International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Volume 2 Issue 1 (January 2015) www.ijirae.com

Drip Stains on Non-absorbent Paper and Fabrics on Visualization of Crime Screen Reconstruction

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Abstract -- ***A reference database of bloodstain drip pattern on different types of fabric (i.e. fabrics made from natural fiber, man-made fiber, fabrics used for industrial purposes) is created. This paper presents a window based tool that particularly enhances bloodstain patterns on difficult surfaces in a crime scene.***

Keywords: Fabrics, Bystander, Perpetrator, Room and Victim

INTRODUCTION

Locard[1] believed that no matter what a perpetrator does or where he goes ,by coming in contact with things at or around a crime scene he can leave all sorts of evidence , including DNA, fingerprints, footprints, hair , skin cells, blood, body fluids, pieces of clothing fibers and more[1]. While the criminal leaves something at the crime scene he is also expected to take something away from the scene with him[1]. On a very loose connect it might be said that when killing an individual with a hammer hit the criminal might take away the murder weapon with him but at the same time he might end up leaving behind bloody stains of the blood bearing hammer at the crime scene . 'A bloodstain resulting from contact between a blood-bearing surface and another surface' has been termed as 'Transfer Stain' by the International Association of Bloodstain Pattern Analysts (IABPA)[2-4]. Thus this work is particularly directed at studying hammer transfer stain patterns at a crime scene.

METHODOLOGY

1. At the very onset, we intend to create a database of drip stains on non-absorbent paper and thereby record how the stain patterns vary owing to difference in flow aperture, height of liquid column, angle of impact, fall height, paper creases and temperature humidity. [Fresh pig blood was preserved by addition of anticoagulant as per requirement. All samples were prepared with blood thoroughly mixed with anticoagulant]

2.Dataset of Blood drip patterns was created using fresh pig/porcine blood that was subsequently treated with two different types of anticoagulants (Warfarin (orally administered) and Heparin Injection (intravenous)) and the effects of different dosage of the anticoagulant medications on the stain pattern on non absorbent paper surface was accordingly recorded by varying the angle of impact and fall height. The day temperature and humidity shall also be recorded during the experimentation by the use of a hygrometer. A statistical analysis highlighting if there is a statistically significant difference in the stain patterns cast when the dosage of anticoagulant is varied shall be carried out.

3. 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 particularly divided into 3 basic types. They are –Fabrics from natural fibers, Fabrics from man-made fibers, Fabrics for special uses (Refer Figure 1).

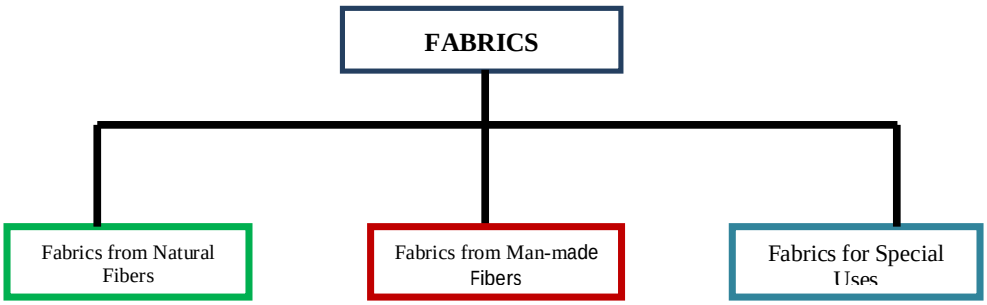

Figure 1: Basic Classification of Fabrics [1]

4. The Fabrics from Natural Fibers (Refer Figure 2) , Fabrics from Man-made Fibers(Refer Figure 3), Fabrics for Special Uses(Refer Figure 4) can further be subdivided into certain sub categories[1].

