase 32 software program version 2.0.6.5

- The spectrophotometer had fixed specifications with the entrance aperturesetat 50 mm,

-Slit width of 25 mm.

-Optical resolution of 0.1 nm

-Composite diffraction grating that ranged 200 nm to 1100 nm.

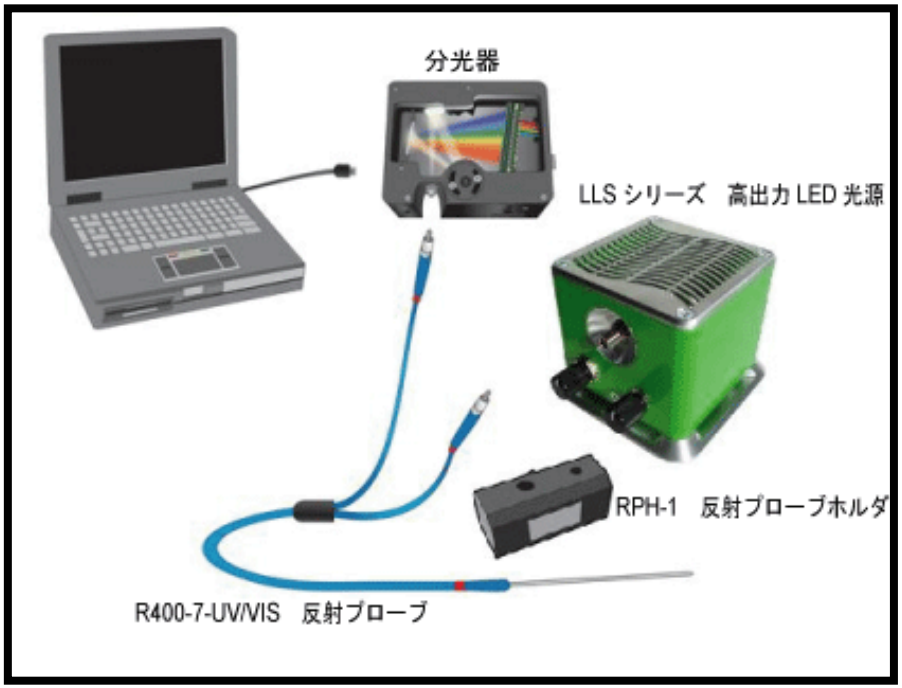
-The boxcar and averaging functions were each set to 5

-All other functions were either set to 0 (zero) or were not selected

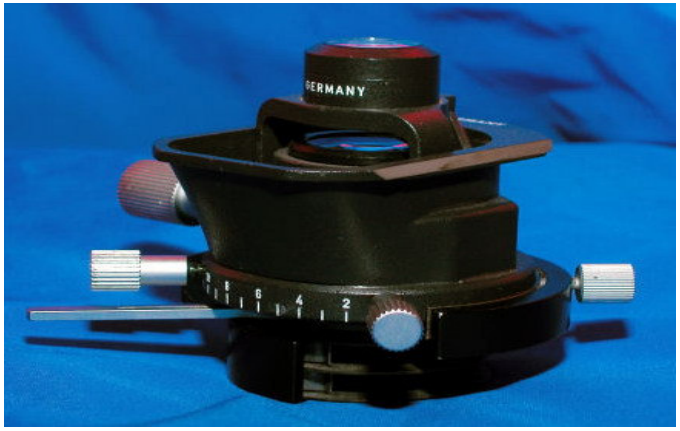
-The lamp was allowed to warm up for a minimum of 60 min before use

-The almagnification was **x**400

-Eyepiece **x**(10) and the objective lens **x**(40).



