

Process of Crime Scene Investigation and Simulated Reconstruction

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Abstract: *Blood was legally procured from Kolkata Municipal Pig Slaughter House, Tangra Kolkata, India. Given that fresh blood coagulates over time, 1100 IU of Heparin Injection was added to fresh pig blood to preserve the colloidal consistency of blood. It might be interesting to mention that 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 and hence reconstruction.*

Keywords: Transfer Stain, Hammer, Imprint in Blood, Porcine Blood, Crime Scene Documentation

1. Introduction

The Oxford Dictionary defines 'Crime' as 'an action or omission which constitutes an offence and is punishable by law'. The Uniform Crime Reporting program conducted by the Federal Bureau of Investigation (FBI) divides offences particularly into 3 broad categories based on the seriousness of the crime[1-2]. They are – Part I offences, Part II offences and Other Offences. Part I offences as the FBI records are serious crimes that occur with regularity in all areas of the country and are likely to be reported to the police. Part I offenses include Criminal homicide, forcible rape, aggravated assault, burglary (breaking or entering), Larceny-theft (except motor vehicle theft), motor vehicle theft, arson. Part II offences include, other assaults (simple), Forgery and Counterfeiting, Fraud, Embezzlement, Stolen property: buying, receiving, possessing, Vandalism, Weapons: carrying, possessing etc., Prostitution and Commercialized vice, Sex offenses(except forcible rape, prostitution, and commercialized vice), Drug abuse violations, Gambling, Offenses against the family and children, Driving under the influence of an intoxicant, Liquor laws, Drunkenness, Disorderly conduct, Vagrancy. Other offenses include Suspicion, Violations by juveniles (under the age of 18) of

local curfew or loitering ordinances, runaways by juveniles (under the age of 18) taken into protective custody under the provisions of local statutes. Figure 1 provides a graphical description of the crime classification system endorsed by the UCR program conducted by the FBI. As per the UCR program conducted by the FBI, Violent Crime primarily comprises of murder and non-negligent manslaughter, forcible rape, robbery and aggravated assault[3]. The UCR program defines Violent Crime as those offenses which involve force or threat of force. In coherence with the crime definitions put forward by the UCR program, the National Crime Record Bureau, India, categorizes violent crime under the following heads – Murder, Attempt to Commit Murder, Culpable Homicide not amounting to murder, Rape, Kidnapping and Abduction, Dacoity, Preparation and assembly for dacoity, Robbery, Riots, Arson and Dowry Deaths. These crimes are under most circumstances accompanied by bloodletting events. It is this subset of crimes that we intend to work on this particular project. The 'Crime in India Report 2013' published by the National Crime Record Bureau, suggests that there has been a subsequent yet persistent increase in violent crime rate over the last 20 years.

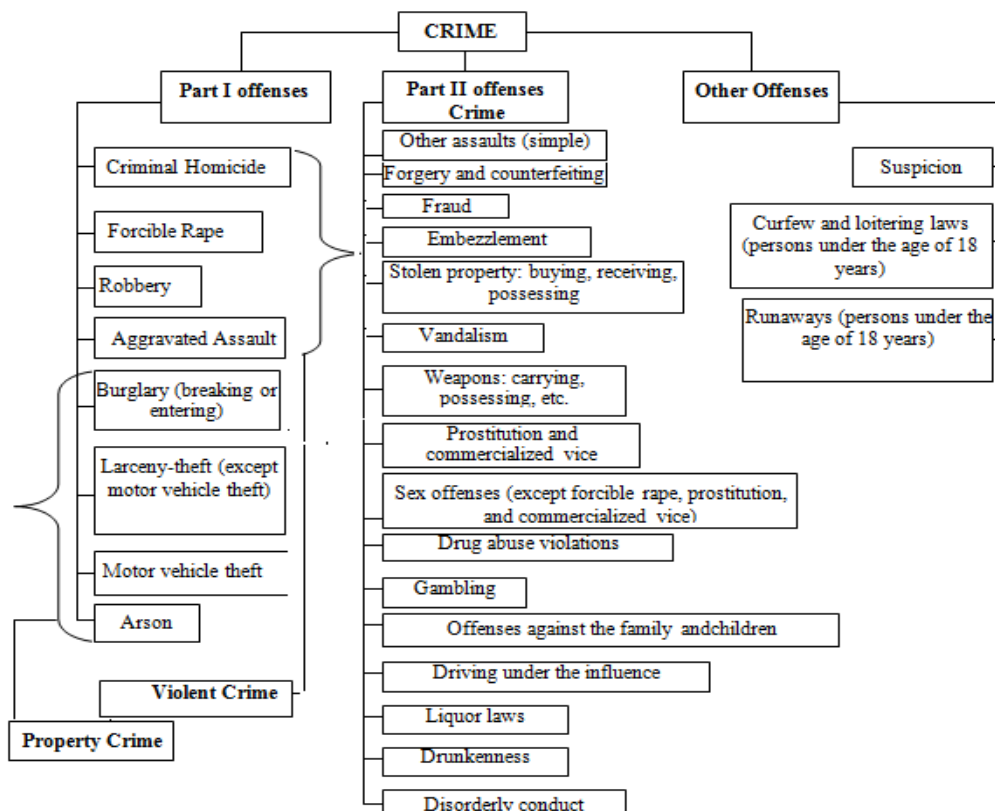


Figure 1: A Crime Classification Chart developed by the United Crime Reporting Program conducted by the Federal Bureau of Investigation

2. Methods Used

Now that the reader/s has a clear idea of which particular subsection of crime we particularly intend to deal with, it would not be out of place to provide a graphical overview of

how criminal offense is dealt with within the Indian juridical setting[4]. Figure 2 summarizes the Juridical setting relevant to trial of a criminal complaint within the Indian juridical system.