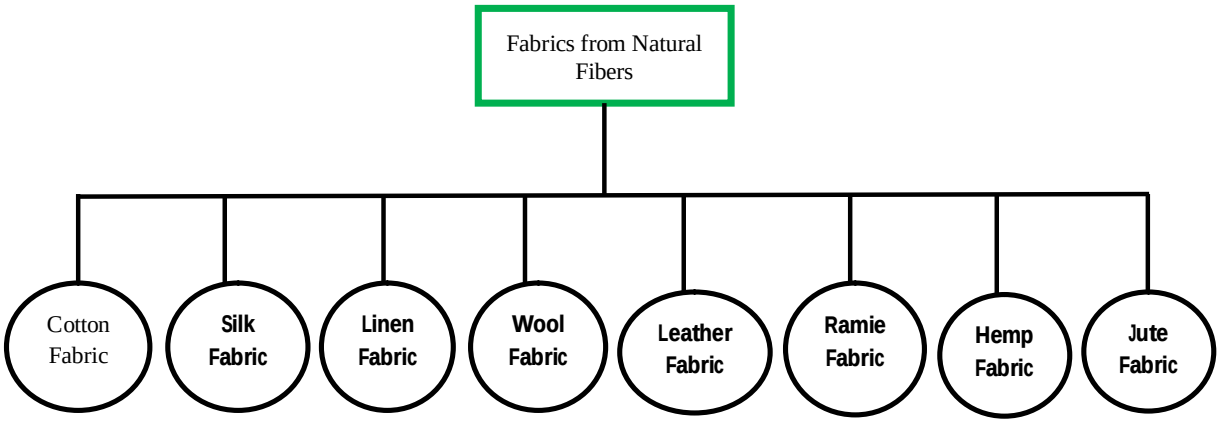

Figure 2: Classification of 'Fabrics from Natural Fibers' [1]

