LUMINOL: THE NEXT GENERATION *

Max Courtney, Frank Shiller, Thomas R. Ekis,
Michelle O'Neal, and Jon B. Brooks

Forensic Consultant Services
P. O. Box 11668
Fort Worth, TX 76110

ABSTRACT:

Responses of blood with luminol reagent have been successfully captured by use of a low-lux CCD (charged, coupled device) video camera and recorded onto a videodiskette. This method of recording luminol images has several advantages. Very weak responses can be captured. No extended exposure times are required; therefore, image diffusion is minimized. Light-filled images for contextual orientation are easily obtained. Images are viewed on a monitor before they are saved onto diskette. Captured images can be reviewed for quality, and faithful image reproduction is possible each time.

INTRODUCTION:

The use of luminol (3-aminophthalhydrazide) for presumptive detection of bloodstains was reported in 1939 [1]. Luminol is mixed with an oxidizing reagent in an alkaline aqueous solution. This reagent generally is sprayed within a darkened scene onto surfaces suspected of being bloodstained [2, 3]. Although identification of blood is only presumptive by chemiluminescence, the nature, size, shapes, and patterns of the detected stains sometimes provide useful information about the crime scene and the offense [4]. The resulting chemiluminescence may be photographed, and some special techniques have been described [5, 6]. The authors have attempted unsuccessfully to record luminol images with a standard VHS camcorder. Several references were found that describe using videomicroscopy in crime scene applications [7, 8, 9, 10]. No references of previous research in digital recording of luminol images were found in a review of the pertinent literature.

In the experience of the authors, photography of luminol impressions involves some guesswork and some luck. Due to the low light levels of the luminescence, time exposures are required to capture the images on photographic film. On many surfaces, the image will begin to diffuse or run when sprayed sufficiently to allow photographic capture. After the image is photographed, it is recommended that another exposure, with fill flash, be obtained to orient the image properly within the scene. Sometimes good images are obtained; and at other times only poor images, or no images, are obtained--even by experienced photographers. The investigator cannot evaluate the images until the photographs are processed, which may occur after the crime scene is released.

The study describes the use of a low-lux (0.0025 lux) CCD (charged, coupled device) video camera to capture luminol images. (Lux is a metric unit of illumination equivalent to the illumination of 1 m^2 on which there is a uniformly distributed flux of 1 lumen) [11]. The images are then saved onto a reusable videodiskette, which can hold up to 25 images.

EQUIPMENT:

The following equipment is shown assembled in Figures 1 and 2.

- Optronics DEI-470 CCD video camera with RGB output
- Sony color monitor PVM-1390
- Navitar zoom lens, 11-110 mm, f\1.8
- Sony MVR-5600 still video recorder with videodiskettes
- Sony color video printer UP7000 (8-1/2 x 11")
- Benbo 1 tripod
- Plastic block, tapped to accept standard camera screw, with hose clamp

The camera, lenses, recorder, monitor, and printer were obtained from Metallurgical Supply Company, Inc., Grand Prairie, Texas. The Benbo 1 tripod is available at any full-service camera supply center.

The Optronics DEI-470 camera can be used in both automatic- and manual-exposure modes by switching at the processor or keyboard. White balancing is automatic but can be reset if needed. Additional keyboard controls allow the operator to control exposure time (up to

