Limiting Liability via High Resolution Image Processing
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ABSTRACT

The utilization of high resolution image processing allows forensic analysts and visualization scientists to assist detectives by enhancing field photographs, and by providing the tools and training to increase the quality and usability of field photos. Through the use of digitized photographs and computerized enhancement software, field evidence can be obtained and processed as "evidence ready", even in poor lighting and shadowed conditions or darkened rooms. These images, which are most often unusable when taken with standard camera equipment, can be shot in the worst of photographic condition and be processed as usable evidence. Visualization scientists have taken the use of digital photographic image processing and moved the process of crime scene photos into the technology age. The use of high resolution technology will assist law enforcement in making better use of crime scene photography and positive identification of prints. Valuable court room and investigation time can be saved and better served by this accurate, performance based process. Inconclusive evidence does not lead to convictions. Enhancement of the photographic capability helps solve one major problem with crime scene photos, that if taken with standard equipment and without the benefit of enhancement software would be inconclusive, thus allowing guilty parties to be set free due to lack of evidence.

1. Defining High Resolution Image Processing

High resolution image processing is a completely computerized and digitized process. The photography equipment works with the computer platform to produce the most accurate, clear, and precise photographs, even when lighting and print conditions are not optimal. Faded prints, or prints in matted carpet, slushy snow, or mud, can be photographed and provide the same visual resolution as was available from the original. The image processing can also allow the analysts to enlarge portions of the print to pick out distinctive shoe treads, weight patterns or foot patterns, such as if the suspect tends to slant to the side on the shoes. This information assists detectives in determining suspect matches since there is more information available for use.

This process does not create evidence, but rather enhances the evidence and more clearly portrays that evidence which is available. The process acts as a powerful magnifying

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device which assists officers in gaining the most from a piece of evidence. Unlike conventional photographs, the in-depth analysis ability of digital photography allows the analyst to more critically evaluate all the details. It also assists the analyst in making estimates of what the right shoe might look like, if only a left print is available. Although the right print in such case would not be used as evidence, the use of the mirror image may help provided detectives more leads in a perplexing case.

Digital photography and high resolution image processing works as a set of complimentary processes. The digital cameras are basically input sources and encompass several methodologies. The image source may be the direct output obtained from a digital camera or the result of scanning a conventional photograph. Other techniques employed originate from medical imaging and satellite photography applications. They utilize both the capabilities of conventional photography equipment, with the added capacity of working in the digital computer environment. Such equipment is often used in portraits and other photographic works to correct for lighting shadows, and flash marks, which continue to be problems in conventional photography.

The mathematical process behind the enhancement process utilizes the photograph sources, which are processed as images in the processing model. These image files are then centered, adjusted, magnified and/or composited with other images to provide analysts with the opportunity to view angles, positions, and other details that could only be imagined by conventional photos and through the use of magnifying glasses. This process utilizes digital image warping, convolution filters and other mathematical constructs to accomplish the objective of obtaining the maximal amount of knowledge and understanding from the source images.

2. Field Usability of High Resolution Image Processing

The field equipment required to make use of digital photography does not necessarily require a great deal more effort than a conventional camera. Officers can use the digital equipment to obtain images as they would with a still camera, including the prior placement of props (such as rulers or coins to provide size or spatial image comparison) and then take the digital files to the analyst to be processed, much like a photograph would be developed. Also, conventional photographs can be scanned via high resolution color scanners resulting in an image file on the computer which is subsequently processed independent of its origin. If the image originates as a conventional photograph, care must be taken in the scanning process to ensure the file produced accurately represents the photograph. The analyst then will bring up the file and determine the angles, enhancements and compositions that the detectives feel will help them to better resolve who the suspect might be. Hardcopy prints are then produced on a high resolution printer in a precise fashion which provides an accurate representation of the results.

Analysts work directly with detectives, both with photographic prints and on the computer, taking advantage of all enhancement options until the digitized photographs are

set up as needed, or all options are exhausted. These digital photographs can also be interactively compared to others on file, if trying to link up to a suspect from another case, or other shots taken at the same crime scene. This is particularly advantageous if a database of images are available, much like mug shots and finger prints, to use this as a reference to previous criminal activity. If such images exist, they can perhaps be linked to a photograph or other know evidence on a particular suspect.

Computerized data can often be more efficiently utilized and assimilated for constructing the case file. Photographs can be archived in a more usable and storagable format, and access to them can be as quick as a computerized search. This linking and storage capability can also enhance a department's ability to use data from known criminal cases, where motive is similar, and patterns in the criminal act or crime scene mirror a known suspect's style. This does not necessarily find the perpetrator, but it does give detectives some leads to examine and possibly provide better and more conclusive field data from which to work.

3. Advantages of Photographic Applications of Image Processing

High resolution image processing diminishes the possibility of unusable photographs. Issues that may have prevented conventional photographs from being conclusive enough may be eliminated by the use of more sensitive and powerful equipment. Photographs taken at the crime scene can be usable and workable, even when angle may have not been exact. Much of the same protocol will still have to be part of the field photography, such as use of relational props. New types of relational props suggested by this image processing technology may yield even more advances in the precision of future crime scene photographs. Another advantage of this procedure it the potential for objects visible in the photographs to serve as metrics upon which measurements can be made. Hence even when the standard relational props, such as rulers and coins, have not been included in the field-of-view of the photograph, there is still a possibility of objects of an apparent secondary importance providing the necessary points of reference which will allow the accurate determination of the dimensions of all objects within the photograph. It is possible the digital image is not usable, but the options of enhancement lessen the possibility that lighting shadows, incomplete coverage, lack of focus and/or camera position will render the photographic data inconclusive.