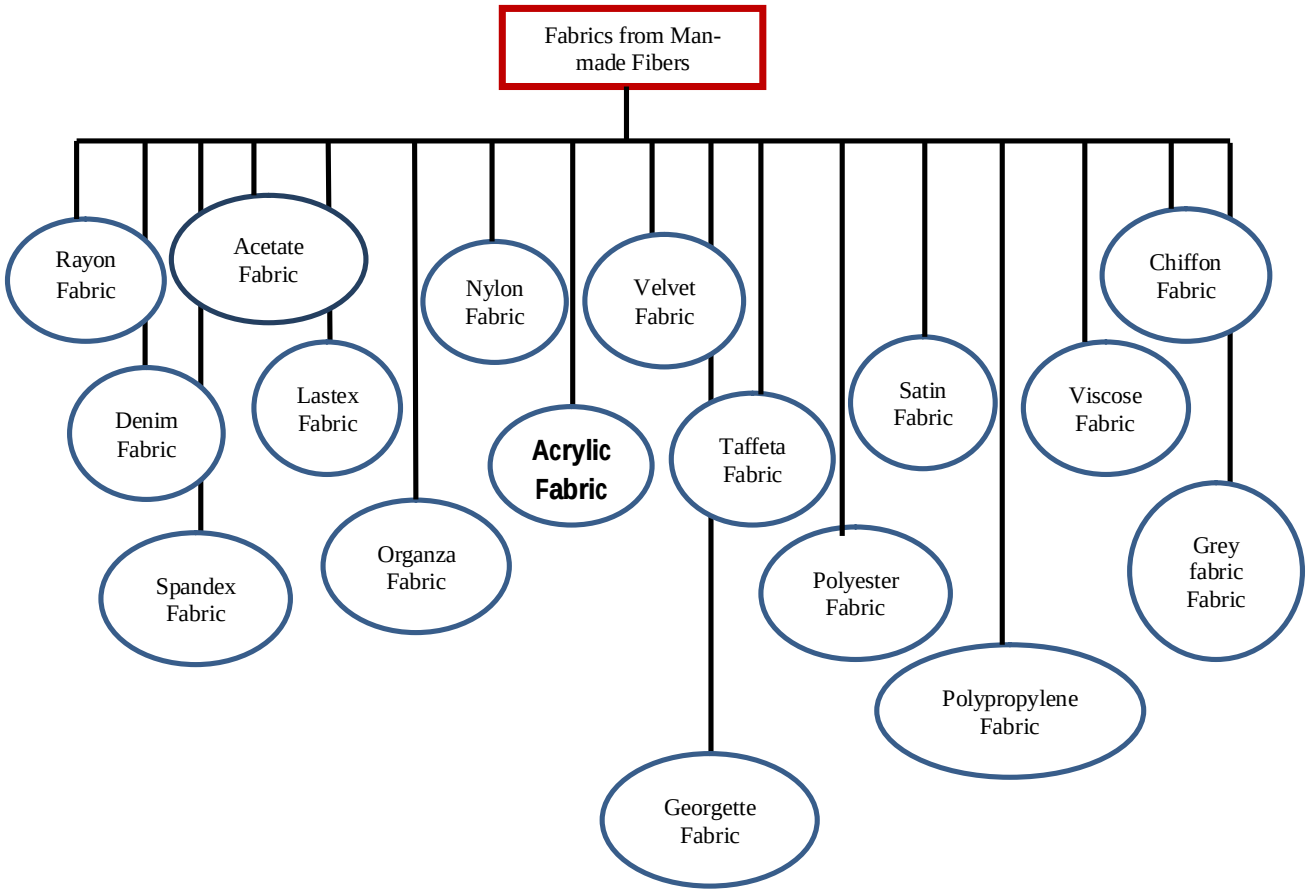

Figure 3: Classification of 'Fabrics from Man-made Fibers' [1]

Again each particular type of fabric can further be divided predominantly into two types – woven and knitted based on the weave of the cloth. We take the weave of the fabric into consideration because it has been previously 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. The shades may vary depending on the availability of the cloth in a particular shade, variance due to weave of the cloth, natural color of the fiber etc. We intend to stain two light colored fabric pieces and two dark colored pieces, to record how the color of the fabric affects visibility of stains to the naked eye

Also we plan to use 3 different types of the same cloth – new, worn out (washed 8 times), sweat stained cloth washed 2 times, to record the same type of stains. From previous research we expect these different types of clothes to have very different stains although the stains might have been dropped using the same mechanism, under similar temperature , humidity and wind condition keeping the volume of liquid dropped , blood column , fall height, angle of impact constant .

5. Using different feature extraction and feature selection algorithms we intend to create a window based tool that can enhance the stain patterns irrespective of the color of the cloth on which the stain was cast, cloth creases, and lighting conditions. However, the capability of the tool shall be restricted to analyzing images that are taken absolutely parallel to the surface on which the stain was formed. The reason for this being that, in bloodstain pattern analysis stain photographs are always taken parallel to the surface on which the stain is formed to avoid distortion in stain dimension owing to angular placement of the camera.

6. A dataset of wipe and swipe bloodstain patterns formed on non-absorbent surfaces (such as non absorbent paper surface, non absorbent floor surface, non absorbent wood surface etc.) shall be developed and an attempt shall be made to understand if there are any marked stain characteristics that can help analysts to distinguish swipe patterns from wipe patterns. Whether the difference (if any) between the two sets of stains statistically significant shall then be analyzed using t-test, correlation significance values.

7. A comparative study of the two bloodstain pattern classification systems put in place by Bevel and Gardener and Sutton and Kish 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.