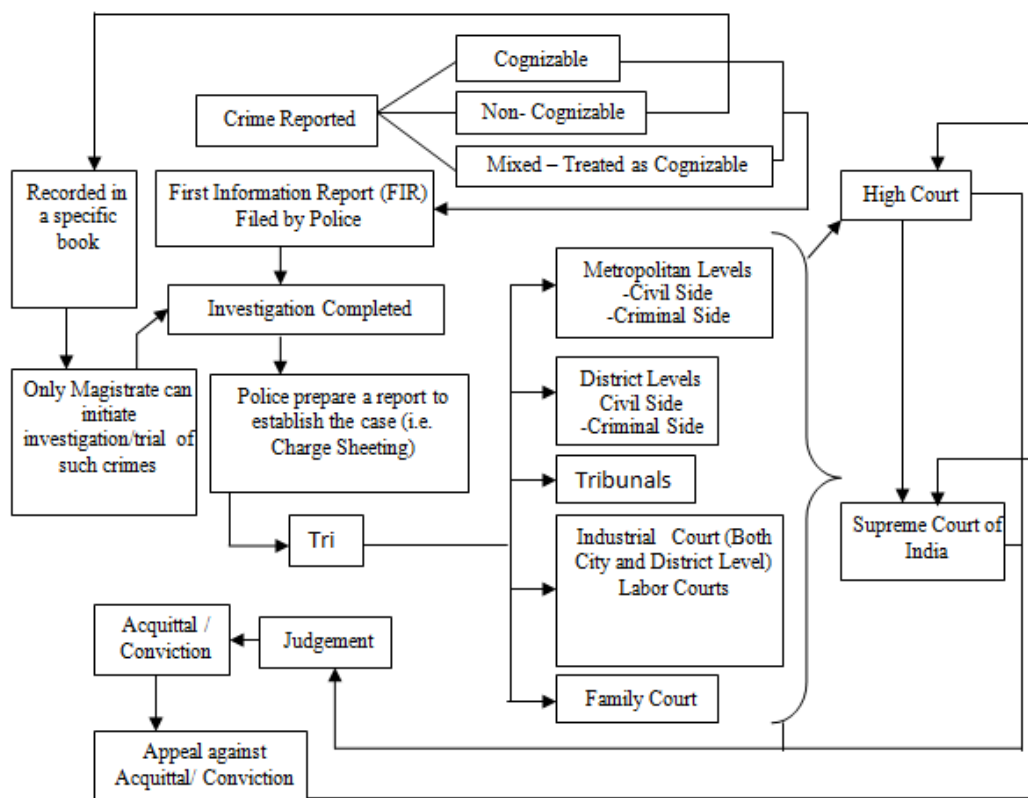


Figure 2: Flow Chart describing the trial of a criminal complaint within the Indian juridical setting

3. Overview of Crime Scene Reconstruction Process

The research work is particularly aimed at improving the process of crime scene investigation and hence reconstruction. Once a complaint is made, based on the

crime type reported (refer Figure 2), the criminal proceedings that take place can broadly be classified into 3 basic phases - Investigation, Inquiry and Trial. Figure 3 provides a graphical overview of the process of criminal case proceedings within the Indian juridical system.