Computerized technology can also provide clear enlargements, and works to eliminate any of the guess work with standard magnification and reliance on an operator's visible ability to pick out shoe tread patters or unique identifying marks in the sole pattern. Also inherent in this form of processing is the ability to capture the maximum amount of detail possible. Hence, one can obtain measurement that are as accurate as the photograph is capable of providing. Often, this is one to two orders of magnitude greater than that currently produced via traditional analog procedures. This unbiased ability to more accurately determine the dimensions of objects represented by the photographs of a crime scene has an obvious and significant impact of the defensibility, and hence, liability, of

expert witness testimony.

4. Law Enforcement and Court Room Applications

As evidence, digital photos are more clear for use as such, and enlargements can be done on computer to meet a specific need, in the court room if necessary. Analysts can explain the technology, how it works, its origin and reliability and the confidence of the produced. Answers to questions regarding prints and other crime photographs can be enhanced with online use of this technology. Comparisons to other photographs can be set up side by side on the screen to aid a prosecutor in pointing out pattern similarities or unique characteristics that exist in both photos. Linking photos together for visual evaluation is easier to do and it makes sorting out evidence easier on juries and judges. This methodology also helps provide an unbiased presentation of the facts, allowing the various participants of the legal proceedings to reach their own conclusions. This marks a stark contrast to the normal approach where juries have to decide between two supposed *experts* presenting the *facts* in a manner that appears to support two very different conclusions.

The enhancement capabilities allow detectives and police opportunities to interactively and presented in a fashion that makes them more readily observable. Images that are off to the side or in the background can be made sharper and printed as individual photographs to provide additional evidence that may not have been obvious in a standard photograph or obscured by limitations in that medium. Analysts can utilize photos to look at multiple positions and background areas to aid detectives in putting crime scene pieces together. This also assists the law enforcement officers when they are piecing together the flow of evidence and possible occurrence patterns.

This technology does not create evidence or make changes that may invalidate the evidence, but makes the evidence more usable and the images more comprehendable. It provides officers with an advantage that did not exist just a few years ago. More leads are possible when critical photographs are clear, and background and foreground items are more visible. The reasons a photograph was shot may be more clear by looking at the enhancements, than by looking at a conventional shot. There is also the ability to gather additional information, which may not have been noticed originally, by enhancing an image to bring out details that were not the focus of attention at the time the photographs were taken. This gives the investigators the ability to obtain additional information, even when the original crime scene is not longer available for analysis.

5. Partnership with Law Enforcement

Visualization technologies and the professionals trained in their use can be a great asset to any department. Beside their analytical capabilities and computer expertise, these professionals can assist officers in making better use of their crime scene analysis tools.

They can show officers how to use the field portions of the equipment to their advantage in putting together evidence. They can assist officers in making suspect associations by running patters and images against a database and pulling out images that match or closely match ones taken at the crime scene under investigation. If the department is linked to other departments, such as in a larger city, this data search becomes even more powerful by potentially including larger, more diverse, data bases.

The ability to digitally transfer files, which do not lose resolution as they would in the standard photographic printing processes, also makes this technology a powerful tool. Instead of faxing photographs or mailing prints, these files could be sent through the network nearly instantaneously and with the same resolution as the originals. No image resolution is lost, and valuable time is saved by such a capability. These images can be stored as part of computerized crime files and transferred to the courts, prosecution and defense attorneys, in a complete and concise file package, and all done quickly and efficiently. This can occur in a secure fashion so that the issue of evidence tampering and improper release does not occur.

The data manipulations representing the image enhancement process can be stored for future reference, and multiple files can be generated from single photographs to enhance the crime scene evidence package. Also, these manipulations are available for review at any time so that questions regarding the accuracy and appropriateness of the processing steps can quickly be resolved. These enhancements can assist in making cases and in locating suspects. A digital photograph may also lead to the detection of other evidence that may remove doubts in cases where the evidence is not completely conclusive. The connection of image processing technology to law enforcement opens up numerous opportunities for utilizing the advances achieved in other sectors, such as medicine and national security, to assist busy agencies and solving difficult cases. The efficiency of the computerized approach also aids departments in managing files so that valuable evidence is not lost or damaged such as could be the case with a standard photograph. Evidence can also be protected against tampering or pilferage because the image files can be redundantly archived, password protected, restricted from unauthorized access and/or digitally watermarked. The digital photographs represented by these files can also be set with view only functions which prevents data from inadvertently being erased or modified.

6. High Tech Solutions and High Tech Training

Since detectives and field analysts currently are adept in using equipment in the field for photography, the step up to digital platforms is not large and does not require major changes or retraining. Officers and analysts can be easily trained to use the more either the new equipment, such as the digital camera systems, or to make better use of the conventional photographic systems already employed by their departments. The initial costs of such equipment can also be recuperated through the increased efficiency, and accuracy of images being processed for cases. Analysts can work directly with the officers in determining their specific needs and the image acquisition process can be optimized to

accommodate particular agency preferences or case requirements.

7. Imaging Processing and the Future

The future for law enforcement is heading quickly down the information superhighway. Utilization of high resolution image processing and the digital warping of photographs will move agencies ahead in terms of accuracy, productivity, and information management. The trends in photography and computerized processing are advancing at such a rapid rate that this type of technology will become a necessity the very near future. The current technology is also adaptable to upgrading and future enhancements to keep an agency up-to-date with visualization trends as they are developed in this and related fields. The overall effect is that liability is reduced, sometimes substantially, due to the increased precision of the digital procedure and the additional information provided by the image enhancement process.

8. Acknowledgments

9. References

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SOFTWARE: Advanced Visual Systems' AVS 5.02

CASE FILES: Bonneville County, Idaho, Sheriff's Office Case Investigation 92-05977