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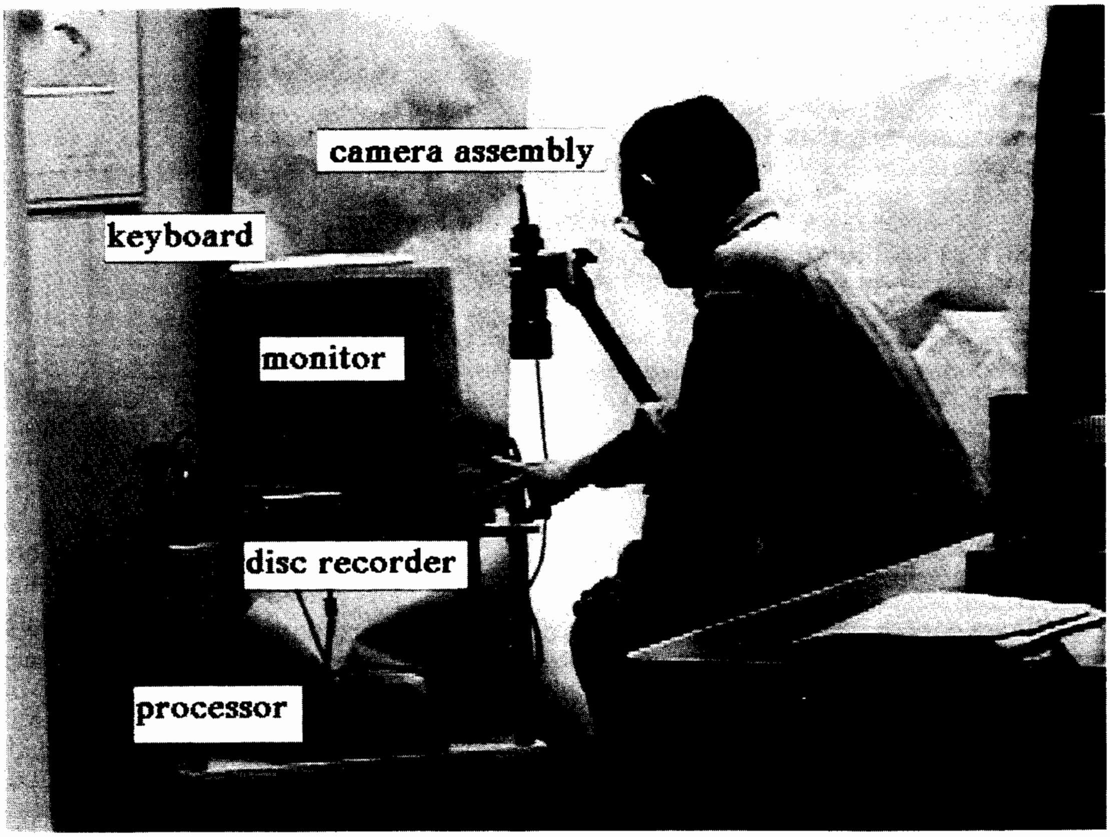

Figure 1. Assembled equipment.

