Short Communication

Investigation Process Observed By Bloodstain Pattern Analyst from Examining Murder Scene

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Abstract

The reconstruction of dynamic blood shading events from static bloodstain patterns is the basic idea of Bloodstain Pattern Analysis (BPA). Bloodstain pattern analysts analyze the size, shape, distribution and location of the bloodstains to form opinions about what did or did not happen. It helps to identify sequence of events and try to draw inference about the position of the victim/s, perpetrator/s and bystander/s (if any) of the crime scene. Bloodstain pattern analysts analyze the size, shape, distribution and location of the bloodstains to form opinions about what did or did not happen. This paper helps crime scene investigators i.e. police to identify investigation process based on evidence observed at the crime scene.

INTRODUCTION

BPA helps to establish specific events associated with violent crimes. Bloodstain analysts examine bloodstain evidence at a crime scene. It includes related information, observation, and documentation for making analysis and conclusion. All tests and experiments based on evidence is reproduced by analysts to ensure accuracy and quality. Bloodstain pattern analysis is performed in two phases: pattern analysis and reconstruction. In this paper we concentrate on the process for analysis by analyst.

We will now discuss proposed process to recollect evidence for actual reconstruction of crime happened in the present scene. Bloodstain pattern analyst evaluations helps to determine what action(s) or sequence of actions could have created the bloodstains and/or patterns observed. Information that may be gained with bloodstain pattern analysis include, for example, the position of the individual when the blood was deposited (sitting, standing, etc.), the relative position of individuals at the time of bloodshed, the possible type of weapon used as well as possible mechanisms that could have produced the blood staining on a surface.

Analyzing different case studies we observed that of the different types of bloodstain patterns, the most common stain patterns visible at the crime scene, particularly in the case where the victim was found to suffer blunt force injuries, are saturation, impact, cast off and transfer stain patterns. Footwear impressions are among the most commonly found evidence at crime scenes. For investigation it is also important to study foot print pattern for identification of person who actually involved in the crime.

The aim of this paper to specify process of crime scene investigation from the detailed study of bloodstain patterns obtained from a crime scene. It will prove to simulate to examine evidence for part/full crime scene reconstruction based on process follow by the analyst.

Blood Procurement

Blood procured legally from Kolkata Municipal Pig Slaughter House, Tangra Kolkata, India. Injection was added to fresh pig blood to preserve the colloidal consistency of blood. Adding anticoagulant does not alter the viscosity and specificity of the Non - Newtonian fluid, blood. The research work is particularly aimed at improving the process of crime scene investigation. The University of Calcutta along with Kolkata Police and PG Hospital has been doing jointly the work for crime scene investigation and reconstruction.

Investigation Process

At the place of crime scene physical evidence has come to the notice of the investigators. It is necessary to preserve and protect before the arrival of the investigator. Photographs are taken randomly to cover each evidence observed at crime location. The investigation team to cover the whole area of the scene and its proximity so that the observation and search of the scene can be done thoroughly. The purpose of the search of the crime scene is to determine the facts of the crime and identify its perpetrator.

The investigator should also bear in mind that view of insignificant evidence may prove to be evidence of immense value. So, the scene must be viewed with closest attention. Correct search at the scene of crime and search for clues are essential for proper investigation process at the place of crime. Physical evidences help connecting the criminal with the crime scene.
Before starting the search at the scene, the process of making search to find out physical and other clues. The following processes are normally followed by police/investigator. These are:

1. Dog squad should pick up the scent.
2. Do not touch anything at the scene and its close proximity.
3. Photographs in various angles are taken.
4. Foot print impressions at the scene and on various articles found there on.
5. A thorough search shall be conducted by the investigator and its team members.

During the process of investigation rough sketch of the scene has been made for helping investigation of crime as well as it may as an initial step for bloodstain pattern analyst.

Blood evidence confirms the investigator in the direction he or she needs to go for solving the case. If blood evidence is documented, collected, and stored suitably, it can be presented to a bloodstain pattern analyst. Bloodstain analysis brings to the investigation the ability to define those events that could or could not have occurred during the course of bloodshed. Once identified, these facts are considered in light of all other evidence as a means of corroborating or refuting statements, confessions, or investigative theories.

The role of the Bloodstain Pattern Analyst in a criminal investigation is to assist investigation process by observing the blood stains and stain patterns present at a crime scene. He also observed bloods on cloth of the victim as well as direction of blood stains and stain patterns present at a crime scene. He also conducted a bloodstain pattern interpretation using photographs.

