Using Multiple Void Patterns at Crime Scenes to Estimate Area of Origin in Bloodstain Cases

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Abstract: Void patterns in bloodstain pattern analysis are often used to determine the absence or movement of an intermediate object from its original position during or after a bloodletting event. This article examines the use of void patterns as a method of estimating the area of origin of events that produce bloodstains. Employment of this method, which the authors have termed the Void Pattern Shadow Matching (VPSM) method, can help the analyst or investigator at the scene to quickly determine an approximate area of origin, which can later be confirmed by mathematical analysis.
Keywords: bloodstain pattern analysis, void patterns, void pattern shadow matching

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Introduction

Void patterns, or the absence of blood within an otherwise continuous bloodstain pattern, have been traditionally used by analysts for a number of purposes. A void is caused when an intermediate object intercepts the trajectory of blood droplets in flight, while on their way to an otherwise unobstructed final target surface. A void can indicate, often by its distinct shape, the absence or movement of an object that was present during the bloodshed; and in many cases, the physical dimensions of that object. Void patterns may also reveal the precise position of clothing on an individual at the time of the bloodletting incident. (Wonder) The condition of windows and doors (open or closed and to what degree) during bloodshed may also be determined. And, the location of individuals at the time blood was shed may be concluded from voids on surfaces with otherwise uninterrupted bloodstain patterns. This article explores yet another reason for examining void patterns: to help estimate the area of origin of an event producing a spatter pattern.

Void Pattern Shadow Matching

The Void Pattern Shadow Matching (VPSM) method involves the utilization of a controlled light source in order to cast shadows which duplicate the void patterns found at the crime scene. Measurements are then taken of the position and location of the light source, resulting in an estimate of the area of origin (generally defined as the location in three-dimensional space from which the spatter originated). Unlike using voids to determine the location of objects after they have been removed or repositioned, VPSM requires that the objects cre-

Figure 1: This scene, in which objects and structures of varying dimensions are found in different locations and on different geometric planes, lends itself to the use of the VPSM method for estimating area of origin.

ating the voids be present in their original positions.

Figures 2a and 2b are from the same crime scene as Figure 1. In this example the electrical outlet has served as an intermediate target producing a void pattern on the wall behind it (illustrated by the rectangular outline in Figure 2b). The location of the void (above and to the right of the receptacle) should suggest to the analyst that the source of the blood was, in general terms, below and to the left of the outlet as pictured. The use of VPSM would provide the analyst at the scene with a much more precise assessment of that area of origin.

Figure 2a (left): A void pattern is located above and to the right of the electrical receptacle.

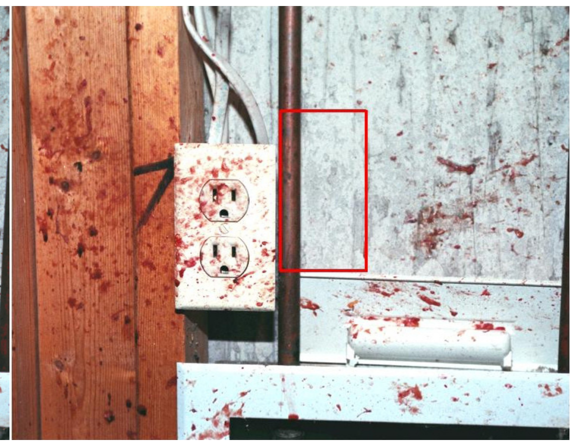

Figure 2b (right): The void pattern from Figure 2a is outlined in red.

Theoretically, VPSM could be used with a single void pattern at a scene; however, the precision and accuracy of the method is greatly increased when multiple void patterns, occurring on separate geometric planes, are present. Due to this observation, the more complex the physical aspects of the scene are, the better results will be obtained using VPSM. Figure 1 is an example of one type of complex scene in which VPSM could be used to benefit the scene investigator or analyst. Note that the scene contains numerous objects of different shapes and dimensions. Note, also, that the objects are located on several different geometric planes in relation to the overall scene. As such, spatter from a single blood source impacts only the exposed surface of each of the objects and creates multiple void patterns behind them.

