



F48 Image Resolution: Digital vs. Traditional Film Photography

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The goal of this presentation is to evaluate the quality of images produced by current digital camera technology compared to traditional film photography and to determine if digital photography can be used in forensic odontology applications.

Background: Numerous scientific fields have used digital image technologies for many years; however, its application in the criminal justice system is relatively new. Forensic odontology requires imaging systems to produce images with quality adequate to evaluate fine detail particularly in bite mark cases. Until recently, the image resolution produced by digital cameras has been substantially less than that produced by traditional film photography. However, with digital technology continuing to make significant strides in equipment quality, the images produced by these cameras should be continually evaluated for forensic applications.

Resolution is defined as the ability to distinguish separate visual information such as details and fine patterns. Traditionally, the measure of resolution is expressed in line pairs per millimeter (lp/mm). High resolution lenses can actually resolve over 100 lp/mm. Some of the best color printing papers can reproduce approximately 75 lp/mm. However, the human eye is only able to distinguish 10 lp/mm under optimal conditions. This does not mean that an image printed at 10 lp/mm will be sharp because sharpness has two components - resolution and acutance. Acutance refers to the ability to see the transition between brightness levels. As a result, a sharp image (high resolution and high acutance) is printed at a minimum of 25 lp/mm. The point is that there are a large number of factors that determine whether or not a print will be sharp. Factors common to both digital and traditional photography include: the lens' resolution, lens' aperture, camera motion, resolution of the printing paper, and resolution of the printer. Traditional film is also affected by film thickness, film grain, and enlarger parallelism while digital photography is affected by quality of the scanner chip (CCD). To further confuse the issue, traditional photography negatives are scanned prior to production of the print by many laboratories. Thus, in the end even traditional film is often digitized resulting in the necessity of including the scanner quality and resolution.

Many people also like to convert film to a "megapixel equivalent" and compare to the film resolution to the resolution of the digital camera. In other words, they assume two pixel columns represent a line pair. Thus a single frame of 35mm color ISO 200 film, rated at 50 lp/mm would contain 3600 x 2400 pixels, totaling 8.64 million pixels. Today's high-end digital cameras can produce up to a 6 million-pixel image. It should be noted that since images are two-dimensional objects. Therefore, doubling the resolving power necessitates a fourfold increase in pixel number. Using this correlation, today's 6 megapixel digital cameras should produce an image within twelve percent of traditional film resolution. However, this is an unfair comparison because not all CCDs are of the same quality and physical size or have the same size or shape pixels. Additionally, the image size produced by traditional film and digital photography will usually differ. When using high end digital SLR cameras with lenses designed for 35 mm film photography, digital image size will usually be smaller than the image produced by a comparable 35mm film camera as seen in Figure 1. The above discussion has made it quite obvious that the debate regarding resolution quality of digital versus film photography is confusing. There are too many factors to be considered. Therefore, when evaluating digital and traditional film photography, a practical comparison is in the evaluation of the printed images produced by individual cameras.

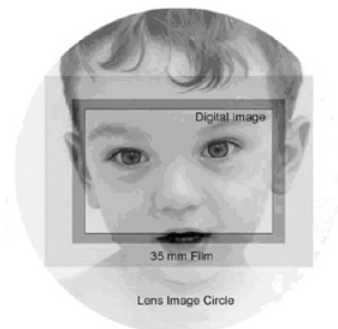


Figure 1



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Methods: Image quality was evaluated and ranked between digital, print film and slide film photography using a Nikon DX1 digital camera, Nikon D100 digital camera, Nikon Coolpix 5000 digital camera and a Nikon N70 traditional 35 mm film camera. As many extraneous factors as possible were eliminated. With exception of the Nikon Coolpix 5000 (a non SLR camera), all photographs were taken using the same lens, a 105 mm Vivitar 1:1 macro lens. The images were printed using the same photographic lab processor and photographic paper. Kodak Select Royal Gold 200 ASA print film and Kodak Professional Ektachrome 200 ASA slide film was used.

Two separate images were taken and evaluated at 1X and 3X. The first image was of the PIMA proposed International standard, ISO 12233 chart used for evaluation of camera resolution. This chart allows for resolution evaluation at the center and corners of the chart as well as for the three major axes – horizontal, vertical and diagonal. Since this image is a very controlled evaluation of camera resolution of a flat surface, a second image of a human ear with an ABFO scale number 2 was also taken and evaluated for image quality. The digital images were taken on each of the cameras highest resolution setting in Tiff mode. The slide film images and print film images were taken using the Nikon N70 camera body. The slide film was scanned at a low resolution (300 dpi) and a high resolution (2400 dpi) and then printed. Therefore, a total of 5 photographs of each image were produced.

Results: The two sets of photographs were evaluated by one hundred individuals who were asked to rank the images from best quality to worst. Individuals with forensic experience were also asked to evaluate the images for forensic acceptability.

Conclusion: Results indicate that photographs produced by certain digital cameras can produce images with an image quality comparable to the print film photographs taken in the study. Dependent upon the quality of the digital camera chosen, photographic results should not be compromised when using digital systems. The data indicate there is no photographic reason that digital systems should be excluded from forensic investigations. The prints produced from slide film, whether scanned at low or high resolution, produced an inferior result to both the print film photographs and the digital photographs.

Forensic Odontology, Digital Forensic Photography, Image Resolution