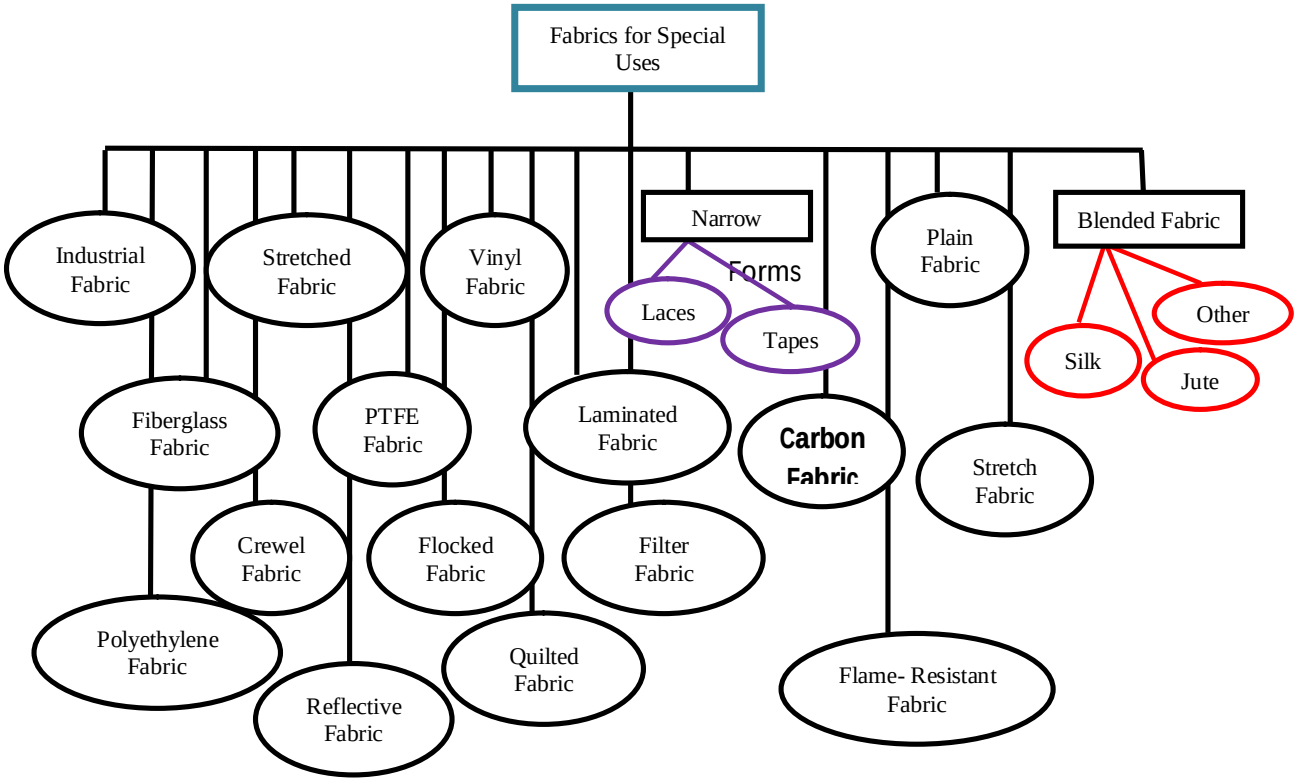

Figure 4: Classification of 'Fabrics for Special Uses' [1]

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 sceneand 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.).

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.