Methods and Materials

To explore the potential efficacy of the Void Pattern Shadow Matching method, the authors created a simulated crime scene with a target area consisting of a plastic shelving unit with three shelves, various household objects placed arbitrarily on the shelves, and a wall which was covered with white poster board and located behind the shelving unit. A sponge was affixed to a stack of cinder blocks and positioned approximately 28 inches (71 cm) from the back wall and approximately 34 inches (86 cm) above the floor (see Figure 3). Medium energy impact spatter was then generated by striking the blood-soaked sponge with a rubber mallet. Once the impact spatter was created, the sponge and cinder blocks were removed so that the authors could examine the spatter and void patterns.

◀ **Figure 3: Setup of simulated crime scene used for testing the VPSM method.**

Figure 4: One of the authors using a floodlight with reflector as a light source for creating shadows within the target area. ▶

Figure 5: Multiple void patterns, which were caused by both the upper shelf and the Triscuit® box, are shown to correspond with shadows created within the target area by use of the small LED flashlight. ▶

Pursuant to the VPSM method, various portable light sources were utilized in order to create shadows within the target area. The authors employed a floodlight with reflector (see Figure 4), a hand lantern with a 6V block battery, and a small LED flashlight. All three methods produced satisfactory results; however, it was found that the more focused light from the LED flashlight produced shadows that were better defined and, therefore, easier to match to the void patterns.

The light source was moved about the scene until the light cast shadows which duplicated the outline of the void patterns created by both the household objects and the shelving unit on which they were placed. In adjusting the position of the light, effort was made to duplicate multiple void patterns simultaneously. In order to achieve the greatest accuracy, one of the authors controlled the light source, while the other two (with full view of the target area) provided guidance regarding the positioning of the light. It should be noted, also, that all room lights were extinguished during the process in order to avoid any extraneous shadows caused by lighting other than the intended light sources.

Figures 5a and 5b illustrate shadows matching void patterns in one portion of the target area. Note that the edge of the upper shelf creates a void on the wall behind it; and at the same time, the Triscuit®

◀ Figure 5b: Red outlines illustrate the void patterns and corresponding shadows from Figure 5a.

box creates a void on the shelf on which it sits, as well as on the wall. In matching these multiple void patterns on more than one geometric plane, VPSM allowed the final position of the light source within the scene to replicate the original position of the blood-soaked sponge, which was above and to the right of the Triscuit® box. Once the precise position of the light source was obtained, three measurements were taken to document the x, y, and z coordinates of the light source within the scene, thus determining the area of origin for the spatter. In this experiment, these measurements indicated that the x and y (horizontal) coordinates corresponded to those of the original measured position of the blood-soaked sponge. The z coordinate of the light source was found to be three inches (approximately 7.6 cm) above the original position of the sponge. This discrepancy in the vertical measurement was not found to be problematic, taking into account the parabolic arc of the blood droplets in flight.

Validation of Results

Once the area of origin was determined using the VPSM method, the authors recalculated the area of origin employing methods currently in use by bloodstain pattern analysts: stringing; mathematical calculations (tangent method); and computer-aided analysis (BackTrack™). In utilizing these methods, the authors documented the position and impact angles of 10 well-formed stains, chosen from various locations on the poster board. All three traditional methods gave results that were within four inches (approximately 10 cm) of the known location of the blood source. Interestingly, the three traditional methods each gave results that deviated slightly on the horizontal plane, while the VPSM method showed no such deviation.

Conclusions

The Void Pattern Shadow Matching (VPSM) method of determining area of origin proved to be just as accurate (if not slightly more so) as the currently used methods of stringing, mathematical calculation, and computer-aided analysis. It should be noted here, however, that unlike the traditional methods, VPSM requires no mathematical calculations other than measurements of the final position of the light source. Therefore, the additional human measurement and calculation factors involved in the traditional methods (measuring the short and long axes of the stains, calculating angles of impact, determining gamma angles, and physically stringing the blood droplets' flight paths), are likely the sources of the (perceived) increase in accuracy of VPSM over the other methods. Furthermore, although the precision of the measurements in this experiment were documented in some cases to two decimal places, the area of origin derived by any of the four methods would have been reported as approximations or a dimensional range in actual casework. As such, it could be said that all four methods returned results that were analogous to one another.

