Technical Note

The Application of Infrared Photography in Bloodstain Pattern Documentation of Clothing

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Introduction

The observation of bloodstain patterns on clothing can be crucial to an accurate reconstruction of events related to the bloodshed. Chemical enhancement techniques, such as amido black or leucocrystal violet, can be successful, but can alter the appearance of stains and may hinder DNA analysis. The advantage of photographic techniques is their noninvasive effect on appearance and biological integrity. Conventional photographic techniques, such as subtractive or additive color filtration, are successful with lighter colored materials but are ineffective on dark fabrics [1]. Nonconventional photography techniques can be utilized to increase the contrast in the appearance of blood against some types of backgrounds. Infrared photography is one of these techniques and should be considered for specific case situations. To note at the outset, conservative conclusions need to be drawn from bloodstain patterns on fabrics because of their widely varying characteristics regarding liquid absorption and diffusion. The conclusions will, at best, only be limited to directionality and the general nature of the mechanism that caused them [2, 3].

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The Theory of Infrared Photography in Bloodstain Cases

When clothing items that contain apparent bloodstains are of a color that is similar to, or darker than, the color of the deposited blood, the accurate determination of the patterns can be difficult to visualize. Infrared lighting can cause many fabrics to reflect a large percentage of the light. In contrast to this, bloodstains typically absorb most wavelengths of visible light and also the near infrared (700 to 900 nm) wavelengths. This results in the fabric appearing gray or white and the bloodstains dark in color (in black and white infrared photographs). When using photographic lighting containing the near infrared portion of the light spectrum and specialized films sensitized for these regions, the differences in reflected light will be documented, resulting in enhanced stain patterns. This procedure has been specifically mentioned in texts as early as 1961, but has been noticeably absent since then [4, 5, 6].

Application of the Procedure

In the homicide case presented here, a black sweatshirt that was allegedly worn by the accused had bloodstains on the front that were dark red in color (because of the oxidation of the blood from extended storage). The fabric composition of the sweatshirt was unknown. The victim had been shot in the head, allegedly by the driver, after being pulled headfirst through the driver's door window. Because of a lack of witness statements, the bloodstain patterns on the front of the sweatshirt were important in placing the victim's head in close proximity to the sweatshirt when the bloodshed occurred. When the clothing was initially collected from the suspect, it was photographed with 35 mm color negative film (Figure 1). An examination of the photograph revealed the lack of detail in the stains because of the dark sweatshirt color. In the year preceding the trial, and prior to the infrared film being exposed, the clothing was examined by the local police DNA lab. At this time, the partially visible stain was marked with a black Sharpie marker, and a small portion of the fabric was removed for DNA analysis. The sample was taken from a heavier area of the staining and did not affect the additional detail found through this photographic process. The use of a Sharpie pen, as in this case, is recommended for marking areas in infrared photography, because it shows up well with this technique.

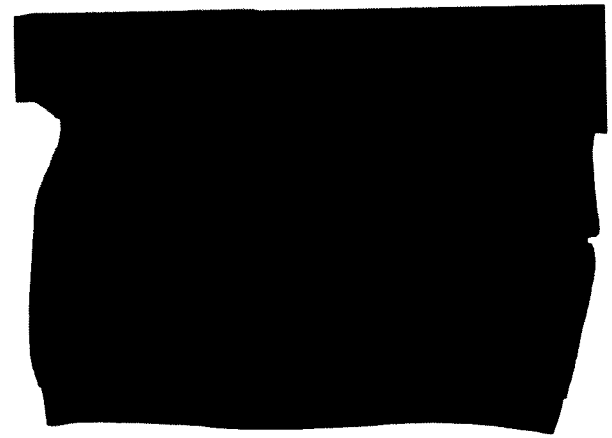

Figure 1

Photographed with conventional panchromatic film.

The infrared photography was done with a conventional 35 mm camera, a 55 mm macro lens, and a Sunpak 622 Super electronic flash. Standard electronic flash heads generally emit a large amount of infrared light, and no filtration over the light source is required. The film used was Kodak High-Speed Infrared, which requires special handling techniques. It must be removed from the film can or camera in complete darkness. One of the reasons for this is that the felt strip of the film cassette will allow infrared light to pass through, potentially fogging the film. This film, while high in sensitivity as the name indicates, is noticeably grainy.

