Development of Latent Fingerprints from Excavated Samples Using Polyvinyl Alcohol (PVA) Film

Abstract:

Fingerprint is crucial evidence which plays vital role in the investigation of crime. Conditions under which fingerprints were found affect the process of development of fingerprint. On the crime scene fingerprint can be found on various surfaces such wooden surfaces, iron surfaces, plastic surfaces etc. in various condition. It can be found in wet condition, dry condition or sometimes it can be recovered from the water, soil etc. If fingerprints recovered from the soil after certain time period then it will become challenging to develop it. There are so many physical and chemical methods are available for development of latent fingerprint. In this study, the Polyvinyl Alcohol (PVA) film lifting technique will be evaluated for its ability to recover, preserve, and visualize degraded latent fingerprints from excavated materials (metal, glass, ceramic, and plastic) under different burial durations and soil conditions.

INTRODUCTION

The fingerprint is the important evidence in the investigation of crime. It is one of the mostly found physical evidence. Fingerprints are the reproduction of friction skin ridges found on the palmer and plantar surface. Fingerprint identification can be referred to as individualization, identifies an individualized pattern which can be used to identify a suspect. The fingerprint doesn't change throughout one's life unless damage occurs to the dermal layer of the finger skin layer.

There are so many physical as well as chemical methods are available for development of latent fingerprint. Mostly use methods are Cyanoacrylate fuming method, ninhydrin and iodine fuming method. Most of studies are available related to these methods by taking various surfaces. These all methods have their own disadvantages like humidity range, background colour development; iodine fuming method is a volatile method, etc.

There is only one study available related to developing the latent fingerprint recovered from the soil up to 7 days and enhancement were done by mass spectrometry imaging. But this study has not done on various surfaces and also not developed fingerprints by using polyvinyl alcohol film.

Polyvinyl Alcohol Film method is good as compared to other methods because this fingerprint film is portable that's why on the crime scene also development of fingerprint will be possible. This membrane is easy to carry because it has light weight. This is one of the most significant chemical, portable and cheaper fingerprint development method.

LITERATURE REVIEW

Barnett and Berger (1977) studied the effects of humidity and temperature on the clarity of a developed latent fingerprint stored for the varying time. They were taken the latent fingerprint from 12 individuals. The subjects were directed to thoroughly wash and dry their hands, then, using five prenumbered slides. Following this first collection, subjects went about their normal activities for two and a half to three hours, they were asked to repeat the procedure of leaving latent fingerprints, using a second group of slides and without washing their hands. Latent fingerprints for the third group of slides were collected immediately following those of the second after having directed the participants to rub their fingertips across their foreheads or through their hair in order to increase the amount of oil and perspiration on fingertips. After obtaining prints from all of the subjects, a few prints from each subject were taken and immediately develop by dusting. The rest of latent prints were placed in a series of 5 closed containers to be kept at various conditions of temperature and humidity. For two months following the collection of the prints, slides were periodically dusted and lift according to a predetermined scheduled. The fingerprints were developed by using a single camel hair brush and Sirchie black fingerprint powder. This study stated that the clarity of developed print is primarily related to the original latent print quality and is not related to the temperature and humidity under which it has been stored. [1]

Exline et al. (2003) studied detection of the latent fingerprint using visible absorption and luminescence. In this study, two different donor deposited latent fingerprints on three different surfaces- paper, plastic, and glass. Sebaceous prints were deposited onto A4 sheets of paper and plastic. Three sheets of the fingerprint on paper were made- one that remained untreated, one for DFO treatment, and one for ninhydrin treatment. Three sheets of the fingerprints on plastic were made- one that remained untreated and two for Cyanoacrylate treatment with enhancement using two different stains. Three glass slides of latent fingerprints from each donors were made- one that remained untreated and two for Cyanoacrylate and different stains. The latent fingerprint samples were left to age for 1 day, 1 week, 2 weeks, 4 weeks and 8 weeks before treatment and chemical imaging. Additional aged latent prints on plastic and paper supports were obtained from the Australian Federal Police in Canberra. For these samples, the latent prints on paper were aged 2 months, 3 months, 9 years, 15 years and 19 years. The latent prints on plastic were all 2 years old and were on three different plastic supports white plastic garbage bag, black plastic garbage bag, and the transparent plastic zip-lock bag. For the detection of latent fingerprint Poliview forensic imaging system and Chemical imaging system were used. They found that Luminescence chemical imaging and visible absorbance chemical 3 imaging potential detection method for ninhydrin, DFO, Cyanoacrylate and luminescent dye treated latent fingerprints and visible absorption chemical imaging is a potential method to visualized untreated latent fingerprints. [2]