Review Works

Locard’s exchange principle states that “every time an individual makes contact with another person, place or thing, it results in an exchange of physical materials” [1]. The study of evidence at a crime scene is particularly based on this principle. Bloodstain pattern analysis is defined as ‘the scientific study of the static consequences resulting from dynamic blood shedding events’ [2]. As per the International Association of Bloodstain Pattern Analysts (IABPA), a bloodstain pattern is defined as ‘a grouping or distribution of bloodstains that indicate through regular or repetitive form, order, or arrangement the manner in which the pattern was deposited’ [3]. Based on the different case studies presented at the IABPA conference [4] the authors are of the view that of the different types of bloodstain patterns, the most common stain patterns visible at the crime scene, particularly in the case where the victim was found to suffer blunt force injuries, are saturation, impact, cast off and transfer stain patterns. In the IABPA Conference held in Tucson, Arizona, 2004, Peter Lamb presented the investigation report of the late night assault of a young man who was intoxicated at the time of attack and could only recollect part of the savagery that he had been subjected to [5]. Foot morphology confirmed that the prints were left by the suspect who was wearing shoes [6].

By using the amount of anticoagulant that almost accurately mimics the stain patterns created by fresh pig blood. Drip staining shall be done on different sorts of fabrics. The fabrics can be natural fibers, man - made fibers. Each particular type of fabric is further subdivided predominantly into woven and knitted based on the weave of the cloth [7]. We noticed that the fabric type, weave of the fabric, position and volume of blood dropped influence the stain pattern formed. For each fabric type, fabrics of four shades in particular are obtained. They are - white, gray, maroon, black. Different shades on cloth are observed in a particular crime scene [8].

The FBI’s (Federal Bureau of Investigation) Uniform Crime Reporting (UCR) Program, has defined offenses which involve force or threat of force as violent crime [9]. The FBI Uniform Crime Reporting Program states that violent crime is particularly composed of four offenses - murder and non - negligent manslaughter, forcible rape, robbery and aggravated assault [10]. As per the Crime in India Report 2013 published by the National Crime Record. Once crime is reported, the investigation phase commences. The investigation phase in itself can broadly be classified under the following [6,9].

Dawson et al., [11] in his work reviewed the importance of weapon choice in offender profiling. Choon et al., [12] in his work analyzed how weapon used by an offender corresponded to his race. While white sexual homicide offenders (SHO) were more likely to use edged weapons, black sexual homicide offenders were more likely to use personal objects as murder weapon. From an unbiased viewpoint in their work Choon et al., [12] emphasizes that information about the murder weapon may not have significant utility to investigators in their attempt to predict the race of an SHO. Of particular relevance is the wound cast on the body of the victim when making predictions about a murder weapon. While these works largely relate to offender profiling, Bloodstain Pattern Analysis particularly deals with the reconstruction of crime scene.

Kabaliuk et al., [13] worked on the size of blood drops formed as a result of passive dripping from murder weapons. The study elucidated that the number of accompanying droplets increased as the size of the object increased. In addition to that, the authors recorded no significant correlation between the number of accompanying drops and the surface texture. In their work they highlighted that same volume of dripping blood produced more number of accompanying satellites and smaller droplets as compared to dripping of same volume of water. In the experiments undertaken by Kabaliuk et al., [13], the authors used distilled water as the reference point in drawing conclusions with regard to blood dynamics. However, given the large array of uncertainty involved, the interpretations by a pattern analyst often lack objectivity.

Observations by Bloodstain Pattern Analyst

The search of evidence at the crime scene is observed by bloodstain pattern analyst for proper investigation at the scene. The retrieval of bloodstain pattern evidence begins with the effective search of the scene. Physical evidence refers to any tangible article, small or large, which tends to prove or disprove a point in question. Consider the murder held in India in an area where security is considerably high.
A girl was working in an IT company. She loved her senior Manager of the company. After some years they got married and lived together in a place in Central India. In between man loved another teenage girl and sometimes both of them traversed to some places to enjoy with each other. Now the senior manager started to harass the first girl since he did not like her anymore. There is no evidence that man previously assaulted her. One day the first girl was murdered in her house. Police came and found that murderer strangulated her by wrapping an electric wire around her neck. He smacked her face many times with a hammer that made her face unrecognizable. The blood spattered on the walls of the bedroom and floor suggests that victim’s blood was flying in all directions when she was killed. The police investigated the case and they found nothing to conclude that Senior Manager of IT Company was the murderer. Police called blood stain pattern analyst to help them for investigate the case.