The filter that was found to be successful in this instance was the Wratten 89B. This filter is made of gelatin or glass and is opaque black in color. It has a cutoff frequency higher than the 25 (red) or 29 (dark red) filters, but not as high into the infrared spectrum as the 87 series of filters. To be more specific, it rejects all light below 680 nm, but passes 83% at 750 nm, and 89% at 850 nm [7]. The author has found much higher durability with the glass version of this filter (B&W model #092). The flash (tested with visible light to a guide number of 140) was used on manual, and the output was reduced to 1/4 power. The flash-to-subject distance was approximately five feet. The exposures were bracketed from f/2.8 to f/16, all at 1/125 second. The most useable exposure was at f/5.6. The wide range of bracketing is due to the high unpredictability in the infrared reflectance by different materials. The focus was set sharply through the viewfinder, and the noted focus distance was shifted to the infrared focus mark. This is necessary because the longer wavelengths of infrared do not focus on the same plane as visible light. The use of a tripod was crucial to assure that the camera position did not change after the focus was set. It is important to note that smaller apertures do not increase the apparent sharpness of the image, especially if the infrared shift is not done correctly. This is in part due to the diffractive nature of infrared light. Diffraction is defined as the nature of light rays to bend around obstructions (e.g., the edges of the aperture leaves, especially at smaller stops) [6]. Although this optical phenomenon is not greatly noticeable with visible light, the differences are more pronounced with infrared light. Because of this, the light source should be varied with power ratios or flash-to-subject distance, and the aperture should remain in the intermediate f-stops. In addition to this, photography of flat items, such as clothing, does not require the greater depth of field associated with smaller apertures.

Reference scales were placed along one side of the shirt, so that the detail could be measured on the finished photographs and approximate dimensions could be included on the bloodstain analysis report. After the sweatshirt was photographed, the film was processed and printed (Figure 2). This film uses conventional film developers (in this case, Kodak HC-110, dilution "D") and standard fixing and washing as outlined in the instruction sheet provided with the film. The use of other developers is acceptable, as long as a moderate contrast index is obtained. Weaker dilutions are preferred, because the longer development times encourage image uniformity.

Observations and Pattern Interpretation

Two areas of significant detail were noted with the infrared exposures that were not readily visible with the conventional photographic techniques. The first of these is shown under and to the right of label "A" in Figure 2. The continuation of the stain pattern confirms that the larger pattern lower and to the left is a projected pattern. This is consistent with the source of blood being close to the larger stain and the blood being

Figure 2

Photographed with Kodak High-Speed Infrared film.

projected upward and across the shirt. The second area (to the lower left of label "B" in Figure 2) shows a dripping pattern from a horizontal area of projected blood. The dripping patterns are consistent with the sweatshirt being in a vertical position during bloodshed, with the fabric not readily absorbing the deposited stain. Both of these observations are consistent with the theory that the suspect was seated in his vehicle, with the victim's head directly in front of the lower torso of the suspect during bloodshed. Areas of bloodstains on the suspect's other clothing, the victim's clothing, the vehicle's interior, and the handgun were also in agreement with this scenario.

Further Testing

The successful use of the Kodak infrared film led to the testing of another infrared sensitive material, Konica 750. This film is less sensitive in the infrared spectrum than the Kodak film, and this actually becomes an advantage in applying this technique. The Kodak film has sensitivity extending out to approximately 900 nm. The Konica stock peaks at 750 nm and responds no further than 820 nm [8, 9]. This results in greater ease of handling, because the camera can be loaded in normal room conditions. There is also substantially less graininess in the images. Another benefit to this film is its availability in both 35 mm and 120 film rolls. One precaution, however, is that it is only produced once a year (around March) and becomes rather scarce by September or October. Freezer storage is recommended for this stock, because it has a shelf life of approximately one year. It is available from many major photographic suppliers.

Six fabrics were selected for this test:

Sample Number	Fabric Composition	Color / Pattern
1	100% Rayon	Very Dark Blue
2	51% Cotton / 49% Acetate	Med. Blue / Green Plaid
3	100% Wool	Royal Blue
4	100% Acetate	Dark Green
5	100% Cotton	Red / Pink Stars
6	100% Polyester	Black

The fabrics were new and unlaundered for the testing. Blood was applied to the fabrics with a disposable polyethylene pipette using two methods: low velocity drops (i.e., the blood was allowed to fall using only gravitational force) and medium velocity drops (i.e., there was forceful squeezing of the pipette to project the blood). In both instances, the height of the pipette was approximately 24 inches from the fabrics, which were flat on the floor. These two sizes of resulting drops were to determine potential differences in the resolution capabilities of the two films.

Photographs were taken using Konica 100VX color negative film (Figure 3), Kodak High-Speed Infrared (Figure 4), and Konica 750 (Figure 5). The photograph using the color negative film illustrates the appearance of the stains to the naked eye. The numbered scales in the photographs are for identification purposes only and would be scaled differently for real case analysis.

Exposure and Development

The setup was similar to the case presented above, except the flash-to-subject distance was approximately four feet, six inches. Exposures were again bracketed, with the flash power

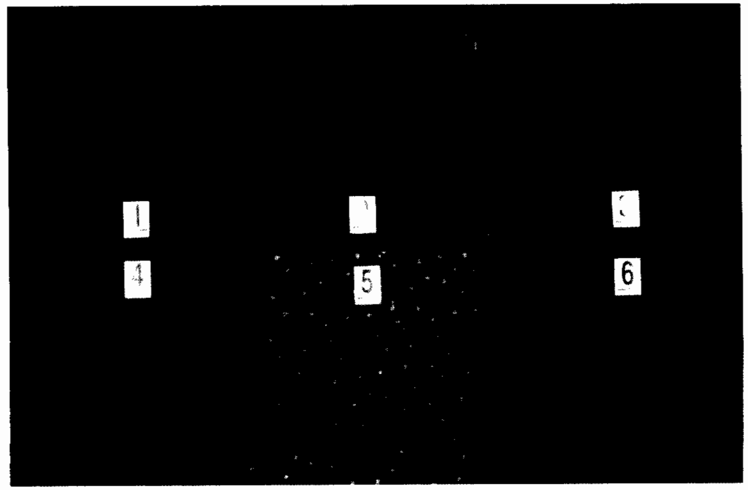

Figure 3

Photographed with conventional panchromatic film.