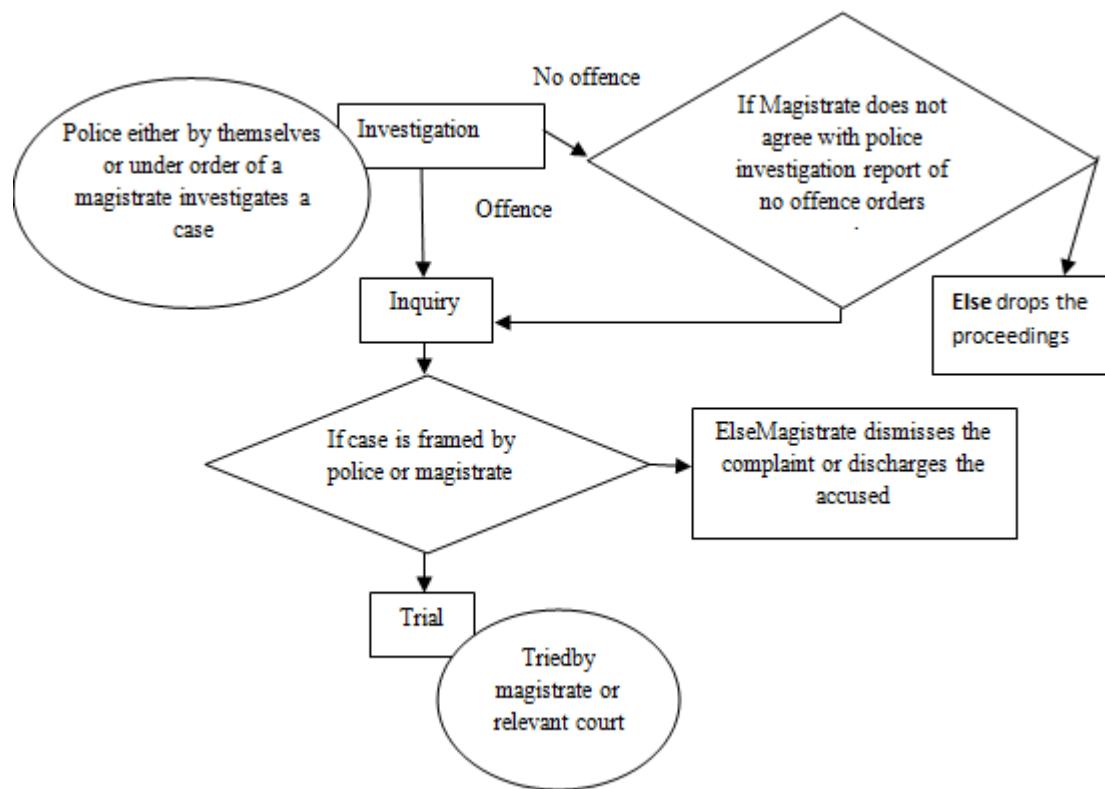


Figure 3: A flowchart documenting how a criminal case is processed within the Indian juridical system

Crime Scene Investigation and thereby Reconstruction in its turn particularly involves 3 basic phases (refer Figure 4). They are,

- Defining the Crime Scene
- Processing the Crime Scene
- Information Collection from and about the Crime Scene

Defining the crime scene refers to identifying the activity areas relevant to a particular criminal event. The Primary Crime Scene is the area where the original crime occurred. The Secondary Crime Scene comprises of the subsequent crime scenes. The Size of the crime scene can further be classified as Macroscopic and Microscopic. While Microscopic focuses on specific type of physical evidence at the crime scene, Macroscopic refers to one particular crime location composed of many microscopic crime scenes. In defining the crime scene, it is of utmost importance to understand the type of criminal offense that has been committed at the scene. It can range from homicide, robbery, rape or an admixture of all. In analyzing evidence, it often stands integral to know the physical location of the crime scene (i.e. Indoors, Outdoors, Vehicle etc.)

Once the Crime Scene is broadly defined, the next phase of the Investigation process deals with 'Processing of the Crime Scene'. At the very onset, the Crime Scene Investigator establishes contact with the Law Enforcement Officer in charge of the crime scene. Also he/she makes a list of other people such as other law enforcement officers,

coroner's personnel, public safety personnel, civilians, newspaper reporters etc. who have or have had access to the crime scene in question. The next step towards processing a crime scene is Securing the scene by use of police line tape or other means in order to prevent unwanted access to the scene by casual passerby, people with malicious intentions etc. The scene is secured in order to leave all evidence at the crime scene undisturbed by wandering individuals. Once secured, the scene is subjected to initial overall survey by investigating officials. At this point, the officials leave all evidence undisturbed and develop initial theories based on apparent understanding of the crime scene. The officials also mark out potential evidence in the initial walk through phase. The first responders as also enforcement officials take into account the entry /exit points in the scene that require attention. This phase also requires the officials to make a list of equipment and precautions that the officials would need to take in order to document as also search the crime scene.

The crime scene is thoroughly documented by way of Notes, Videotaping, Photographing and Sketching. Once clearly documented, systematic search patterns are used in order to avoid missing out on any piece of physical evidence present at the crime scene. The different search patterns that are used to search a crime scene have been graphically documented in Figure 5.

The third phase of the project particularly deals with collection/securing of evidence from a crime scene. The legal system classifies evidence or rather 'relevant' evidence

as – Testimony, Real evidence, Hearsay evidence, Original evidence, and Documentary evidence (refer Figure 6). Evidence is termed ‘relevant’, when the facts that are subject to prove or disprove in a court of law amount to

- Facts in issue, i.e. those which need to be proved by one party;
- Relevant facts, i.e. those which tend to prove the facts in issue;
- Collateral facts which may for example affect the credibility and/or competence of a witness.

Evidence based on its use in understanding a crime scene can broadly be classified into two broad groups – Associative Evidence and Reconstructive Evidence. Associative evidence, in its turn, can also be used for reconstructive purposes. While Finger-mark, Fingerprint, Foot-mark, DNA(from Hair, body fluids), Ear-mark, Bite-mark, Handwriting can particularly be used as associative evidence for uniquely identifying an individual, evidence such as Firearm, Shoe-mark, Fibers, Paint, Glass, Tool-mark, Soil, Drugs, Fire debris, Explosives, Pollen Grain help, Bloodstain Pattern help in crime scene reconstruction.

Given that this Research work is particularly aimed at interpretation of ReconstructiveReal (read Physical) Evidence, it would not be out of place to present a classification of the different types of Reconstructive Evidence that are used for crime scene reconstruction based on how they contribute to the reconstruction process. The different types of Reconstructive Evidence are Temporal/sequential evidence, Directional evidence, Positional Evidence, Action and Associative Evidence.

Bloodstain Pattern evidence can be used for sequencing events at a crime scene. Again, it can be used to trace the direction in which a body was dragged. In addition it can also be used to draw useful conclusions about the relative position of the victim/s, perpetrator/s and bystander/s (if any) in a crime scene. Stain patterns can be used for predicting the probability of events that might have occurred at a crime scene. Bloodstain Patterns cannot in particular be associated with an individual. DNA analysis of blood samples, blood serology test can be used as associative evidence for uniquely identifying an individual.

So, given the widespread application that bloodstain pattern has in crime scene reconstruction, it should not come as a surprise that the authors are particularly inclined towards the study of bloodstain patterns in a crime scene.