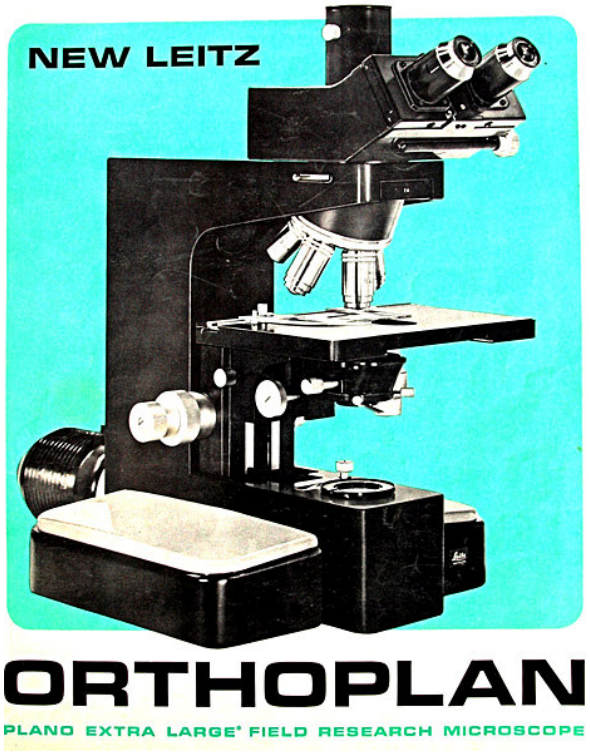
Leica Aristomat and Leitz MVP SP



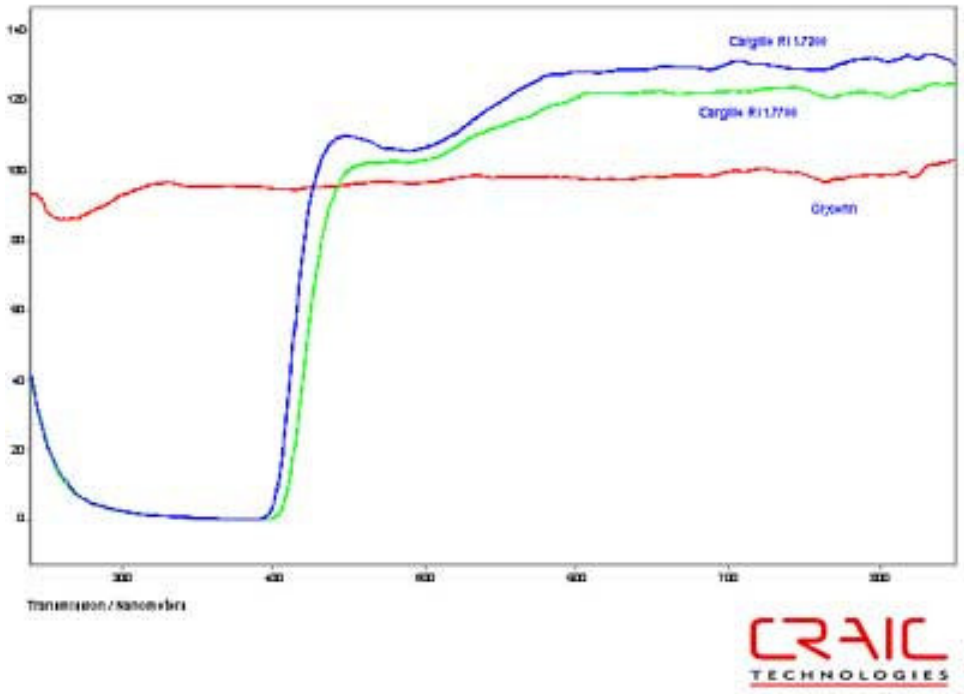
ส่วนประกอบของเครื่อง ***Leica Aristomat and Leitz MVP SP***

- The Leica Spectra Program, version 1.32 for Windows 95

- the sensitivity was set at 7.5%
- lamp brightness was set at 50%
- The interval was set at the lowest value possible, 0.1 s
- The spectrumbox had a range of 400 nmto 700 nm



