STUDY OF APPROPRIATE COLLECTION METHOD FOR OIL-CONTAMINATED FINGERPRINTS

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Introduction

Fingerprints are important contact traces with high importance in personal identification. Most fingerprints detected at crime scenes are contaminated with a number of substances. Not much interest had been put on the development techniques for fingerprints that were contaminated with oil, and fingerprint impressions found on oily surface. At present, the only method used to record an oil-contaminated fingerprint in Thailand is by photography. For this reason, the development techniques for oil-contaminated fingerprints should be determined.

A sequence of methods for developing oil-contaminated fingerprints were designed; and the types of oil chosen for the experiment were soybean oil, engine oil and diesel fuel. The material surfaces selected for the experiment were glass, plastic oil container, aluminum and galvanized iron plates. In the present study, the RUVIS (Reflected Ultraviolet Imaging System) optical system was used in addition to FLS (Forensic Light Source) to locate and photograph untreated oil-contaminated prints. Liquid nitrogen was included in the experiment to freeze oil residue on the surfaces before fuming the print with superglue. Black, white and magnetic powders with Basic Yellow 40 (BY40) luminescent stain were used for the fingerprint development.

The aims of this study were to determine the appropriate collection methods for oil-contaminated fingerprints and to study and compare oil-contaminated fingerprints and fingerprints on oil-coated surfaces by different development techniques.

Materials and Methods

1. ***Materials***

Oils used in this study were soybean oil (B), engine oil (E) and diesel fuel (D). Material surfaces (3”x3”) used were glass plates (G), plastic plates (P) from diesel fuel containers, aluminum plates (A) and galvanized iron plates (Z). Black, white and magnetic fingerprint powders, including, liquid nitrogen, Alteco® Superglue, Tex-Lift and Basic Yellow 40 (BY40) were used in this study.

2. *Fingerprint Samples Preparation*

Every surface sample was cleaned before fingerprint impression. The experiments were divided into two conditions, oil-contaminated finger (F) and oil-coated surface (S). Five microliters of oil was coated on the right thumb and impressed onto a surface with constant force, creating an oil-contaminated fingerprint on the surface (e.g. an *engine* oil-contaminated *fingerprint* on a clean *glass* surface, denoted with *GEF*). Oil-coated surfaces were prepared by adding 60 µl of oil onto each surface and a spatula was used to spread the oil to cover all the area of the surface. Then, the cleaned right thumb was impressed onto the surface with constant force (e.g. an *engine* oil-coated *glass surface* was impressed with the right thumb, denoted with *GES*). Each surface with every oil type was compared and 24 types of oil-contaminated prints were experimented in the present study.

3. *Examination and Photography*

3.1 The SIRCHIE® *KRIMESITE*™ *IMAGER* (RUVIS)

The RUVIS was used to locate fingerprint impressions before and after superglue fuming. The RUVIS optical system was mounted on a tripod perpendicular to the surface of the experimental samples with Canon *PowerShot* G5 digital camera attached to *KRIMESITE*™ *IMAGER* for photography (Fig. 1). The UV mini light source (254 nm) was held at various angles to obtain the best visualization of the print [1].

Figure 1. The SIRCHIE® *KRIMESITE*™ *IMAGER* optical system

3.2 The SPEX Forensics' Mini-CrimeScope® 400 (FLS)

The dyed samples (BY40) were examined under FLS at 445 nm. Photography was taken by using an orange-colored filter with the Canon *PowerShot* A530 digital camera.

4. *Freezing the Experimental Samples*

The experimental samples were frozen after fingerprint impressions had been made. Plastic, aluminum and galvanized iron plates were frozen by using liquid nitrogen. Glass samples shattered when they were immersed into liquid nitrogen, therefore, they were placed in a -20^{0}C freezer instead. Liquid nitrogen was pored into a foam tray and the samples were completely immersed into the tray until the temperature was stable (equal to the temperature of liquid nitrogen).