Guigui and Beaudoin (2007) investigated whether Oil Red O (ORO) interferes with or improves results when used in sequence with other methods. In this study, fingerprints of test subjects were taken on three types of paper such as wet: white and kraft paper, dry: white and kraft paper and thermal paper. At least two test subjects were used on each paper, usually one male and one female. Each paper was cut down the center, such that half of each fingerprint was subjected to one sequence excluding ORO and half was subjected to the sequence including ORO. In case of dry paper, fingerprints were either 1,2,3,4,5,6,7,8,9,10,15,20,25 and 30 days old at the time of testing. The two sequences were tested for dry white and kraft paper was 1,8-diazofluorene-9-one (DFO), ninhydrin and physical developer (PD) on one half; and DFO, ninhydrin, ORO and PD on the other. In the case of wet paper, on the day the testing, the papers were submerged in a water basin for one full hour before the testing began. The two sequences were used PD only on one half and ORO and PD on the other. In case of thermal paper, the fingerprints were either 1, 5, or 10 days old at the time of testing. The two sequences tested on thermal paper were ninhydrin only on one half and ninhydrin and ORO on the other half. This study resulted that ORO has been proven to yield better quality fingerprints than PD on wet white and thermal paper. The result of this study indicated that on dry paper the sequence DFO, ninhydrin, ORO, and PD is recommended whereas the sequential use of ORO and PD is appropriate for wet papers. [3]

Jasuja and Singh (2009) proposed the study for the development of latent fingermarks on thermal paper by using iodine fuming. In this study, latent fingerprint samples were taken on various fax and thermal papers which were collected from the market such as Mitsubishi fax paper, oddy fax paper, D.P. print paper and ATM paper receipts. Latent fingermarks were taken from 10 different individuals of unknown donor capabilities. They took two sets of fingermarks (eccrine and sebaceous) from each individual. For observation regarding the development of aged fingermarks on thermal paper, few samples were kept in the closed plastic box for up to the 1-year period. Iodine fuming was used for the development of marks without any further purification. This study concluded that iodine fuming is a good method to develop fresh as well as old fingermarks on thermal paper with no background coloration. The fingermarks developed by iodine fuming found to be permanent in case of the thermal paper because of oxidation of leuco dyes present in thermal paper surface. No difference could be found in fresh eccrine and sebaceous marks, but in cases of aged fingermarks, the marked difference was observed in both with respect to intensity and permanency of fingermarks. [4]

Paine et al. (2011) conducted the research to establish the effect that changes in relative humidity have on both the effectiveness of the cyanoacrylate fuming technique and the microstructure formed by polymerization reaction during the development of fingermarks. This study included „natural" fingermarks and deliberately groomed eccrine and sebaceous finger marks, all samples were left for 1 week. All exposed to relative humidity levels in the range 60-100%. Fingermarks were developed using the "Sandridge" Super Glue Cabinet. They found that optimum level of relative humidity for the development of the most high-quality marks is approximately 80%. They identified three different humidity regimes. At low humidity~60%, the fingerprints appear to less polycyanoacrylate deposition overall and give flat, film-like polycyanoacrylate microstructure. Within the range 70-90% relative humidity, the contrast between the ridge and background is maximised and formed the noodle-like polycyanoacrylate microstructure. At high humidity~100%, less clearly ridges developed and exhibit high levels of background development and formed thin, thread-like polycyanoacrylate microstructure. This result indicated that eccrine constituents were mostly affected by relative humidity while sebaceous were less affected by relative humidity. [5]

Omar and Ellsworth (2012) examined the difference in physical characteristics of the fingerprint after development using different fingerprint powders within a six-week period. In this study, all fingerprints' samples were taken from a single donor on clean microscope slides. The slides were kept at room temperature facing the ceiling, exposed to dust and air conditioning. Black fingerprint powder and black magnetic fingerprint powder were used to analyze the slides after every week at similar intervals for six continuous weeks. The result of this study proved that black magnetic fingerprint powder was superior as it produced well-developed fingerprints after the 4th week, compared with black fingerprint powder which can only be used for up to 3 weeks. [6]

