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Piecing together the report from the National Academy of Sciences

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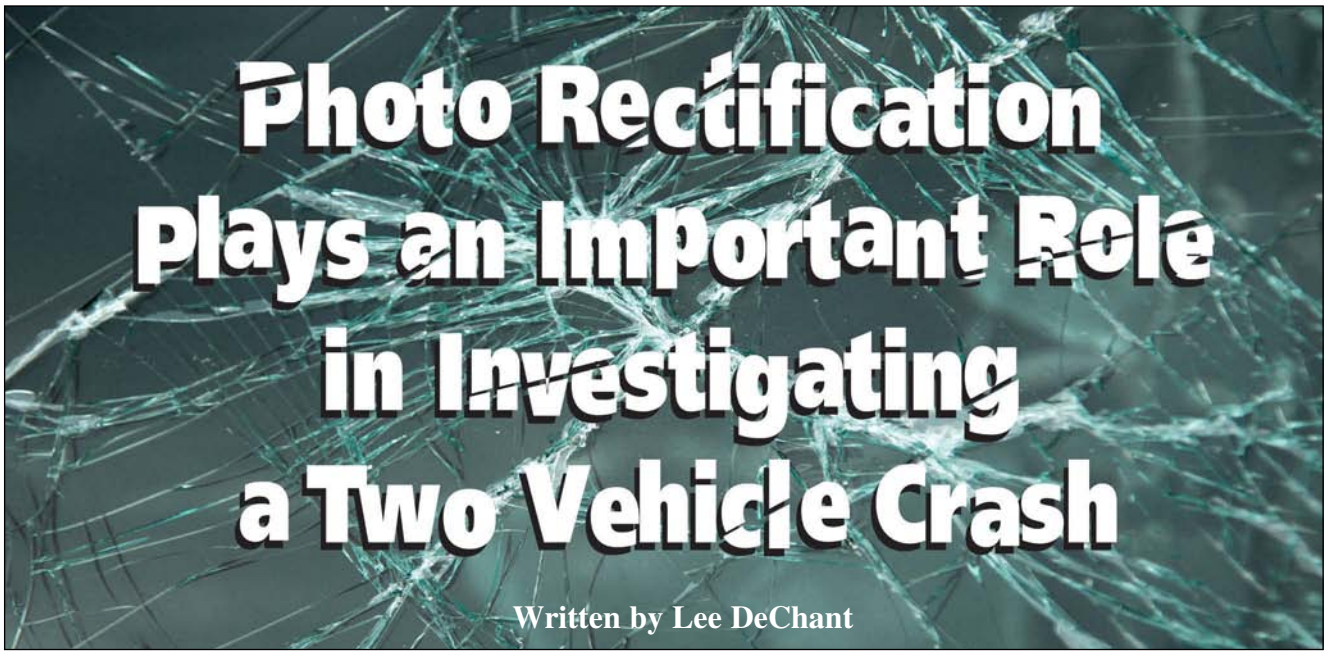

Photo Rectification Plays an Important Role in Investigating a Two Vehicle Crash

Written by Lee DeChant

IN A PERFECT WORLD, every crime scene or vehicle-collision scene is carefully documented, with precise measurements that are taken immediately and photographs that detail every angle of the scene. However, investigators often find—particularly in traffic accidents—that there are just one or two good photos that show the overall scene, and that the measurements were left behind.

Fortunately, with today's technology, just one or two photos of a crash scene can play a very important role in measuring evidence through something called photogrammetric modeling and image-based rectification.

In the case outlined in this article, a single photo was taken by a police officer and used to reconstruct the position of vehicles involved in a head-on crash. The police photo was rectified, where the camera-aim point (an *oblique view*) was transformed into a normal view (a *plan view*). From the plan view, the photo could be accurately measured to help clarify what happened in the crash—either supporting or conflicting with what two drivers reported to police after the wreck.

Detailing the crash

An SUV (Vehicle 1) was traveling northbound on a two-lane road. The driver of Vehicle 1 made an evasive action, swerving to avoid hitting an animal crossing from the east side of the roadway. At the same time, the driver of a truck (Vehicle 2) heading southbound had locked-up the brakes and also swerved across the centerline. Vehicle 1 and Vehicle 2 collided in the northbound lane, which was illustrated by the road evidence and point-of-impact.