Given the large scale uncertainty involved in the study and interpretation of bloodstain patterns, we intend to design a semi-supervised tool that could probabilistically make a prediction of the relative position of the perpetrator/s, victim/s and bystander/s (if any) using bloodstain pattern evidence in conjunction with other circumstantial evidence such as presence/absence of objects in a crime scene, wound analysis results etc. This in its turn would particularly aid the whole process of crime scene reconstruction within a juridical setting.

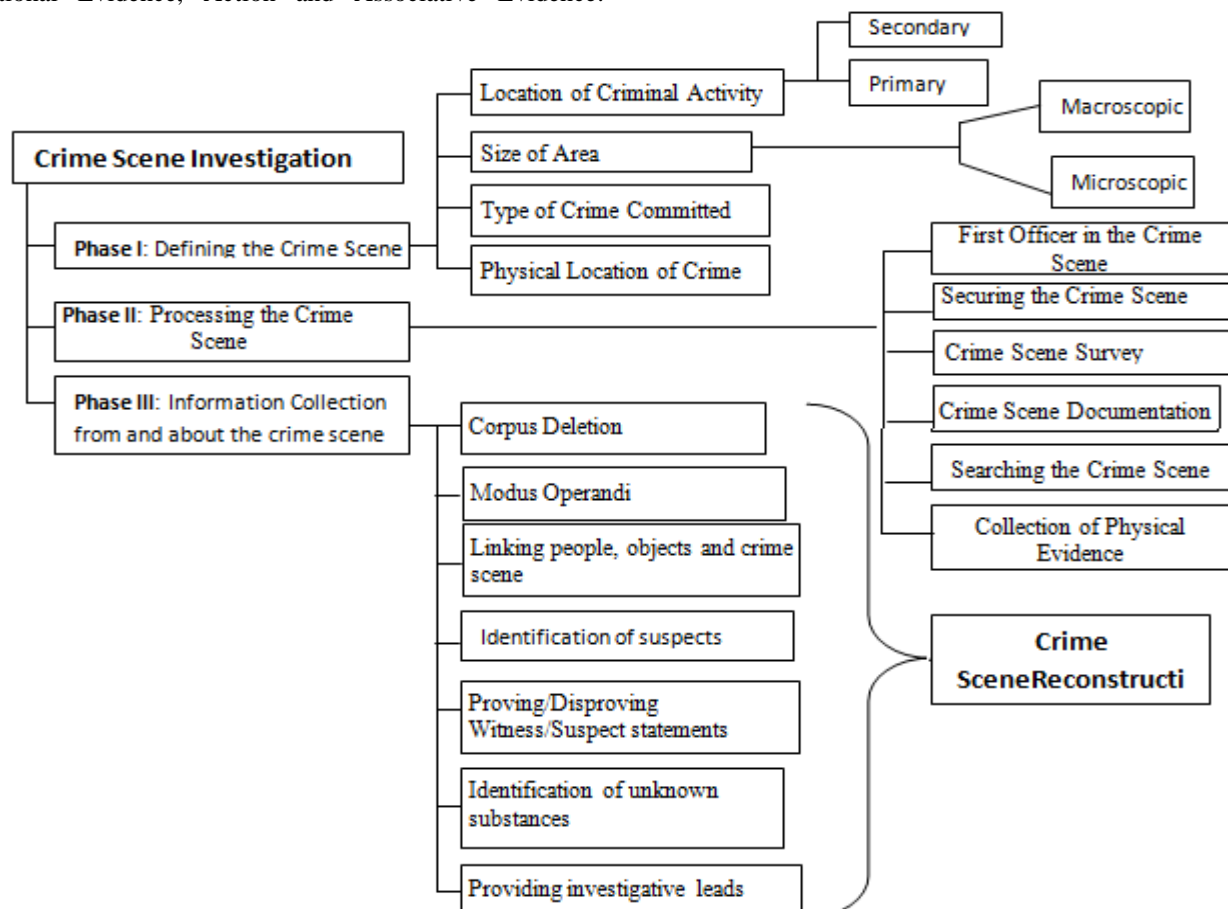


Figure 4: Crime Scene Investigation – a broad overview

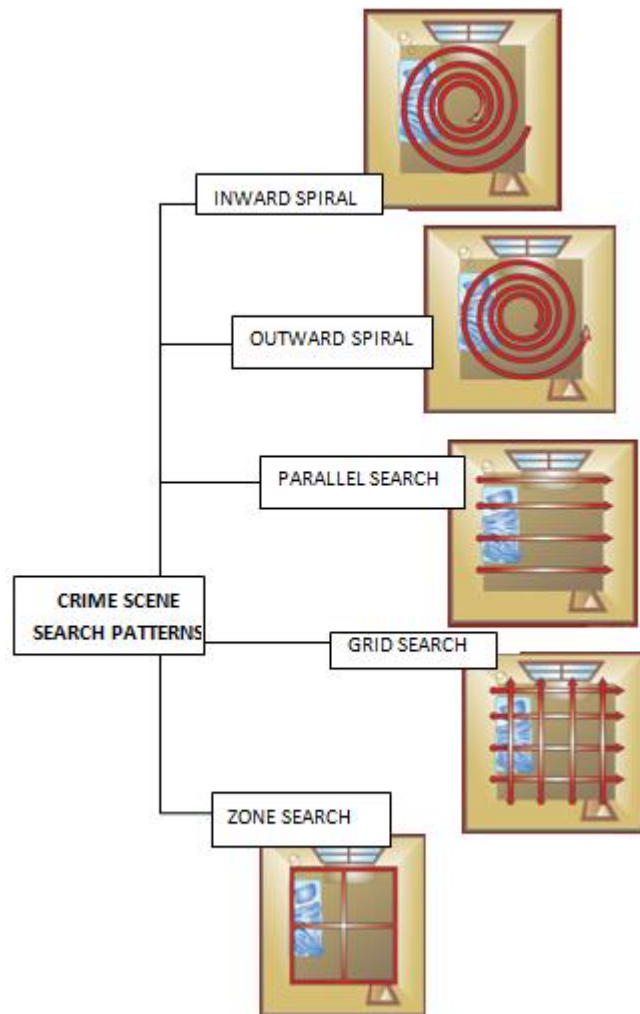


Figure 5: Search patterns used for collecting evidence from a crime scene

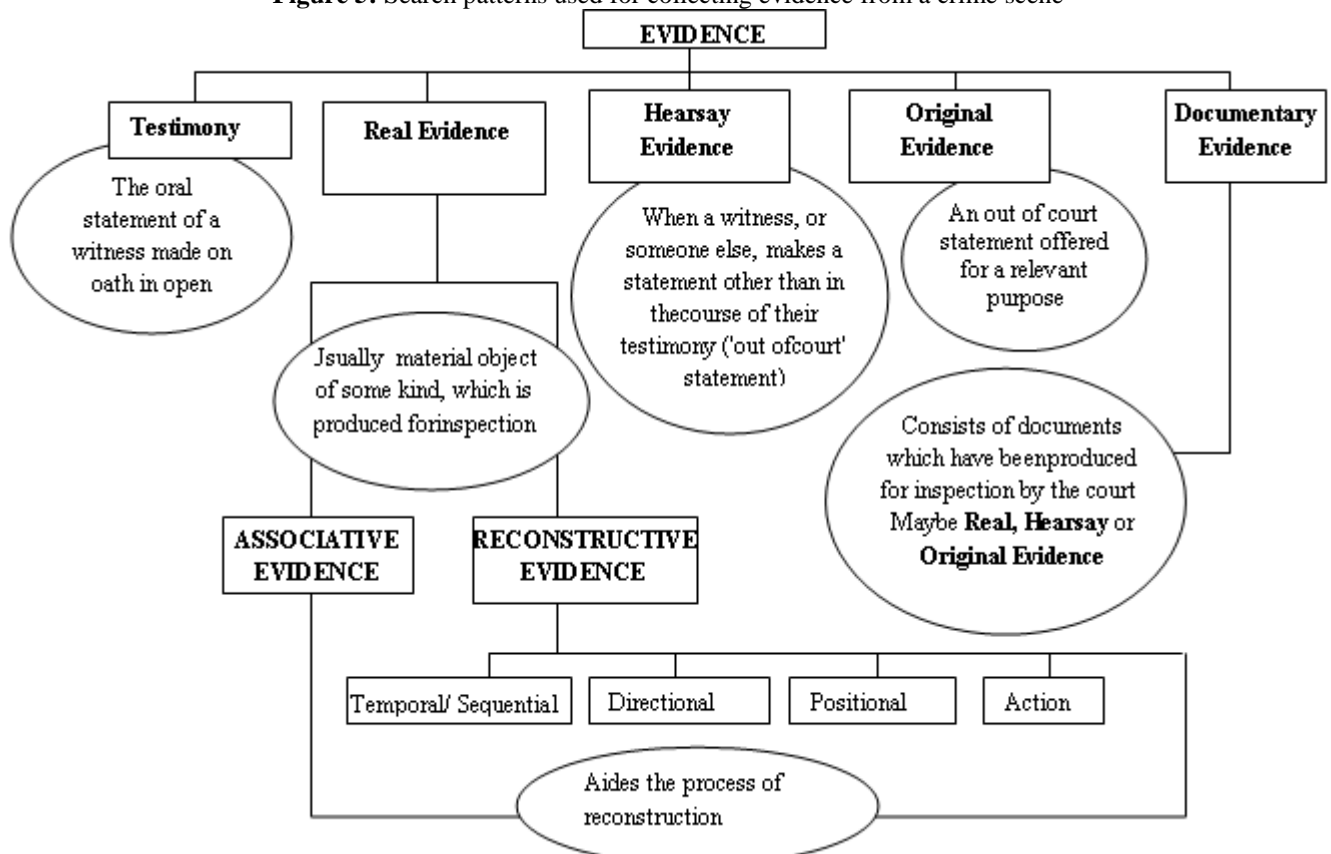


Figure 6: Evidence classification table

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4. Simulated Crime Reconstruction

A comparative study of the two bloodstain pattern classification systems shall be performed thereby aiming to analyze whether a window-based tool can be developed to automatically classify the different types of stains abiding by either of the two classification tables. If not, why it cannot be done, shall be explained with samples and scientific reasoning. If at all it can be done, the possible technical pitfalls shall be outlined.

Some of the possible pitfalls that are already present are ----

- 1) Bloodstain patterns are very fragile evidences that can be easily distorted, contaminated by careless footsteps, other environmental factors in a crime scene.
- 2) Different surfaces react differently to the same volume of blood being poured with the same velocity from the same height, at the same angle of impact using the same physical mechanism. That is to say, apart from absorbent and non-absorbent surfaces, there are also stark differences in stain patterns between cloth pieces of different absorption capability.
- 3) Superimposed stains are difficult to judge and hence separate out for a human analyst owing to unwanted overlapping, distortion of the two stains. More so for a system, due to the large variability in the possible stain patterns
- 4) Presence and Absence of blood in a crime scene are both equally relevant, difficult for software to trace out its cause of relevance.