The crime scene analyst applies each category of evidence to the situation without inferring the situations as far possible, but recognizing the whole. These evidences establish a knowledge base from which the analyst reaches the "truth".

The information we are likely to discover through an examination of the bloodstains includes:

- Find the direction of droplet at the time of impact
- The angle of impact
- The estimated distance from the target to the droplet occurred due to heat by blunt force.
- The nature of the force involved in the bloodshed and the direction from which that force was applied.
- The nature of any object used in applying the force.
- Assume the number of blows struck during an incident.
- Positional view of the suspect, victim, or other related objects during the incident.
- Consider multiple events associated with an incident.
- To understand which hand delivered at the time of heating to victim.

Bloodstain pattern analysis brings to the investigation the ability to define those events that could or could not have occurred during the course of bloodshed. Once identified, these facts are considered in light of all other evidence as a means of corroborating or refuting statements, confessions, or investigative theories. For example, in describing a pattern transfer as "consistent with" something, any analyst should be able to point to some physical characteristic of the stain and then to the correlating item that created it. The analyst should then be able to create some generalized reproduction of the pattern using the item.

The blood stain pattern analyst went to the place and started examining important areas which include the ceiling, the deceased individual’s skin, and the decedent’s clothing. Patterns on the ceiling view may reveal the location of cast off spatters that occurred when blood was hurled from a moving, blood stained object at a scene where the walls and floors have been cleaned up. They started their work with the following evidence observed at the crime scene.

**Footprint analysis**

Impressions of footwear are commonly found in crime scenes. The quality and wide variability of these impressions and the large number of footwear outsole designs makes their manual analysis time consuming and difficult. Computer aided recognition systems for footprint analysis have been the focus of several research endeavors and it based on the idea of processing and analyzing Footprint images for a quick and accurate recognition. In criminal investigation it is necessary to find and prove whether a particular person or persons may or may not present at the scene of a crime. So the collection, preservation and analysis of physical evidence are important for diagnosing motivation of crime.

Images of Foot prints are treated as such for analysis and person identification. Normally the prints are checked against database of footprint for any match in pattern. Footwear evidence can provide bloodstain analyst with certain information that can assist them in locating a suspect. Most footwear evidence, when collected and preserved properly can provide the type, make, description, approximate size, the number of suspects, the path through and away from the crime scene, the involvement of the evidence, and the events that occurred during the crime.

Bloodstain pattern analysis using image processing techniques have been developed over the past two decades to help forensic scientist in detection of footprint image boundary. Most studies showed the measurement of parameters help detection of crime scenario.

The footprints in crime scene have some problems. Maximum of the footprints are broken so it is often difficult to measure the height and width of the footprints accurately. So some reconstruction procedure should be adopted to get the accurate measure of those parameters. Then subsequent steps for prediction could be applied.

There are some noise and artifacts in the images. These should be removed for proper differentiation of the foot and shoe prints. The actual image matrix of the blood - stained footprint is cropped from the whole image by removing scale artifact and other background noises.

In our process initially pre - processing of footprint image after digitization and then segmentation of Region of Interest (ROI) is used. Further we use Divide and Conquer Homogeneity algorithm for enhancement of the image, followed by edge detection for obtaining foot print image boundary.

In preprocessing stage we use our method for image enhancement and noise reduction techniques. It improves the image and the image quality to detect the footwear impression for crime scene reconstruction. The basic preprocessing steps are the following (Figure 1-4):

1. Image is converted to gray scale image in first step.
2. Noise is removed if any.
3. The obtained image is then passed through a high pass
A hollow coconut with a hair wig was used to simulate the head hit event in a crime scene. This is shown in Figure (5). The authors particularly attempted to reconstruct the event of back head hit in a crime scene. The hair wig was soaked in 20 cc. of pig blood in order to create the bloody hammer transfer stains one might expect to see after head hit. The coconut shell was hit with hammer consecutively for 10 times and then hammer was dropped from a height of 40 cms, 60 cms and 80 cms respectively. In order to minimize or control property damage the hammer was dropped on a paper sheet (A3 size) placed on a thermocol sheet.