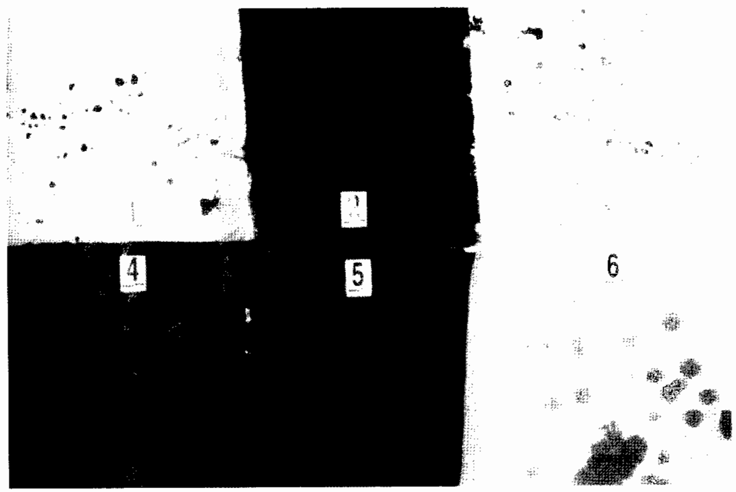

Figure 4

Photographed with Kodak High-Speed Infrared film.

Figure 5

Photographed with Konica 750 infrared film.

ratio set at 1/8 for the Kodak and 1/4 for the Konica. In testing, it appears that the Konica emulsion is approximately one and a half stops slower than the Kodak. Both films were processed in Kodak HC-110, dilution "D". After processing, the films were scanned on a Nikon Coolscan 8000 and were imported into Photoshop 7.0. Image processing was limited to cropping, gray scale conversion (for the color photograph), and resampling for more manageable files. Although other enhancement techniques could further improve results (such as levels and curves), they were omitted here in order to isolate the effect of the films.

Conclusions

The results with the infrared films were dramatic with fabric samples 1, 3, and 6. The technique appears to work best with solid, dark colors, because color patterns cause interference with the stain visibility. It appeared that the infrared reflectance of the fabrics was affected by the material composition and the methods used to color them. Fabric sample 4 showed glare with its shiny finish on conventional film, and this condition only worsened with the infrared films. The differences in bloodstain sizes between fabrics 1 and 6, which were deposited in the same manner, again emphasize the limitations on determining droplet size upon impact. The Konica film had substantially better sharpness with less granularity than the Kodak. The minor

differences in the infrared photos for both films on fabrics 1, 3, and 6 indicate that the most useable portion of the infrared spectrum appears to be between 700 and 800 nm. Fabric samples 2, 4, and 5 show that, with some materials, there is no improvement in visualization with this technique. For some, also this process should be considered an option.

There are possibilities for the incorporation of digital photography in this procedure, because some digital cameras have this capability. Further testing is needed. As a final note, this procedure has also been successfully used for enhancing tiretrack impressions on clothing, because the rubber deposition also absorbs infrared light.

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References

1. *Using Photography to Preserve Evidence*; Kodak publication M-2; Eastman Kodak Co.: Rochester, NY, 1982, p 33.
2. White, B. Bloodstain Patterns on Fabrics: the Effect of Drop Volume, Dropping Height, and Impact Angle. *Can. Soc. For. Sci. J.* **1986**, *19* (1), 3-36.
3. Van Stratton, M.; Griffin, T. *Examination of Bloodstained Clothing*, Presentation at IAI International Conference, Miami, FL, July 2001, handout material pp 1-5.
4. *Infrared and Ultraviolet Photography*; Kodak publication M-3; Eastman Kodak Co.: Rochester, NY, 1961, pp 16-17.
5. *Applied Infrared Photography*; Kodak publication M-28; Eastman Kodak Co.: Rochester, NY, 1981, pp 63-64.
6. Miller, L. *Police Photography*, 4th ed.; Anderson Publishing: Cincinnati, OH, 1998; pp 215, 237.
7. *Kodak Filters for Scientific and Technical Uses*; Kodak publication B-3; Eastman Kodak Co.: Rochester, NY, 1985, pp 35, 84.
8. *Kodak High-Speed Infrared Film*; Kodak technical data sheet M-19; Eastman Kodak Co.: Rochester, NY, 1999, p 1.
9. Konica Infrared 750 Black & White Film; Konica technical data sheet TDSB-701; 2001, pp 1-2.