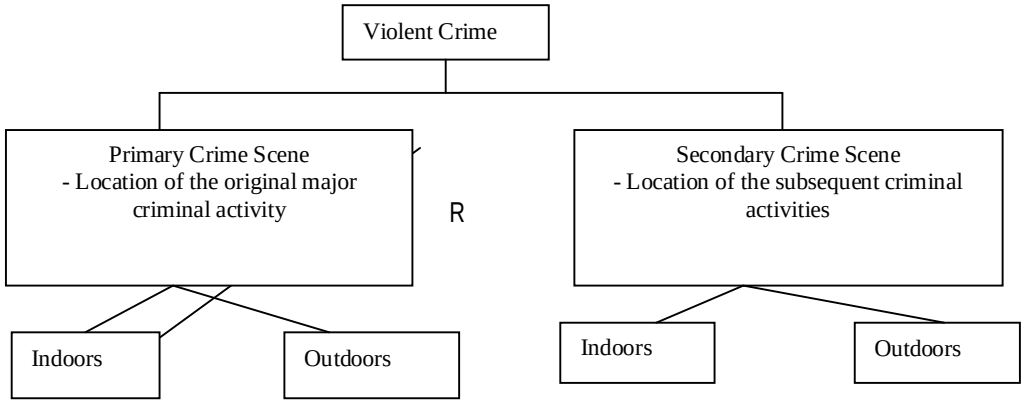

Figure 5 : A graphical representation of crime scene classification

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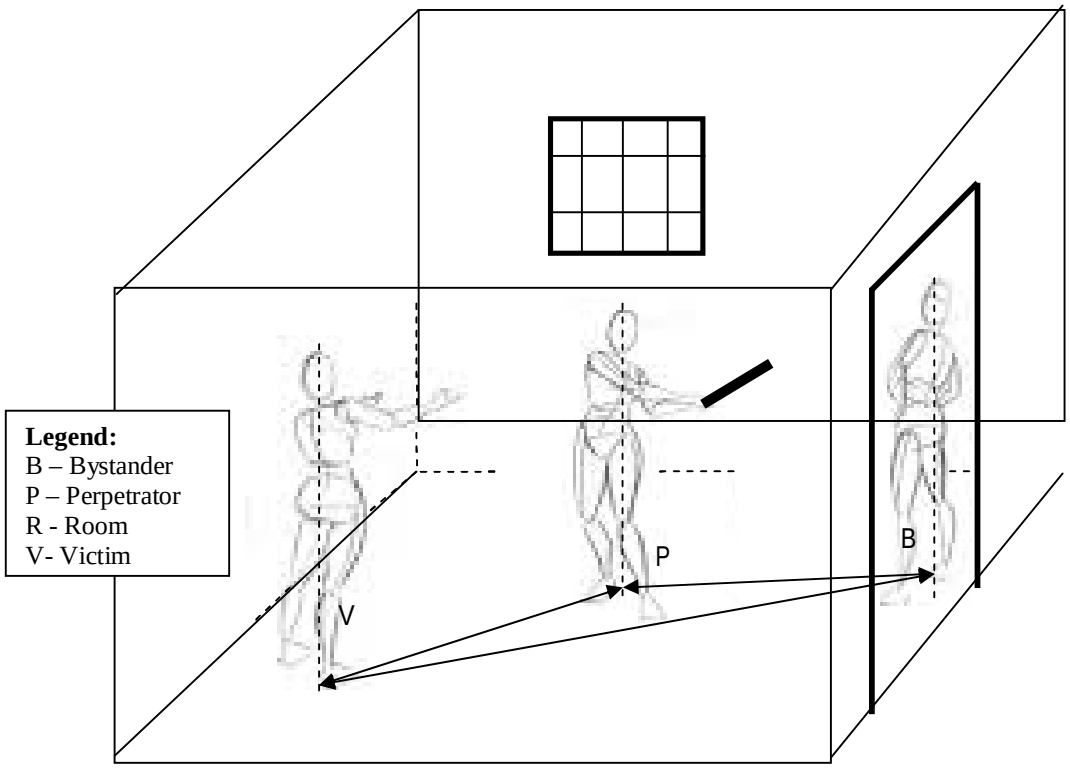
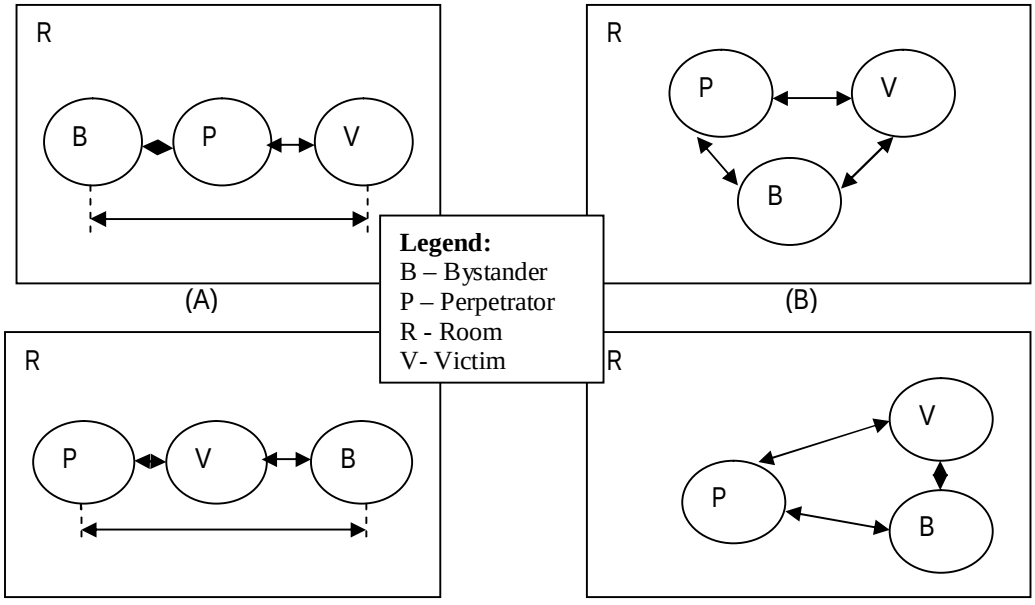


Figure 6 : A 3 dimensional representation of a head hit scenario indoors (Blood stains haven't been marked in the 3D representation)



