F25 The Effect of Geometric Optical Distortion of Photographs on the Forensic Image Superimposition Analysis

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This presentation will describe the optical errors produced by different photographic and video camera lenses, as well as their effect on the morphology of the photographic image, all this to be presented to the forensic community in order to pursuit the standardization of forensic photo and video superimposition analysis.

This presentation will impact the forensic community and/or humanity by documenting the process of the geometric optical distortions of photographs during the application of forensic superimposition analysis. The listener will develop a better understanding of the

methodology for the ideal comparison between the questioned images. The early detection of radial distortions, as well as their precise correction, will promote the fulfillment of better standards concerning the management of forensic images. The results of this experiment could be extrapolated to the rest of forensic imaging analysis.

Every time we take a still image or a video scene with a photographic or video camera, we make the assumption that, what we see through the viewfinder is what we get on our photograph or video clip, but this is not always the true story. All the photographic lenses produce some kind of geometric distortion, and for the forensic point of view, documenting this physical variable, plays an important role in the standardization of this technique. Since the results of the forensic superimposition analysis, depend on the degree of coincidence between related anthropometric landmarks located on two different photographic or video images, the optical quality of the images used, should be documented in order to standardize the technique.

Geometric distortion occurs due to an optical aberration of the photographic lens, as the light from the object passes through their glass. The distortion modifies the resulting image radially, producing a difference in magnification between the center and the periphery, this geometric distortion is also known as radial distortion. There are two types of radial distortion: pincushion distortion (positive), produces an image with outward corners and contracted sides resembling a pillow shape; barrel distortion (negative), produces an image with inward corners and expanded sides resembling a barrel shape. Both distortions show a redistribution of the original image coordinates relative to the center of the image area, modifying the shape of the photographic image, rendering a non-utilizable picture for measuring or morphological analysis.

In order to evaluate the amount of radial distortion produced by different photographic and video camera lens, a research protocol was designed. It was decided to test a sample of photographic and video systems including: 35 mm and Advantix® film cameras with fixed and interchangeable lens, one-time-use 35 mm and Advantix® film cameras, digital video and still cameras with fixed lens and digital still cameras with fixed and interchangeable lens. The decision was based on the big amount of photographic and video camera models available on the market. The experiment consisted on a first set of photographs taken at different magnification ratios for close range photography (1:1 to 1:10) with the group of photographic and video cameras with close-up capabilities (macro lens and close-up accessories), a second set of photographs taken at a magnification ratio for medium range photography (1:40) with the complete group of photographic and video cameras; and a third set of photographs taken at different magnifications for medium and long range photography (1:40 to 1:oo) with the complete group of photographic and video cameras. For the first two sets of photographs test targets were created for the different camera format size tested. The test targets consisted on a set of rectangular grids of different sizes (magnification ratios), created on a computer with a commercially available drawing software. The cameras were located in front of the targets, perpendicular to the target plane and aligned to the center of the grid with the aid of a mirror. The target distance from the camera lens was modified according to the magnification ratio tested. The first set of photographs was taken with the cameras mounted on a copy stand and the second set with the cameras mounted on a tripod. For the third set of photographs we utilize rectilinear architectural structures as a test targets, mounting the cameras on a tripod and aligning the system with a spirit level.

Professional imaging systems with special interchangeable lens and close-up capabilities presented the lesser amount of radial distortion. Consumer imaging systems with fixed lens and zoom capabilities presented the higher amount of radial distortion.

Conclusion: The results of this experiment confirm the existence of radial distortion on photographs taken with different photographic and video imaging systems. The results also validate the differences between radial distortion and angular distortion. Forensic imaging systems should be tested in order to document the amount of radial distortion incorporated on the imaging process, as part of the standardization of the forensic image superimposition analysis.

Optical Distortion, Forensic Photography, Forensic Superimposition Analysis

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