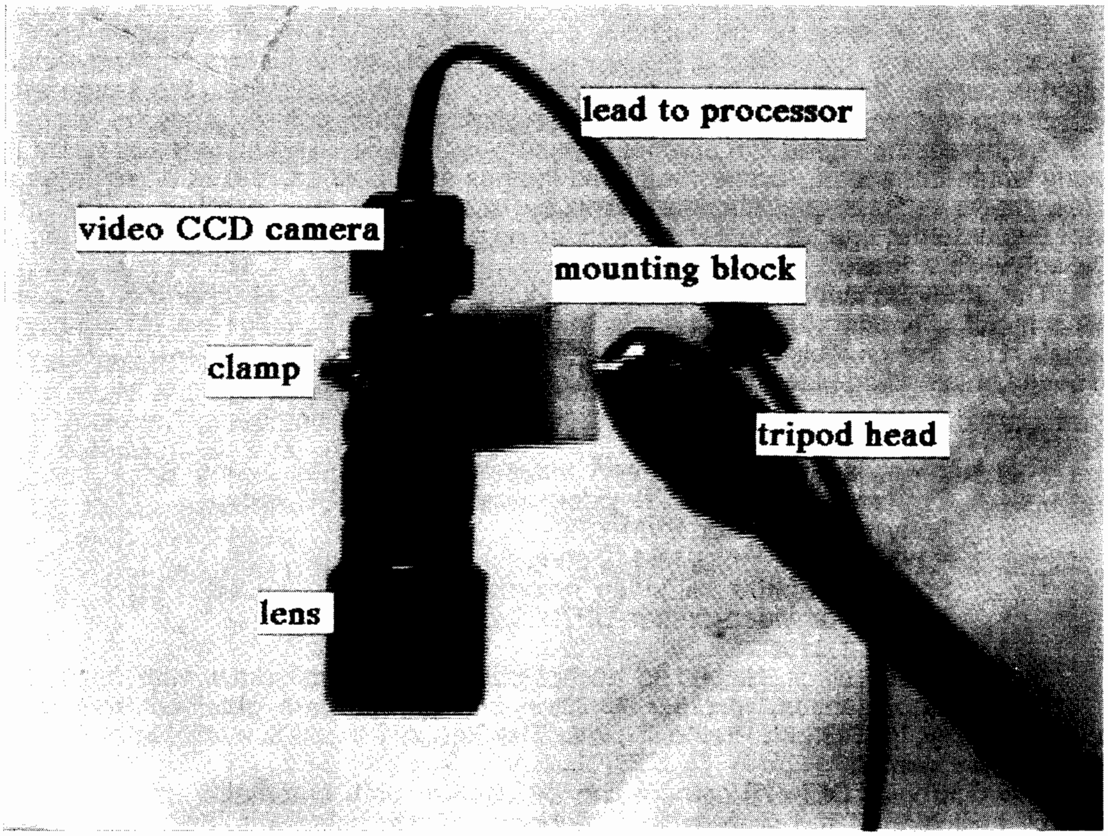

Figure 2. Closeup view of assembled video CCD and lens on tripod mount.

4 sec), contrast, brightness, sharpness, red balance, and blue balance. A freeze-frame key allows one to lock in an image if exposure conditions are changing during the process.

PROCEDURE:

Prior to the processing of the scene, the monitor, video recorder, video CCD processor, and keyboard are assembled on a wheeled cart. The video CCD head is attached to the lens, the lens is mounted to the tripod attachment with the hose clamp, and the lead from the video camera is then attached to the processor.

Luminol reagent is freshly prepared by dissolving 0.5 g of luminol and 25 g of sodium carbonate in 450 mL of distilled water. 50 mL of 3% hydrogen peroxide is added, and the solution is transferred to a plastic spray bottle.

The darkened scene is sprayed lightly with luminol reagent. Depending upon the size of the scene and other logistical considerations, the scene may be divided into blocks for processing. Areas of chemiluminescence are evaluated, and those worthy of capture are marked. With lights on, the video CCD is aligned with the area by moving or adjusting the tripod. The area to be captured is framed and brought into sharp focus on the monitor.

The general area is again darkened, and the marked area is resprayed with luminol reagent. The image is captured with the lens fully open and with a maximum (4 sec) exposure time. Focus and framing can be corrected. When a suitable image is observed on the monitor, it is saved onto the videodiskette.

To orient the image in the context of the scene, another exposure is done with the image area bathed in a dim red light. This effect can be accomplished using a small flashlight with red lens cover. When the monitor image is suitable, it is saved onto the videodiskette.

At any point in the processing of the scene, the saved images can be reviewed on the monitor by playing the diskette on the video recorder. The user can determine if additional work is required.

Sampling of stains for serology or DNA testing should be done prior to luminol processing. However, if the areas producing chemiluminescence have not been sampled prior to luminol processing, they can be sampled or collected at this time. The samples then can be tested for confirmation of blood or for further characterization tests, if they are deemed suitable.

In cases where only a small area is sprayed or where a given area is suspected of having bloodstains suitable for luminol processing, one can set up the equipment prior to the first processing. This step is especially useful on non-absorbent surfaces, so that the image can be immediately recorded before significant running occurs.

RESULTS:

Chemiluminescent images from bloodstains have been recorded onto videodiskette in both lab trials and field investigations. The saved images can be viewed directly on the monitor and can be printed on a video printer. Videographs of chemiluminescent images from lab trials and casework are shown in Figures 3, 4, and 5.