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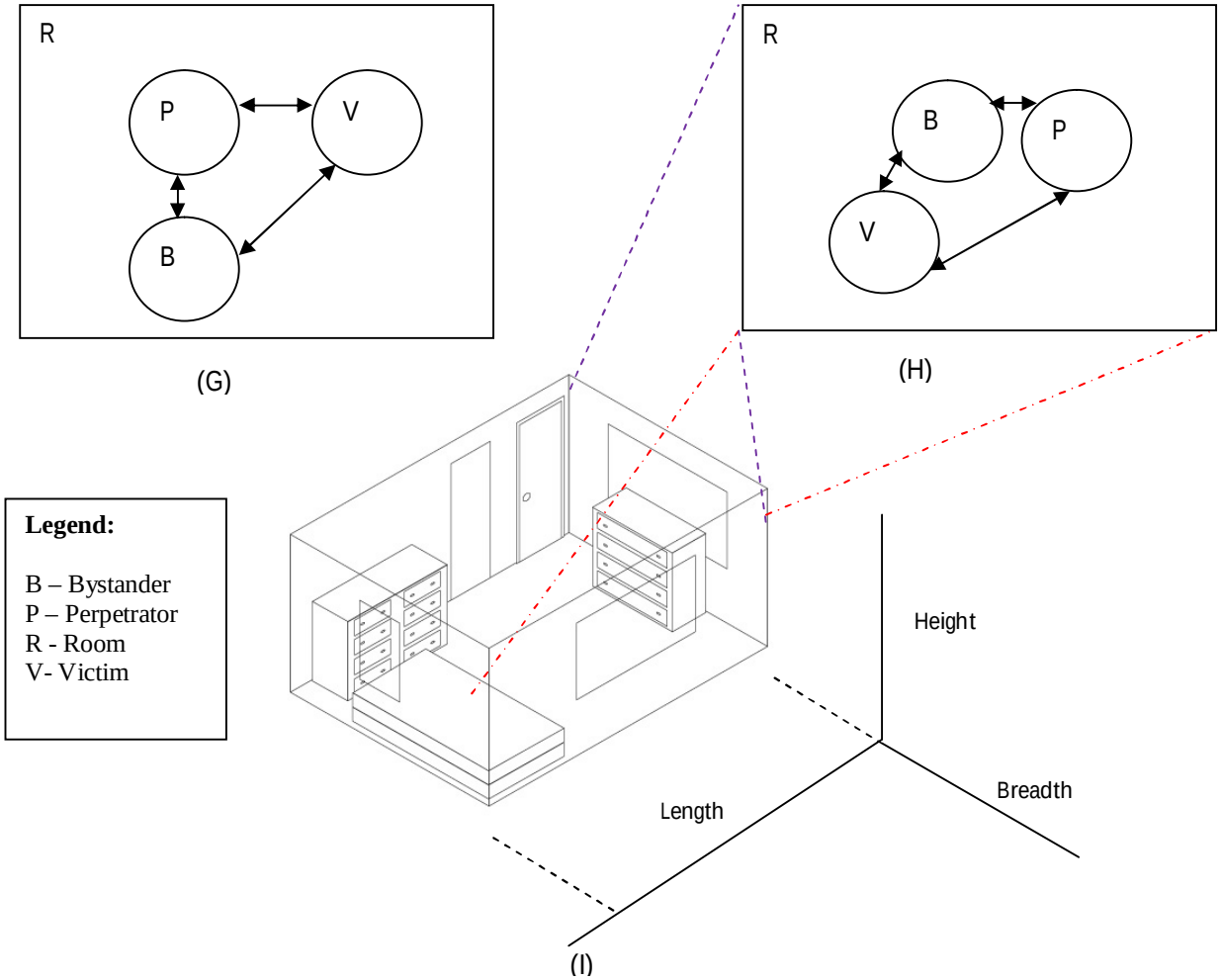

Figure 7 : (A-H) 2 Dimensional representation of the position of a victim, perpetrator and bystander (if any) along with their relative positions represented by double headed lines, (I) Figure I represents the 2D representation of a 3D room. In all the Images, B represents the position of the Bystander, 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.

Head hit by use of different instruments can further be classified as displayed in Figure 8(A). Figure 8(B) displays how the information from a crime scene head hit event can be used for part/full reconstruction of crime scene.