CRAIC QDI 2010



CRAIC TECHNOLOGIES

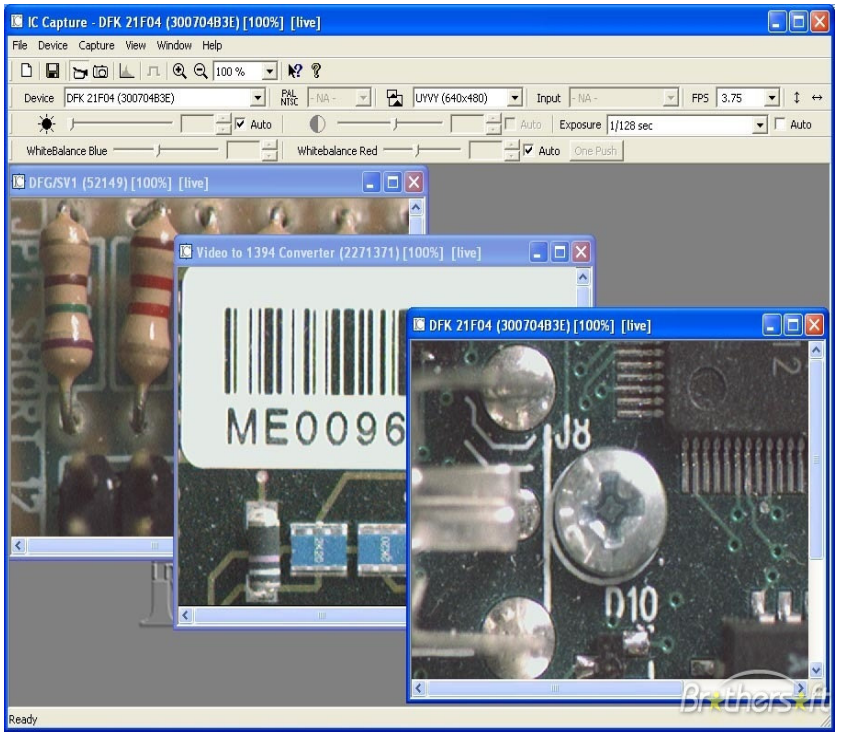
UV-visible-NIR Microscopes

- CRAIC CCD Image Capture (IC)
- software (DFx**41**AF**02**)
- The optimum integration time was calculated by the instrument at **1913.23** ms
- Standard analysis conditions were set with **400** nm to **700** nm selected

- sampling time of 1242.51 ms
- resolution factor (0–15) was set at 4
- The video formats hada frame rate of 1280 x 960 at 7.5,3.75 frames/s.
- DC was 10 bit and the signal to noise ratio was ADC 9 bit at 25 C^{o} gain 0.

IC Capture

- **IC Capture คือ โปรแกรม Windows ที่สามารถรับภาพเดียว, ลำดับภาพและวิดีโอจากอุปกรณ์วิดีโอทั้งหมดที่มาพร้อมกับโปรแกรมควบคุมระดับกระแส**



IC Capture

- IC Capture **2.0** was set at **50%**

- The exposure was set between **1/83** s and **1/120** s

- Brightness was set to **63**, gain to **300** and auto reference parameter to **690**

- optimum values with hue **181**

- image parameter was set at gamma **12**

Fingermark exemplar material

จุ่มน้ำหมึก

ประทับลงใน

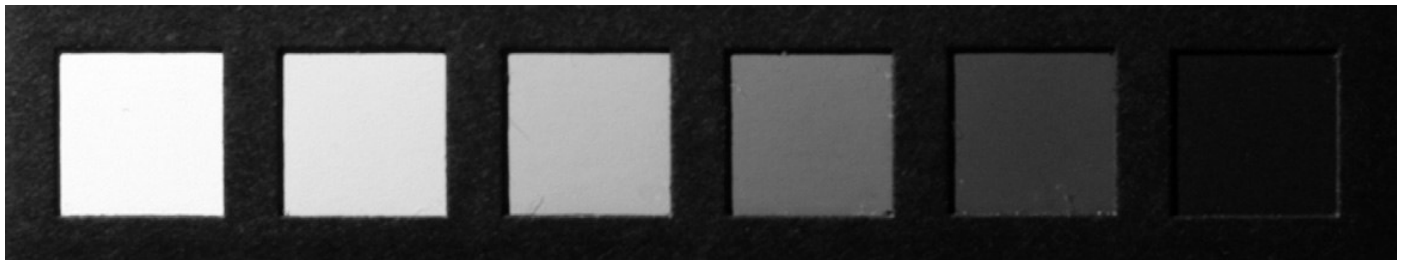
3 ครั้ง

ทำซ้ำ **30** ครั้ง = **90** แบบ

แบ่งเป็น **3** กลุ่ม **(n_1 n_2 n_3)**

Reference standard and control

- mini GretagMacbeth ColorChecker



Data collection and analysis

- อ่านจากเส้นร่องและเส้นนูน 10 ครั้ง
- Microsoft Excel
- วิเคราะห์เชิงสถิติ (ONE WAY ANOVA)