On six occasions the equipment has been taken into the field for case investigations, and evidence from two other cases have been examined with the equipment in the lab. The field applications include three vehicle examinations and three indoor scene examinations. Luminol images have been recorded in each instance. The procedure has not been compared directly against photography. No testimony has been offered yet concerning the videorecorded luminol results. However, testimony has been given regarding unrelated applications of the same equipment.

DISCUSSION:

The described method allows collecting and saving chemiluminescent images of bloodstains at crime scenes. The method has been used in field investigations on several occasions with suitable results.

The use of video recording offers several advantages. (1) Most importantly, the collected image can be viewed and optimized before it is saved onto diskette. Since the image is WYSIWYG (what you see is what you get), one is assured that the collected image will be saved onto the diskette. (2) The image can be reviewed while the equipment is still in place, so that improved images can be attempted. (3) The short time required for image capture minimizes the problem of image diffusion or running. (4) A light-field image can be captured in the same manner, without the guesswork of fill-flash photography. Again, if the image on the monitor is suitable, the resulting stored image will match it. (5) Overall processing time is shortened, and the investigator can clear the scene confident that the images observed during processing will be reproduced faithfully. (6) As the operator goes from lighted to dark views, eye adjustment time is not necessary; the video image is viewed directly on the monitor.

The ease of operation is illustrated by one case history. A four-room apartment was processed with luminol reagent. Nine different patterned stains were recorded both in darkness and with fill light. The entire process took well under an hour.

There are also several disadvantages. (1) The cost of the system as described exceeds $21,000. It should be considered, however, that only the video CCD (approximately $8,200) was acquired specifically for the purpose of capturing luminol images, and the other equipment is used in numerous applications in both the laboratory and the field. (2) The system is bulky compared to a camera setup. It would be difficult for one person to operate the entire system in a darkened room. (3) The state of the art in digital imaging is such that photography will capture finer detail with better resolution. However, video is suitable for luminol images; absorbent surfaces will not show as fine detail, and nonabsorbent surfaces often cannot be recorded by photography because of the short time afforded before the detail is lost. The resolution afforded the viewer can be increased somewhat by displaying the image in court with the video recorder and monitor. It is possible that high-resolution printers could augment the resolution of printed images.

The video camera appears to capture light more efficiently than the human eye. If maximum exposure is used, the image that appears on the monitor will be more easily discernible than the image viewed by the unaided eye. This fact provides additional versatility in two ways. First, stray light that might make viewing difficult has much less effect upon the on-screen image. Second, with greater light capture, one can place the video camera at greater distances so that larger areas can be processed in the field of view. For example, an entire automobile trunk can be processed at one time, showing the stains more clearly in their context.

The lens choice affords the user additional versatility. The Navitar lens is similar to a 35-mm camera zoom lens, with zoom ring, aperture ring, and focus ring. The parfocality of the DEI-470 camera allows zooming without refocusing. The aperture ring serves as another means of controlling the exposure. Other lenses are available and are useful for other applications; but they seem superfluous for this technique.

The recorded images can be transferred to a computer equipped with an image-capture software. Using PAXIT, by Midwest Technologies, one can import the images into a filing system. PAXIT offers additional versatility by allowing the image to be refined by colors, brightness, and contrast. Images may be marked with text, arrows, circles, etc. Additionally, the compressed images can be stored in an organized system that requires only 80 - 180K memory per image.

The downloading of the digital images from the reusable videodiskette to a computer hard drive poses a question. Should the moderately expensive ($10) videodiskette be reused, or should it be preserved as a piece of evidence? While the data are reproduced in the image transfer, the first generation of data remains on the videodiskette. Retention of the original videodiskette is, perhaps, the prudent approach until case law develops.

Although we are unaware of testimony that has been given regarding the method, it is suggested that this represents no new scientific theories. Testimony has been given widely about luminol results, and digital video data have been likewise introduced in numerous proceedings. Rather than a new method for detection of bloodstains, the procedure simply is another means of documentation and presentation.

The lack of direct comparisons of quality of luminol patterns from video and photography suggests a need for further research. A reasonable approach at this point might be to continue to photograph patterns in addition to the videorecording.

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