5. ***Cyanoacrylate (superglue) Fuming***

Approximately 3-4 drops of Alteco® Superglue (SPG) was added onto a tray which was put in the chamber 15 min. before fuming each sample (to produce a chamber saturated with cyanoacrylate vapor). The samples were placed into the fuming chamber immediately after they were taken out of the -20^0C freezer or the liquid nitrogen (to minimize the moisture that would be developed after they had been taken out to room temperature). The fuming chamber was a cylindrical plastic tank (3.14 x 6.5 x 15 cm^3 = 1.989 liters). When dye staining was required, the developed prints after fuming were left overnight at room temperature before treating with BY40 [2].

6. ***Basic Yellow 40 (BY40) Staining***

The BY40 working solution was prepared by dissolving 1g of BY40 in 500 ml methanol [3]. The fumed samples were immersed into a tray containing BY40 for 10 seconds and they were rinsed gently with running tap water for 10 seconds. The samples were examined under FLS at 445 nm and the development color is yellow fluorescence [4].

7. ***Fingerprint Powder Dusting***

Black/white powder was applied to the developed fingerprint after superglue fuming by lightly brushing the powder onto the surface sample. When Tex-Lift was necessary for fingerprint lifting, magnetic powder was applied instead of black/white fingerprint powder. In the present study, the magnetic powder was applied to the plastic which was a rough surface.

8. ***Coating with Tex-Lift***

One drop of Tex-Lift was added on the magnetic powder dusted print and it was spread to cover complete fingerprint area. The coated print was allowed to air-dry before lifting with transparent tape [5].

9. ***Fingerprint Lifting***

Fingerprints were lifted by using a lifting tape.

10. ***Experimental Methods***

Every oil-contaminated fingerprint impression was first examined and photographed with RUVIS and, then, they were frozen by dipping into liquid nitrogen (glass samples were kept in -20^0C freezer). The samples were then fumed with superglue for a period of time, reexamined and photographed with RUVIS and Canon digital camera. Every fingerprint was dusted with black/white powder dusting, photographed and lifted (pathway I). The developed prints that did not yield clear ridge lines were retested with BY40 staining procedure (pathway II). The dye stained fingerprint was photographed by a digital camera using FLS and an orange filter. The fingerprints were later dusted with black powder and lifted. The rough surface samples (plastic surface) were tested with the application of Tex-Lift via the use of magnetic powder (pathway III). In pathway II, the dye stained fingerprints on plastic surface were also dusted with magnetic powder and lifted with Tex-Lift. The overview of the experimental methods was shown in Fig. 2. Each experimental sample was performed at least 4 times.