8. With due help from authorized law enforcement agencies (state police, army) and scripted court proceedings we intend to re-create primary (i.e. Location of the original criminal activity) crime scene and the different sort of blood stains we could see particularly on different sorts of fabrics, floor, ceiling, walls, ground, both indoors and outdoors in a violent crime scene by use of a range of murder weapons (eg. Axe, Knife, Screw-driver, stick etc)

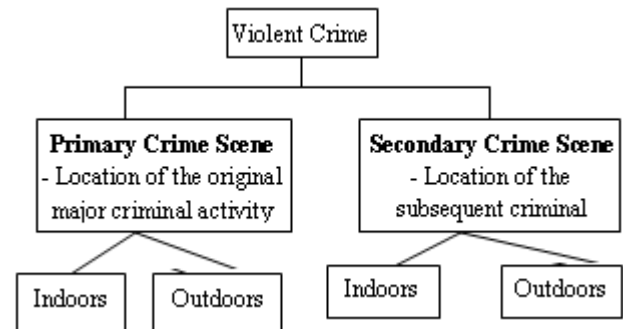


Figure 7: A graphical representation of crime scene classification

a) In the very beginning, we intend to document the stain type we can see or might expect to see on the clothes of an individual when he is a victim, perpetrator or a simple bystander in the event of a head hit of a victim using a stick, rod, axe etc. (The instruments of head hit shall be decided in discussion and study of court proceedings of several violent cases that have so far been solved) in an indoor setting. Based on the velocity of hit, stain type on cloth of an individual, number of hits, distance between the victim, perpetrator and bystander, relative position of the three at the time of hit, movement of any party before probable subsequent hits, direction of movement of weapons and people, room temperature, humidity, room dimensions, person height, weight, using Bayesian networks, correlation and regression we would try to probabilistically infer the position of an individual (victim, perpetrator, bystander(if any)). While Figure 6 provides a three dimensional view of head hit, Figure 7 documents some of the possible positions of a victim, perpetrator and bystander in a crime scene at the time of first head hit in 2 dimension.

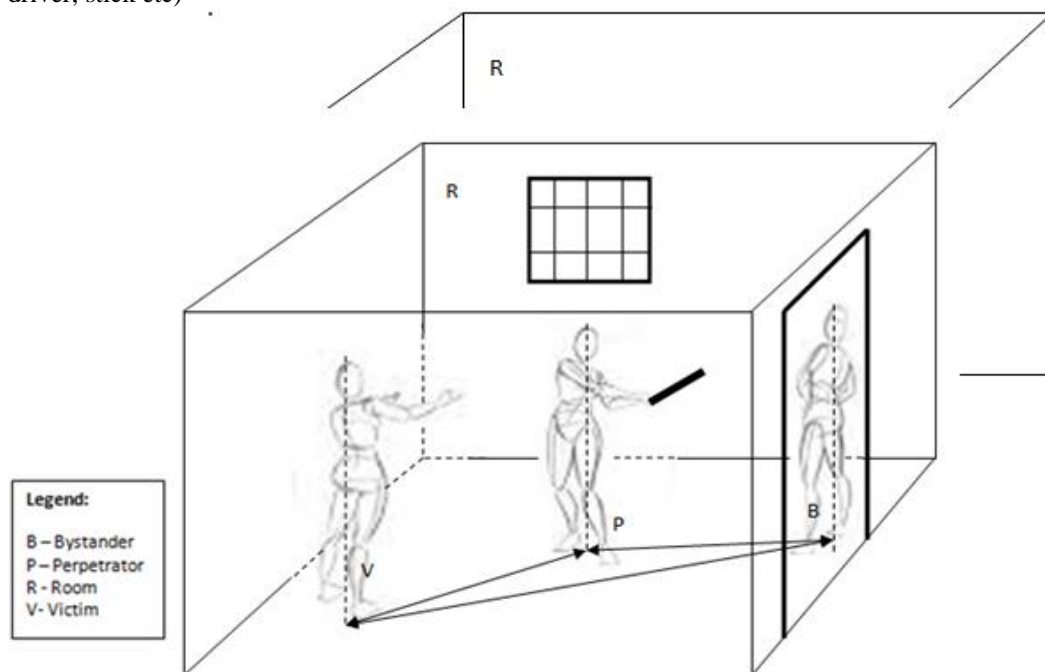
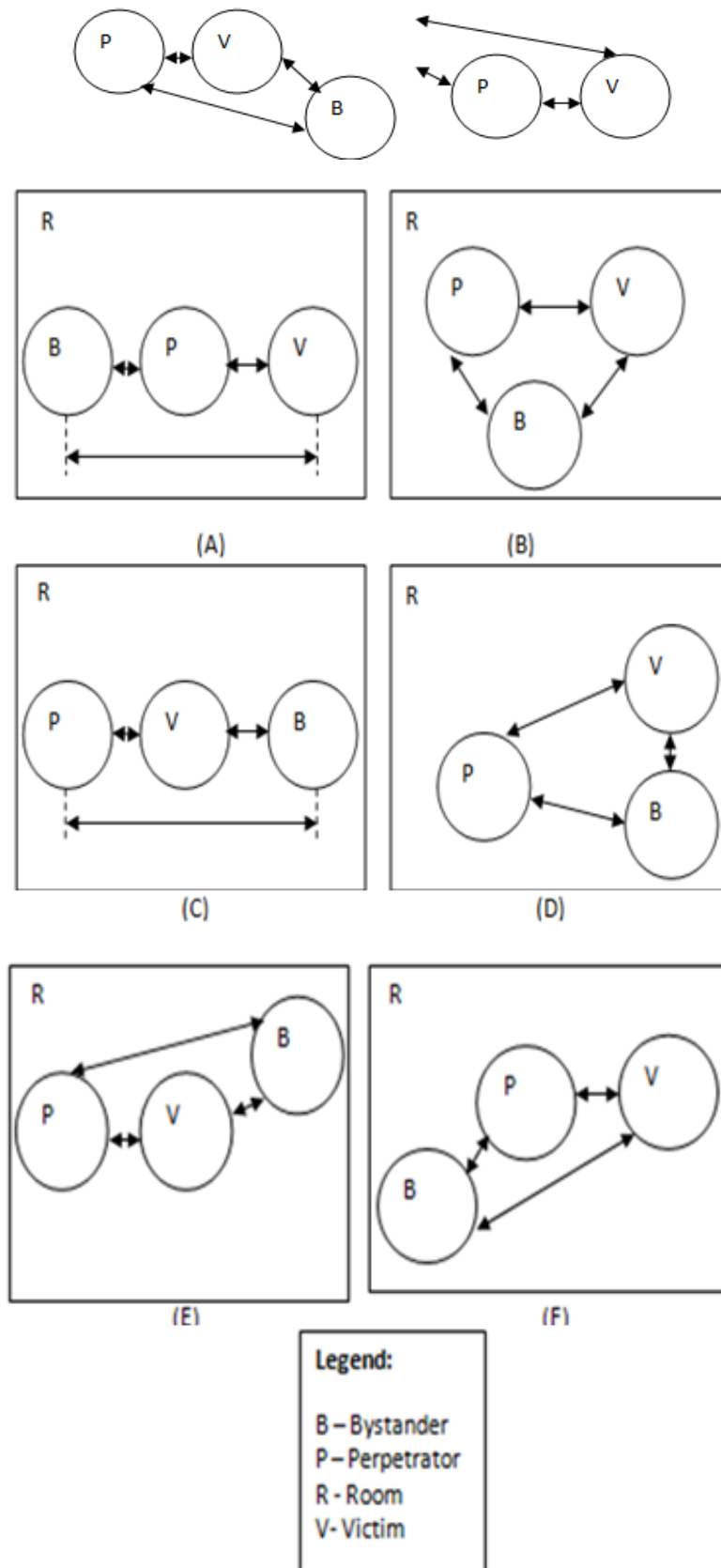