Matej Trapecar (2012) study was done to investigate whether three fingerprint methods can recover latent fingerprints on transparent foil submerged in water. In this study 36 transparent foils were taken for fingerprint deposition and fingerprint samples were taken from three donors. Donors deposited two fingerprints on each transparent foil surface. Fingerprint detections were done in laboratory under control condition , with room temperature ranging between 21° C to 23° C and relative humidity at roughly 55%. After the deposition of fingerprint, all samples were place in stagnant water. After an adequate interval, samples were removed from the water and dried in the air, at room temperature around 22° C. Fingermarks were recovered 30 min after the impression had been deposited and then 20, 67 and 168 h post deposition. Fingerprints were examined with enhancement techniques of SPR, cyanoacrylate fuming and powder Swedish soot mixture. This experiment found that the quality of fingerprint development on objects found in water would depend on the time of exposure to water and the method used for the development of fingerprints. The results showed that all three methods are applicable but the most effective method for developing fingermarks on transparent foil exposed to water is SPR. [7]

Sodhi and Kaur (2012) proposed a novel, fluorescent small particle reagent (SPR) based zinc carbonate hydroxide monohydrate for detection of latent fingerprint on wet non-porous items. In this study, non-porous items such as glass, plastic, laminates, ceramics, steel, aluminium foil and bakelite bearing latent fingerprints were immersed in water from 0 to 36 h. After that SPR reagent was sprayed on the surfaces bearing latent fingerprints. This study found that quality of fingerprints developed with novel reagent than those developed with the conventional one. [8]

Bailey et al. (2013) proposed the study to enhanced partially recovered fingerprint by using mass spectrometry imaging i.e. time of flight secondary ion mass spectrometry (ToF-SIMS). In this study, three different types of surfaces such as aluminium foil, hand grenade handle and glass slides were used to investigate the feasibility of ToF-SIMS to enhance the visibility of partially developed fingermarks. Fingermarks on aluminium foil were developed with Cyanoacrylate fuming; fingermarks on hand-grenade handle were aged for 24h and 48 h and developed with Cyanoacrylate fuming, crystal violet, SPR, vacuum metal deposition and CAST formulation of wet powder and Wetwop®. Fingermarks on glass slides were submerged in soil for seven days and then developed with aluminium powder, black magnetic powder, black particle suspension, basic violet 3, Cyanoacrylate fuming and vacuum metal deposition. This study found that chemical imaging can be used to obtain enhanced images of fingermarks deposited on aluminium foil, hand-grenade handle and glass slides compared with conventional development techniques. [9].

Yang and Lian (2014) proposed a new series of fingerprint developing membrane (FDM) were prepared using ninhydrin as the developing agent and pressure sensitive emulsifiers as encapsulated chemicals. The membrane can be applied to both porous and non-porous surfaces. This study found that fingerprints that are difficult to develop on surfaces such as leather, glass, heat-sensitive paper using traditional chemical methods can be successfully developed with this membrane. [10]

AIM & OBJECTIVES

Aim: The aim of this study is to development of Latent Fingerprints from Excavated Samples using Polyvinyl Alcohol (PVA) Film.

Objectives:

- To recover latent fingerprints from excavated or buried evidence exposed to various soil environments and time durations.

- To apply the PVA film technique for developing and lifting latent prints from excavated samples.

- To compare the clarity and ridge detail obtained through PVA film with conventional methods (powdering or cyanoacrylate fuming).

- To evaluate the efficiency, sensitivity, and preservation capability of the PVA film method for aged latent prints.

PROPOSED METHODOLOGY

In this method, excavated latent fingerprints will be developed by using polyvinyl alcohol film. Latent fingerprints will be taken from various individuals on various types of surfaces. Surfaces bearing latent fingerprint will be buried in the soil for various time periods. Dried film will be taken and applied it on each sample. After applying film, heat will be provided to it by using iron up to fingerprints will be developed. Results were drawn out on the basis of observation.

EXPECTED OUTCOMES

The study is expected to demonstrate that polyvinyl alcohol (PVA) film is an effective and method for developing latent fingerprints from excavated samples. Clear ridge details are anticipated, especially on smooth and non-porous surfaces, even after varying burial periods. The controlled application of heat is expected to enhance film adhesion and fingerprint visualization. The method may also outperform conventional techniques in recovering degraded or soil-contaminated prints while preserving the integrity of the evidence. Overall, the results are expected to establish the PVA film technique as a reliable and practical approach for fingerprint recovery in forensic archaeological investigations.

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