The driver of Vehicle 2 told police that the driver of Vehicle 1 was "completely in the southbound lane". The police report was subsequently filed stating that the incident was the responsibility of the driver of Vehicle 1.

Months after the incident, an experienced reconstruction practitioner reviewed and analyzed a digital copy of one of the scene photographs acquired by police. The reconstruction practitioner determined that the police photograph revealed faint tire markings (a yaw-mark) created when the driver's-side tire on Vehicle 1 crossed over into the southbound lane. Looking at the photograph, the tire mark of Vehicle 1 appeared to be less than one foot into the opposing lane in relationship to the solid double-yellow centerlines. If that were the case, the driver of Vehicle 2 could have just stayed "on course" (southbound), or swerved just slightly to the right in the southbound lane, and the two vehicles would not have contacted each other.

Proving vehicle position with photo-based rectification

The reconstruction practitioner had contacted DeChant Consulting Services (DCS) for help in measuring the tire markings created by Vehicle 1. In order to perform a planar rectification from the image, a minimum of four control points are needed. DCS reviewed the scanned image and determined that there were enough natural features present in order to yield the required tire measurement on Vehicle 1.

The scanned photograph displaying the faint tire marking of Vehicle 1 and point-of-impact had actually been "marked-up" by someone with a ballpoint pen before it was scanned, and the image quality of the scan was certainly not "high resolution". Nevertheless, at the time of preliminary photogrammetric review, the scanned photo was believed to be satisfactory for the image-rectification and measurement process.

The reconstructionist went back to the scene and imaged it with a metrically calibrated, consumer-grade digital camera. While photographing and surveying the scene, specific natural features were maintained in the field-of-view at all times. These digital images were later measured with the iWitness photogrammetry software system, and control points were derived for the image rectification using the XYRectify software program. The same control points were marked in the original scanned police photo (Figure 2) to help complete the rectification process.

It should be noted that XYRectify assures the scanned pixels are square, a requirement for accurate rectification measurement. As previously mentioned, the oblique view of the photo is transformed into a "normal" view or, in this case, a *plan view*. With the image rectified, it can then be measured accurately in the XY axis in the plan view. In this accident, the position of the Vehicle 1 tire mark was determined to be less than four inches away from the double-yellow centerlines. The point-of-contact—or the physical orientation of the two vehicles upon crashing—was determined through review of multiple crash-scene photos taken by the police.

Summary

Image-based rectification requires the area rectified to be fairly flat for two-dimensional (2D) measurement within the rectified plane. From this plane, four (or more) spatially separated 2D (XY) or three-dimensional (XYZ) coordinates (referred to as *control points*) are required to convert the oblique photo into a plan view for accurate measurement. Once placed in a CAD diagramming program, the rectified image also requires unit scaling in either the X or Y coordinates of the image.

iWitness and XYRectify are low-cost, accurate, and easy-to-use image-based measuring tools for accident reconstruction and forensic measurement. As in this case, it is possible to perform mapping from a single scanned photo. In many reconstruction applications, XYRectify (a program suited specifically for single-image rectification) can be used when a scene was not initially measured with tape, laser, or a total station.

About the Author

Lee DeChant is president of DeChant Consulting Services (DCS) in Bellevue, Washington. He is the co-developer of the iWitness Close-Range Photogrammetry software system, software specifically designed for law enforcement and private accident reconstruction practitioners. If you would like to get more information about the XYRectify or iWitness, visit:

www.iwitnessphoto.com

***Figure 1**—Months after the crash, the reconstruction practitioner returned to photograph the scene to derive control points. Control points were calculated using the iWitness photogrammetry software system.*

***Figure 2**—The same control points in Figure 2 were marked in the original police photo using XYRectify software.*

***Figure 3**—This oblique view with a CAD overlay shows how the scene may have looked just prior to and at the moment of impact. Vehicle 1 is shown here in purple; Vehicle 2 is green. The deer location is not exact and included for illustrative purposes only.*