Figure 8: A 3 dimensional representation of a head hit scenario indoors (Blood stains haven't been marked in the 3D representation)



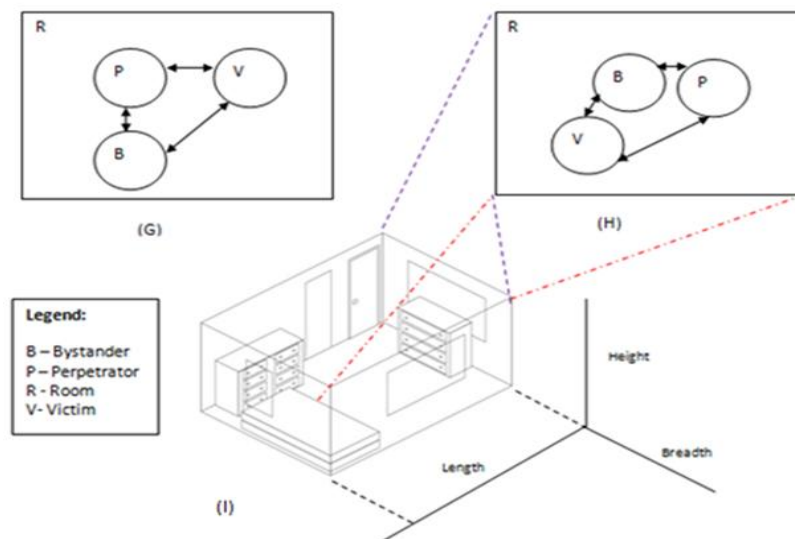


Figure 9: (A-H) 2 Dimensional representation of the position of a victim, perpetrator and bystander (if any) along with their relative positions represented by double headed lines, (I) Figure I represents the 2D representation of a 3D room. In all the Images, B represents the position of the Bystander, P represents the position of the perpetrator, R represents the room and V represents the Victim (refer Legend). Similar images can also be generated in an outdoor environment.