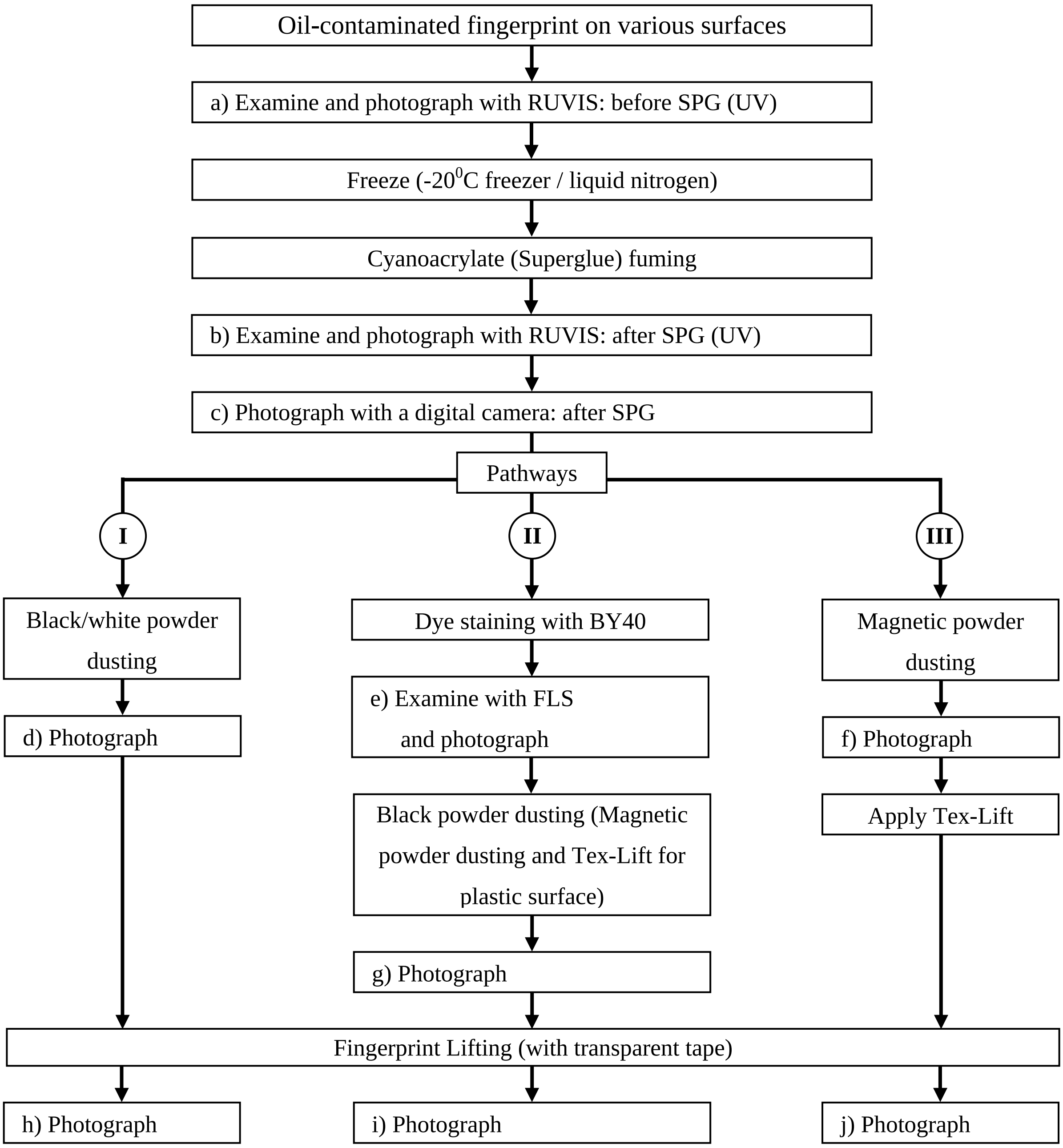

Figure 2. Sequence of methods used for the detection of oil-contaminated fingerprint on various surfaces (a - j are designated for photography steps)

Results

The scores of the developed prints were illustrated in Table 1 and the examples of the well developed prints were shown in Fig. 3.

From Table 1, the step with the highest score was the best method for fingerprint development. Oily fingerprints on glass surface could be developed by pathway I except GDS samples that were smeared by powder dusting and could be developed with BY40 staining (pathway II). Pathway I and pathway II were not appropriate for plastic surface because fingerprints were unable to be lifted with typical lifting tapes and dye staining did not develop continuous ridge lines. Therefore, pathway III was the best collection method for oil-contaminated fingerprints on the plastic plates. For aluminum surface, pathway I was suitable for developing oil-contaminated fingerprint samples (F) while pathway II was appropriate for developing fingerprints on oil-coated surfaces (S). All fingerprints on galvanized iron plates were suitable for developing with pathway I, but pathway II was appropriate for ZDS fingerprints. ZES fingerprints were poorly developed by both pathways but the best ridge lines were obtained after superglue fuming with the photographs taken by RUVIS.

Table 1. The appropriate collection methods for oil-contaminated fingerprints with the score of the ridge details.