The advantages of using the VPSM method are several. First, VPSM provides a quick and accurate alternative to traditional methods, and can be used to easily estimate the area of origin of impact spatter while the crime scene is still being processed. In this way it can be an investigative tool that may be helpful in further evaluating the scene, or in interviewing witnesses and suspects. The method requires no equipment other than a light source (e.g. an LED flashlight) and a tape measure; thus, it is easily accessible to any crime scene investigator with a rudimentary knowledge of bloodstain pattern analysis. The final target surface is less critical with VPSM than it is with traditional methods, since the analyst is only identifying void patterns and not looking for a sufficient number of well-formed stains to use for impact angle calculations. Finally, VPSM requires fewer measurements than the traditional methods; therefore, reducing the likelihood of human error. It has been shown, for example, that measurement error, particularly regarding stains that have impacted the target surface at angles greater than 50 degrees, can result in a fairly large discrepancy in calculated impact angles. (Pace)

Discussion

The authors see the Void Pattern Shadow Matching method as an investigative tool, which can provide the analyst or investigator with immediate results at the crime scene. It's important to note, however, that a competent and experienced bloodstain pattern analyst, using one or more of the traditional methods, should verify the VPSM results before testimony is given in a court proceeding, particularly if the VPSM method was used by someone other than a court-qualified expert in bloodstain pattern analysis. To that end, the scene and the bloodstain patterns should still be thoroughly documented to such a degree that a traditional bloodstain pattern analysis can be performed.

The authors feel that additional experimentation with VPSM is warranted and should be carried out by independent researchers. Included among the goals of further research would be the exploration of the effects of two different variables: the distance between the object creating the void pattern and the surface on which the void pattern is found; and the distance between the blood source and the void-creating intervening target(s). It is hypothesized by the authors that the closer the void-creating object is to the target surface containing the void pattern, the sharper will be the delineation of the void itself. Therefore, it should be easier to visualize the correspondence between the void and the shadow in cases where the intermediate target is closest to the target surface containing the void.

It is further hypothesized that the farther the blood source is from the target area, the less accurate the area of origin will be. This is based on consideration of the parabolic arc described by each of the blood droplets. Blood droplets of similar volume and mass, which travel a farther distance without being intercepted by an intermediate target (thus, spending more time in the air) are expected to be more susceptible to redirection by the forces of gravity and air resistance than those traveling a shorter distance for a shorter period of time. (James) Depending on the length of the flight path, the final segment of the blood droplet's course may be sharply downward, which is likely to affect the position and dimensions of the void pattern. Therefore, in cases where the blood source is a considerable distance from the target area, two phenomena would be expected to occur. First, the void patterns themselves would be less delineated and more diffuse—a phenomenon caused by the arc of some of the blood droplets allowing them to clear the intermediate target and strike the final target surface at points that would otherwise be devoid of blood. Second, the area of origin determined by VPSM would be expected to be higher (have an increased z coordinate) than the original position of the actual blood source.

In the methodology used for this article, all three authors were aware of the location of the blood source prior to the utilization of the VPSM method for finding the area of origin. Future experimentation and validation studies should include a blind procedure in which one or more analysts would not be present during the deposition of the blood and creation of the void patterns. In such a scenario the blood source would be removed prior to the VPSM analysis and subsequent verification by traditional methods, and the results of the analyses would be checked against the known location of the blood source.

Finally, although the blood source as found by the VPSM method can be documented simply by the use of a tape measure and thorough note taking, future research might include a method for photographically documenting the VPSM analysis. Ambient light photographs might be considered in which the camera would be placed on a tripod and positioned, for example, behind the light source (perpendicular to the target area), as well as to the side of the light source (parallel to the target area) in order to document the location of the blood source as determined by VPSM. This research could also include recommendations for camera and lens types, as well as for exposure settings.

Certainly, not all crime scenes will lend themselves to the VPSM method. The analyst or investigator will have to evaluate each scene to determine if VPSM will be of benefit to the investigation. In the future, with adequate validation, VPSM may, in some circumstances, be able to replace one or more of the traditional methods of determining area of origin. For now, however, in cases where the physical aspects and configuration of the scene suggest that this type of analysis would be beneficial, VPSM can serve as a useful addition to the crime scene investigator's analytic toolbox.

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