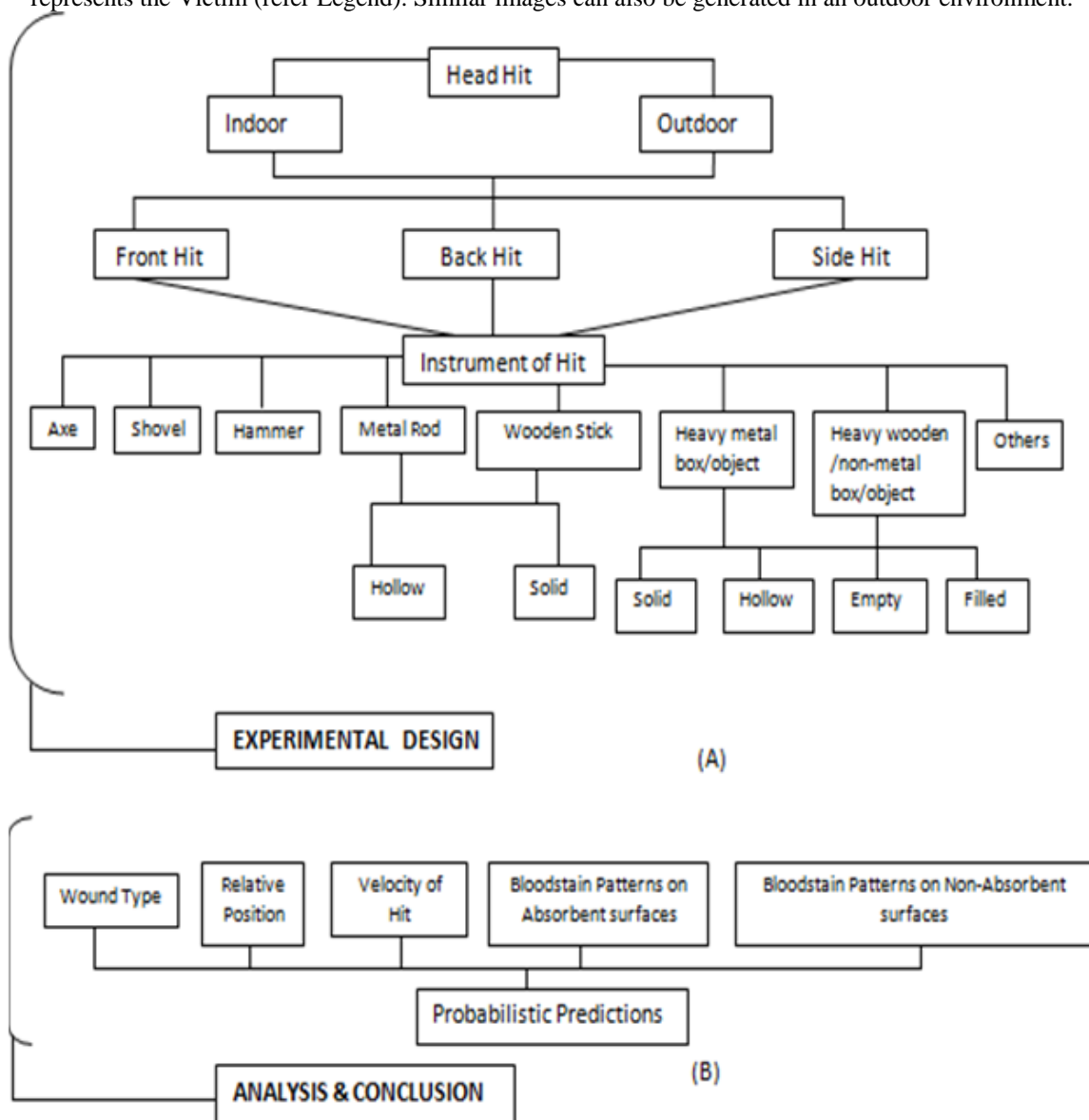


Figure 10(A): Elementary Classification of possible Head hits in a crime scene ,
(B) : Data Analysis and Conclusion based on Head hit events

- a) The second stage shall record the staining observed on the walls and ceiling as a result of subsequent head hits without change of position of any of the 3 individuals in the room and with subsequent change of position of the three individuals in one way or the other during the hit. The differences in the pattern formation on the walls and on the ceiling shall be recorded, thereby documenting the changes in position/movement that caused the differences in pattern.
 - b) The third stage shall record the head hit staining on the surroundings in an outdoor environment, based on the same positioning of the victim, perpetrator and bystander. The outdoor position shall be selected based on case study and in discussion with police staff who investigate crime scenes. An area study on which could easily be extended to other outside framed crime scenes would be an ideal area for experimentation.
 - c) A crime scene dataset with special emphasis on bloodstain patterns shall thereby be created containing recreated real crime scenes and thought out probable crime scenes to aid the presentation of bloodstain pattern evidence in a juridical setting
- [3] Toplikar, D. (2010, December 13). Blood stain with hammer imprint shown in ex-FBI agent's murder trial - Las Vegas SunNews. Retrieved from <http://www.lasvegassun.com/news/2010/dec/13/blood-stain-showed-imprint-hammer-says-analyst-ex-/>
 - [4] Bevel, T., & Gardner, R. M. (2002). *Bloodstain pattern analysis: With an introduction to crime scene reconstruction* (3rd ed.).

5. Conclusions

A window based tool shall then be developed that shall allow the end user (law professionals, police, forensic analysts) to draw up a room or an outside arena (probable choices shall be predefined). It shall facilitate the concerned individual to mark out different stain patterns within a closed space (room) or an outside arena, so that the concerned analyst can visualize the events in a 3 dimensional space.

Technical constraints –

- 1) While position based distances between individuals in the crime scene can be varied, the outside arena cannot be selected/ designed beyond the predefined options.
- 2) Though we intend to make the predefined options as varied as possible, yet inclusion of all possible scenarios cannot be guaranteed.
- 3) The particular emphasis of the software shall be on the position of the perpetrator, victim and bystander/s (if any) in the crime and on the different possible bloodstain patterns as extracted from the crime scene photograph that have been marked out by a pattern analyst.
- 4) The tool is not intelligent in itself, given the large scale variability and fragile nature of bloodstain patterns the tool shall help crime scene reconstruction with due input from an experienced investigator.
- 5) Over time the functionality of the tool shall be extended.

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