Experimental types		RUVIS		Canon	Pathway I		Pathway II			Pathway III	
		a) Before SPG	b) After SPG	c) After SPG	d)	h)	e)	g)	i)	f)	j)
Glass	GBF	4	3	3	2						
	GBS	4	2	1	2		1	0			
	GEF	2	2	2	4						
	GES	2	3	1	2		1	0			
	GDF	2	2	1	3						
	GDS	2	1	0	0		3	1			
Plastic	PBF	1	1	0	1		1		0	1	2
	PBS			0			0	0		0	
	PEF	1	2	1	2	1	2		2	3	4
	PES			0			0	0		0	
	PDF			0			1	0	0	1	2
	PDS			0			1	0		0	
Aluminum	ABF	2	3	3	4						
	ABS	1	1	1	1		2	0			
	AEF	2	3	3	4						
	AES	0	0	1	1		2	0			
	ADF	2	2	3	2						
	ADS	1	3	0	0		2	0			
Galvanized iron	ZBF	1	0	0	2						
	ZBS	0	0	0	1	1	0	0	0		
	ZEF	1	2	1	4						
	ZES	0	2	1	1	1	1	0	1		
	ZDF	1	0	1	2	3					
	ZDS	1	1	1	0	1	1	1	2		

Scoring:

4 Identifiable: clear and sharp ridges, no marks or smudges, good contrast

3 Identifiable: clear ridges except for several smudges

2 Possibly identifiable: partial prints, ridge lines not sharp, small ridge characteristics visible with smudges or marks

1 Not identifiable: almost the entire print smudged, only some ridges visible but not able to make any ridge characteristics identification

0 No fingerprint ridge could be developed

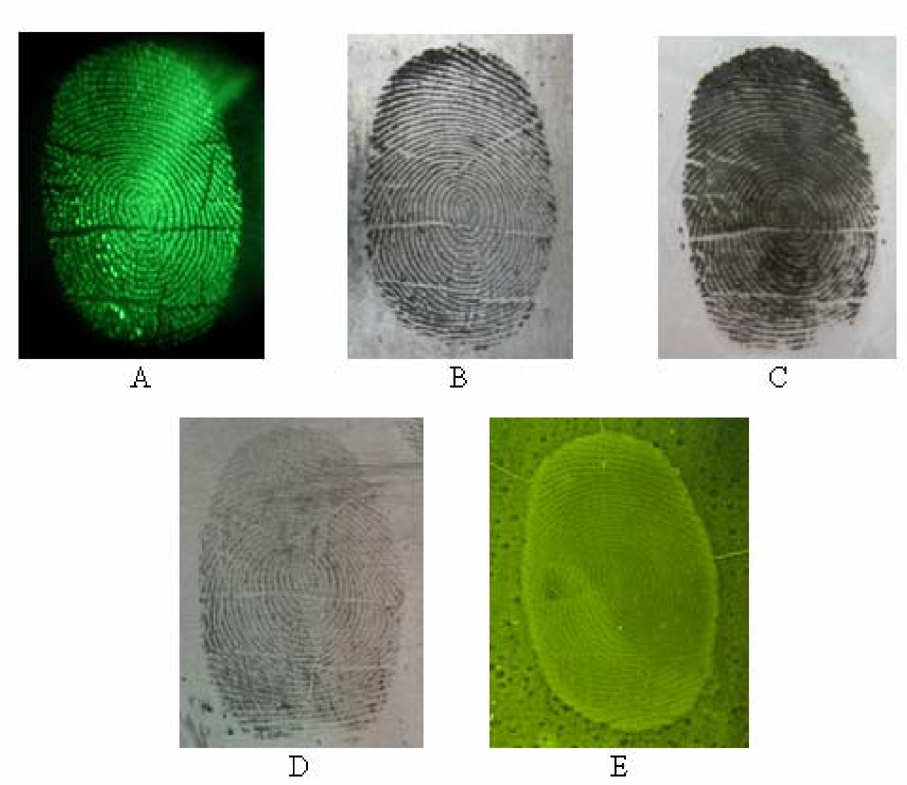

Figure 3. Developed prints with the score of 4 (Figs. A-D) and 3 (Fig. E).