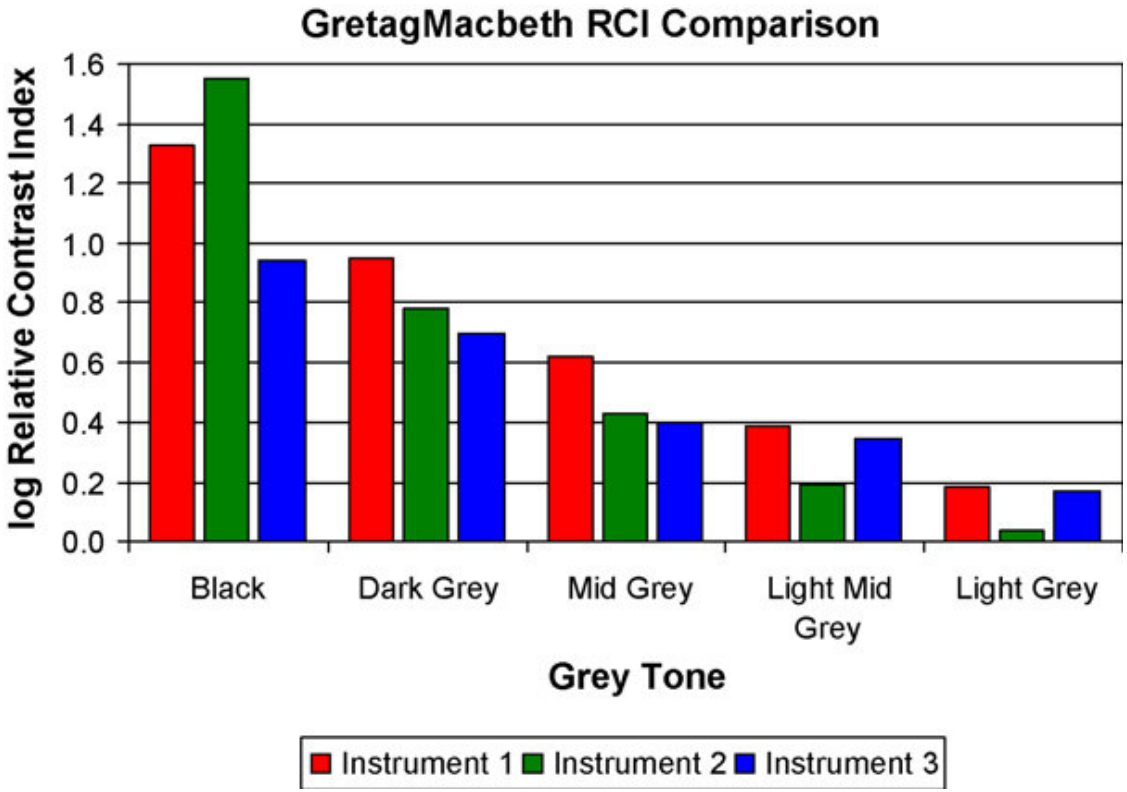
Relative contrast index results from each fingermark depletion group.

Depletion	Data analysis	Average ridge	Average valley	RCI
n_1	Integration	19035.73	52862.13	0.4436
	Averaging	28.63	79.49	0.4436
n_2	Integration	30520.95	53011.68	0.2398
	Averaging	45.9	79.72	0.2398
n_3	Integration	38098.11	54723.11	0.1573
	Averaging	57.29	82.29	0.1573