Transfer stains from blunt ended tools are often used by murderer as ‘weapon available at that particular moment’ or it is being carried out by murderer. Experiments made to study transfer stains produced by a blunt ended object (hammer in this case). Computer - aided simulation is done to find out the effect of heating by hammer several times in the particular case. We observed the following based on evidence available at crime scene.

1. If the transfer stain or imprint of a hammer or hammer like blunt object is present at the crime scene it implies that the particular tool has been used as a murder weapon in the crime scene.

Blunt force injuries

The most common blood stain patterns visible at the crime scene where the victim is found to suffer blunt force injuries, are saturation, impact, cast off and transfer stain patterns.
2. Based on the quantity of blood, hammer shape and material, the transfer stain formed when a hammer is placed in a blood pool. It is placed on a plain non-absorbent surface. It is different from the transfer stain formed when blood is allowed to drip over a hammer and then an impression of its face is taken.

3. Hammer-like transfer stains/imprints could also be created with other blunt ended objects. So other evidence like stain on the floor needs to be taken under consideration on a particular type of murder weapon.

Abrupt fall of hammer on paper (say from a height of 40 cm) after 10 head hits might leave a rough impression of the head of the hammer on paper, in case of a tiled floor. The temperature and humidity of the room was accordingly recorded on the day the experiment was conducted. In the first instance, a 30 cc blood pool was created. Hammer is placed in the blood pool for a brief period of 10 minutes (measure with a stop watch) and the hammer was then placed with the bloody face down on a plain, non-absorbent A3 size paper. This is shown in Figure (6).

When an object is placed in a pool of blood, if there are undulations, certain parts will touch the blood pool while others (i.e. undulations/raised sections) might not very well come in contact with the blood pool depending on the depth of the pool and the way in which the hammer was placed, partly or fully in the pool. It established that transfer patterns clearly mimicking hammer is used for murder.

**Transfer stain patterns on fabrics**

Some bloodstains on fabrics cannot be seen with the naked eye. Bloodstain pattern analyst can use chemical reagents such as Luminol to find and photograph unseen bloodstains. When sprayed on blood, Luminol creates a bright blue luminescent glow by reacting with iron in the blood's hemoglobin.

Of the different types of bloodstains patterns such as drip trails, impact patterns, expiration stains, blood flow pattern, saturation stains etc. the authors were particularly interested in the present murder case on the impact patterns, expiratory bloodstain patterns and transfer stain patterns on fabrics. The images are shown below Figure (7,8).

The following general features are examined at the spot by viewing the dress used by the victim.

1. Distortion of fabric at the crime spot.

2. Changes happened in dress worn by the victim.

3. Blood spots which are seen in the fabric worn by the victim. Direction of the severance line relative to the thread directions in the fabric.

4. View the puncturing action on dress and find rupture at neighboring yarns at different positions.

**Figure 7** Drip Stains/Patterns (caused by the force of gravity only).

**Figure 8** Transfer stain/patterns in Fabrics.

By way of experimentation the authors arrived at the conclusion that the angle of inclination of the hammer during hit on face of victim touched the target surface first. All the above process described so far indicates the investigation process by the bloodstain pattern analyst along with the following helps to get an idea how murder was happened. The bloodstain pattern analyst follows step A and step B as confirmation process for arriving a solution for a crime.

1. Step A: Finding distance from the blood source to the target.

2. Calculate direction of travel of blood with impact angles.

3. Force used to cause the bloodshed.

4. The weapon used to cause the bloodshed.

5. Observe multiple bloodshed at crime scene.

6. Interpretation of contact or transfer patterns

**Step B:**

1. Confirm or refute the position of a victim, witness, suspect, or defendant.
2. Determine if there is evidence of a struggle, or if the assault is “one sided”

3. Are stain patterns on a particular person’s clothing consistent with accounts given by the victim, witness, or defendant?

CONCLUSIONS

Violent criminal acts are often accompanied by dynamic blood shedding events at the crime scene. Bloodstain pattern analyst particularly deals with estimation of the dynamic blood shedding events from the static bloodstain patterns that have been left at the scene. Of all the stain patterns present at a crime scene, drip stain patterns are common stain patterns one would expect to document at a violent crime scene. The paper describes the procedural steps that are taken by the bloodstain pattern analyst during the investigation of a crime.

REFERENCES