A : Photograph of a GBF (Fingerprint contaminated with soybean oil on glass surface) sample taken by RUVIS before SPG fuming showed bright green ridges on dark background.

B : ZEF (Fingerprint contaminated with engine oil on galvanized iron surface) fingerprint developed by black powder dusting showed dark, clear ridge lines.

C : PEF (Fingerprint contaminated with engine oil on plastic surface) fingerprint developed by magnetic powder dusting and Tex-Lift showed dark, clear ridge lines.

D : ABF (Fingerprint contaminated with soybean oil on aluminum surface) fingerprint dusted with black powder showed black ridges.

E : GDS (Fingerprint on glass surface coated with diesel fuel) fingerprint best developed by BY40 staining showed clear ridge lines.

Discussions

The quality of the developed ridge details depend on many factors; the amount of oil presents on each fingerprint, type of oil and surface, fuming time and the duration of freezing process for glass plates (the formation of ice crystals destroyed the ridge lines). Excess oil could cause smudges when the print was dusted. On the other hand, if oil is too thin, the fingerprint might not be developed by both dusting and dye staining techniques. Therefore, the untreated prints should be recorded with RUVIS before attempting to develop them with any techniques to reduce the risk of accidentally destroying fragile evidence before it has been safely documented. The optimum fuming time for each oil-contaminated sample depends on the type of oil, the viscosity and the thickness of the oil residue on the fingerprint, the superglue brand and the concentration of cyanoacrylate vapors within the chamber. It is recommended that the fuming print should be carefully examined with the naked eye and with RUVIS every 3-5 min. during the process to avoid overfuming (characterized by the entire surface being covered with cyanoacrylate polymer).

Many instances from the present study have shown that some fingerprints were better if they were collected after dusting for the second time. The first powder dusting could result as an overdusted print that the ridge characteristics were obscured. By lifting the print and dust it for the second time helps refine the developed ridge lines.

The usefulness of the designed sequence of methods in this study was considered from its applicability, simplicity and the expenditure of the experiment. Its advantages over other existing development techniques are that it has less chemical enhancement procedures in the experimental pathway, and the developed oil-contaminated fingerprints were able to be lifted off the surface while other development techniques could not. The overall experiment involves typical fingerprint processing techniques (superglue fuming, powder dusting and dye staining) that are well documented and are commonly available in crime laboratories. Using liquid nitrogen to freeze the experimental samples was a fast and easy process for the operator; however, extra cost for purchasing liquid nitrogen would have to be considered if it was used in any fingerprint laboratories.

In the case of RUVIS, this technique requires regular practice, training and an understanding of its specifications and features to obtain optimum viewing of the fingerprint. The most important factors affecting the visualization of the oil-contaminated fingerprints are the type of oil and surface. RUVIS detection technique is both a non-destructive and non-corrosive method of discovering valuable evidence. This means less clean-up and reduce crime scene contamination (no powdering and chemical enhancement needed), as well as less damage to property and evidence. In Thailand, RUVIS is quite expensive and, therefore, it is not widely available in crime laboratories. If an examination on an oil-contaminated fingerprint was conducted without RUVIS, oblique lighting technique should be applied as an alternative method.

Conclusions

Fingerprint contaminated with soybean oil on glass surface showed the best ridge details (4) before SPG fuming under RUVIS. Photographs taken by RUVIS after SPG fuming showed the best image (3) for GES, ADS and ZES samples. ADF samples showed the best ridge details (3) after SPG fuming under room light. Oily fingerprints on all surfaces [GEF (4), GDF (3), ABF (4), AEF (4), ZEF (4) and ZDF (3)] except plastic (rough surface) could be developed by black powder dusting. Some oil-contaminated fingerprints that could not be detected by previously mentioned methods, BY40 (pathway II) was used and moderate results [GDS (3), ABS (2), AES (2) and ZDS (2)] were obtained. Only magnetic powder (pathway III) could be used for oil-contaminated fingerprint on plastic [PBF (2), PEF (4) and PDF (2)].

Acknowledgement

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