ผลของดัชนีเปรียบเทียบความคมชัดของชุดการทดลองรอยนิ้วมือ

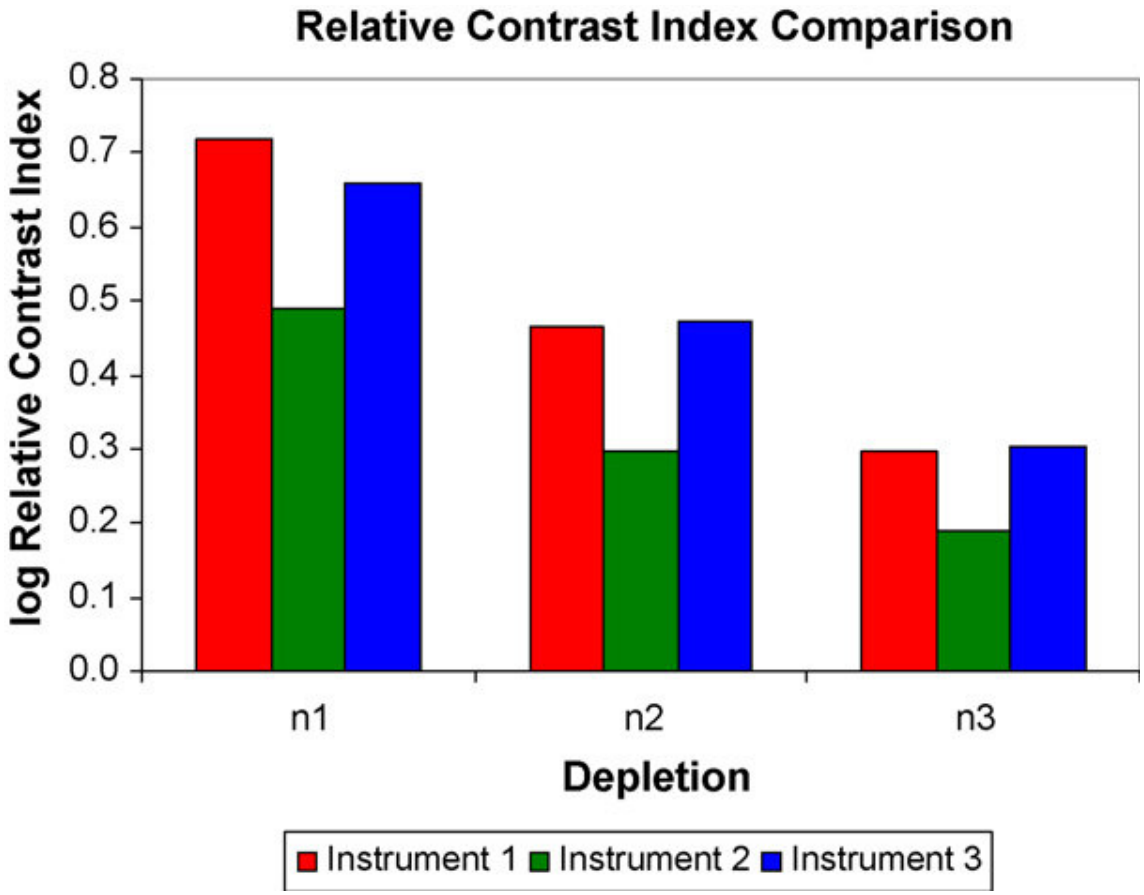
Results

- Reference standard



ผลของดัชนีเปรียบเทียบความคมชัดจากมาตรฐานที่ใช้อ้างอิงของเครื่องมือทั้ง3

Fingermark exemplar samples



ผลของดัชนีเปรียบเทียบความคมชัดของกลุ่มการทดลองในเครื่องมือทั้ง3แบบ

Relative contrast index results from the three instruments used in the experiments made from each fingermark depletions.

Depletion	Instrument	RCI	Standard deviation	Standard error
n_1	1	0.718	0.076	0.014
	2	0.489	0.078	0.014
	3	0.659	0.053	0.01
n_2	1	0.464	0.063	0.012
	2	0.296	0.035	0.006
	3	0.474	0.05	0.009
n_3	1	0.296	0.036	0.007
	2	0.191	0.022	0.004
	3	0.304	0.035	0.006

ค่าของดัชนีเปรียบเทียบความคมชัดจากเครื่องมือทั้ง3 ที่ใช้ในการทดลองกับชุดรอยนิ้วมือ

- ผลวิเคราะห์เชิงสถิติ ONE WAY ANOVA

เครื่องมือที่ 1

$F_{2},87=367.4,P<0.0001$

เครื่องมือที่ 2

$F_{2},87=262.2,P<0.0001$

เครื่องมือที่ 3

$F_{2},87=437.3,P<0.0001$

- ผลวิเคราะห์เชิงสถิติ ONE WAY ANOVA

n_1

$F_2 87 = 86.5, P < 0.0001$

n_2

$F_2 87 = 115.3, P < 0.0001$

n_3

$F_2 87 = 119.7, P < 0.0001$

Conclusions

- The relative contrast index model
- Identifying the model's applicability to quality assurance in forensic science
- Quantification of fingermark contrast reduces or eliminates ambiguity
- The relative contrast index model provides a valuable framework and positive outcomes for future forensic science research.

Discussion

- Irreconcilable differences existed between the instruments
- The sampling aperture, operating software and instrument sensitivities

Thank you

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