Photogrammetric Analysis in Trip & Fall Investigation

Daniel S. Merrick www.danielmerrick.com

Photogrammetry is the science, art and technology of obtaining measurements from photographs. Photogrammetric methods have been used almost since photography was invented and are still used today in many applications such as mapping. The USGS uses photogrammetric methods to determine both the location and elevation of terrain features for the topographic maps that they publish.

We have all experienced 3-D imagery and movies in which binocular vision is used to provide three-dimensional information. A single image only provides a monocular view and three dimensional information must be implied by perspective from a single image. Single image perspective can be very misleading and is often used in trick photography. Two images of the same scene taken from different perspectives can provide three-dimensional information about everything that is visible in both images.

The only tools required for simple photogrammetry are photographs taken with a known lens focal length, the negative or digital sensor dimensions, paper and common drafting tools. Computational photogrammetry will also require high school geometry and trigonometry. Precision photogrammetry involves calibrated cameras, lenses and complex calculations. Modern software can expedite the required calculations.

I have been retained in several trip and fall cases after the irregularity that caused the incident has been removed. For example, a cracked and raised sidewalk section may have been repaired or a wrinkled floor mat may have been disposed of. If adequate photographs of the scene were taken before any changes, it is usually possible to measure the defect using photogrammetry. All that is required is two photos taken from different perspectives with known camera parameters.

Digital cameras have simplified photogrammetry. With film images, it was necessary to acquire not only the camera and lens parameters but also the actual negative for full frame scanning. If a film camera had a variable focal length or zoom lens, it may not have been possible to use the images. Digital cameras always record the full frame image but also store image data such as the focal length of the lens.

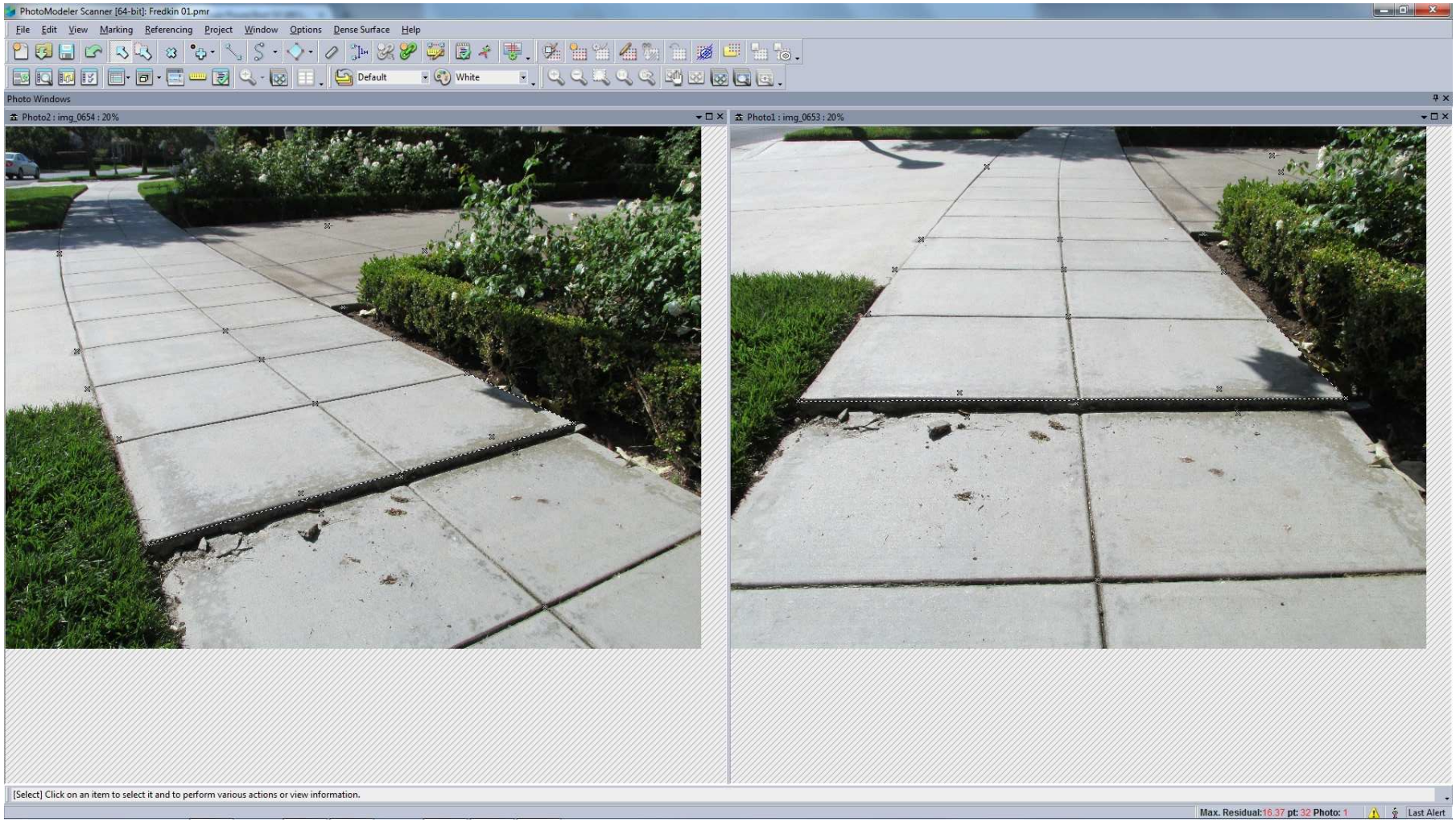
The two images above were taken by the plaintiff in a case shortly after tripping over a sidewalk offset. By the time I was retained, the sidewalk had been repaired but since the plaintiff had taken two photos from separate points of view that included the entire scene and had preserved the original digital files, I was able to measure the height of the offset using the images and a few measurements of what remained at the scene.

By looking at the data encoded in the JPEG image file, I found that the camera was a Canon PowerShot SX 160 IS and that the focal length of both images was 5mm. A web search found that the camera sensor is 1/2.3" (6.17 x 4.55 mm). The only other information required was a dimension of something in the image to use for scale. I visited the site and measured the length of several sidewalk joints that had not been altered to provide scale.

I loaded the images into photogrammetric software and aligned the two images by cross referencing common points in the images. The software solved the geometry including camera position. I then identified a horizontal plane for orientation using the sidewalk joints. I scaled the result to the field measurements and found that the offset varied from 1 to 1 ¼ inches high.

Post Repair

On the following page is a software screenshot. In the images the X's indicate points identified that are common to both. The two dashed lines are reference horizontal. The line across the width of the sidewalk was used for scale.


PhotoModeler Scanner [64-bit]: Fredkin 01.pmr
File Edit View Marking Referencing Project Window Options Dense Surface Help
Default
White
Photo Windows
Photo2 : img_0654 : 20%
Photo1 : img_0653 : 20%
[Select] Click on an item to select it and to perform various actions or view information.
Max. Residual:16.37 pt: 32 Photo: 1
Last Alert