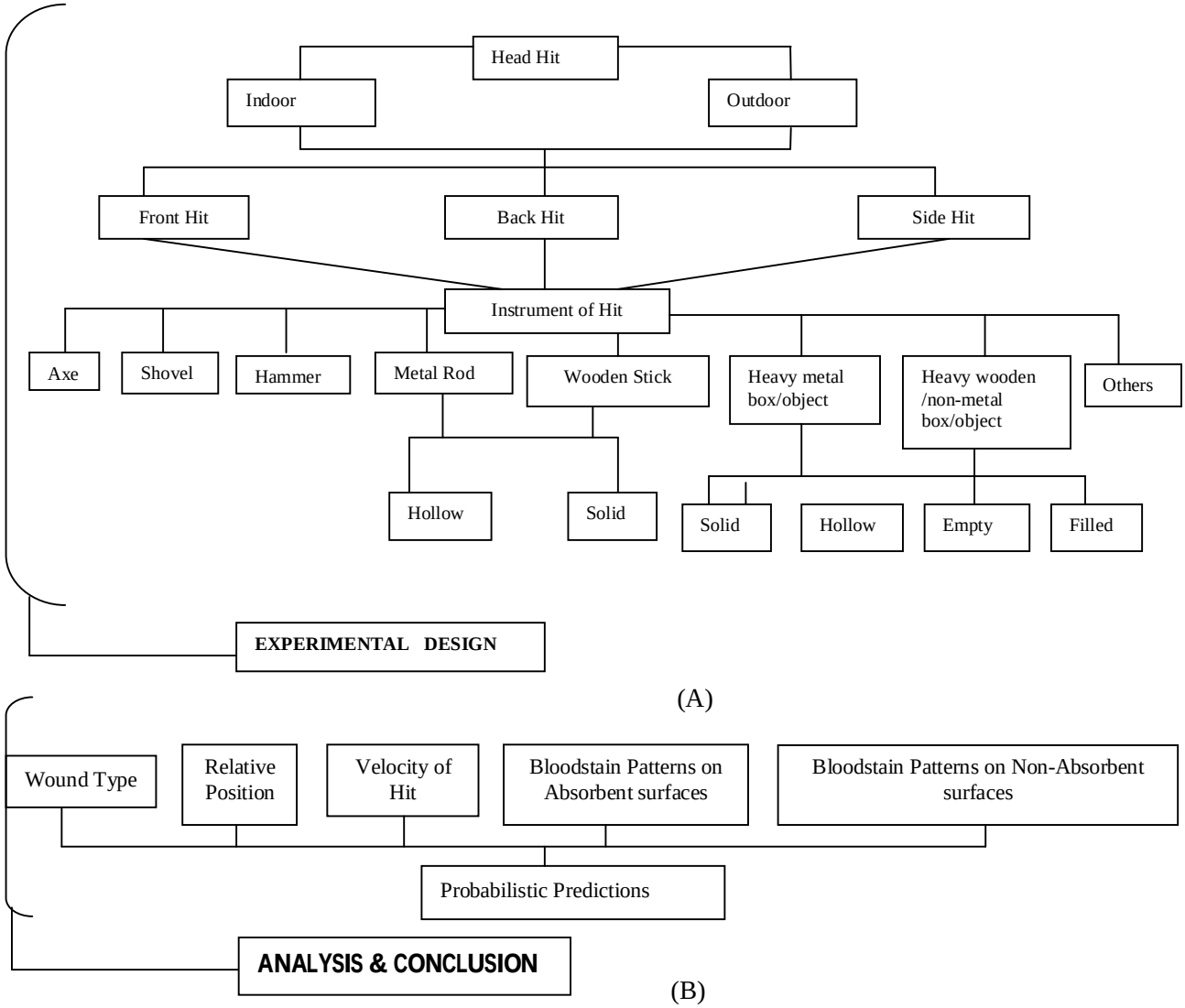

Figure 8(A): Elementary Classification of possible Head hits in a crime scene ,
(B) : Data Analysis and Conclusion based on Head hit events

b) 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.

c) 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.

d) 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

9. A window basedtool 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.

CONCLUSIONS

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.

10. Over time the functionality of the tool shall be extended.

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