Digital Image Compression: Pixels n' Bits

I was thumbing through my copy of the "Monthly Extreme Nerd and Geek Review" (if you get it, then you get it . . .) when I ran across the following personal ad:

> JPEG, 335k, RGB 856X457, seeks developing relationship with TIFF must be uncompressed, have at least 8 bits and a colorful personality. BMPs, PNGs, and especially GIFs need not respond.

ICU docs more than most people realize that information is often the key to success. This month, I am going to explain the complexities of various graphics formats and compression techniques. If you have been following these columns to this point, you have realized the utility of digital photography in the ICU setting; this time I will explain how to optimize your practice to achieve the best results.

Computer graphics come in two basic flavors, those that are produced by telling the computer the exact placement and specific intensity and color of each dot (pixel) that makes up an image, called bit maps; and those that are produced by asking the computer to draw images based on mathematical equations, commonly called vector graphics. The two differ in fundamental ways, but to simplify, images that display true photographic detail are almost always bit maps, while images that appear more as drawings or illustrations are often vector based. Bit maps use a lot of memory and are locked in to a specific size and resolution (more on this in a minute), while vector-based graphics use little memory and can be scaled (enlarged) with little or no increase in memory usage. When we discuss digital photography, we are in the realm of bit-mapped images, and we need to have an understanding of how these images are handled by your computer.

To display a bitmapped image, your computer must draw each individual element of the picture (pixel) in a precisely specific location. In addition to "remembering" the location of each individual pixel, the computer must also remember information about the color and intensity of each pixel. To do so, the computer graphics processor works with different color spaces (often referred to as palettes) and different mathematical ways of displaying these colors. Most computer graphics and digital camera images are created in RGB (red green blue) color space. In RGB color space, each color (red green blue) is given an intensity level, and the mixture of these levels creates the final color. The "bit depth" determines the available number of levels within each color such that a higher bit depth translates into more available colors for the computer to be able to display. This results in more accurate rendition of photographic colors but also vastly increased memory requirements needed to display, store, and save the image. In yonder days of yore (the ancient past from the perspective of the computer industry is about 5 years ago), computers were limited to displaying "8-bit color information." This translated to 2 taken to the 8th power, or 256 available colors. As the human eye (so my wife the ophthalmologist tells me) can distinguish billions of different colors, rendering reality in only 256 left much to be desired. As performance improved, computer graphics were more commonly displayed in 16-bit color, again 2 to the 16th power, or 65,536 colors (put down your calculator and learn to trust nerd-boy [girl]!) Most people feel that this color depth can give an accurate representation of reality, but most modern computers and graphics processors can pump out images with 24 (you do the math . . . 16,777,215 colors), 36, and even 48-bit colors.

It is clear that the more information the computer needs to remember to display the graphic, the larger the eventual file size will be. This constitutes a problem in two ways. The first is that your computer and various storage media can only hold a finite amount of data, and this available space will soon be used up by graphics. The second point has to do with transmitting these files over the Internet or even over a local area network (LAN). In this setting, bandwidth is the limiting factor, and if you want your graphic files to get to their intended destination in a timely fashion, the smaller the better.

Into this arena enters compression technology. Compression technology allows the computer to "smallify" (to make small in "computerese") files for storage, transmission, and display. It is these compression technologies that give us our 3- or 4-letter file types for graphic files. Compression technologies all work in similar fashion; they look for similar data in graphic files and merge areas of similarity so that the computer has to remember less. The exact manner in which they accomplish this task constitutes the difference between these file formats.

For our purposes, only one parameter is of real importance. This is whether the compression algorithm causes a degradation of the final image (so called "lossy" compression schemes) or whether the image is not degraded by the compression. The JPEG (Joint Photographic Experts Group) technology is the most common compression format used today. This is a lossy compression scheme but also an extremely powerful one. Using JPEG compression, one can smallify a file of 1 MB down to 38k with little degradation in quality. To accomplish this, various software programs will allow the user to see "before and after" views. The trick here is to set your camera to take the best image it can (usually in the "fine" mode, which gives out an uncompressed TIFF [tagged image file format]), then download this image to your computer, and using image-processing software (discussed in previous columns) compress the image to the point where the quality is still acceptable. If you have adequate storage, you can save the uncompressed image for future uses; this can be done in either the format native to your image-editing program (Photoshop and Photoshop elements use PSD format) or as a TIFF, a format that supports uncompressed images. The final size of your image will be determined by your uses for the image and will be a function of the image dimensions (height multiplied by width) and its resolution (dots per inch [dpi]). For images that will be viewed only on a computer, resolution need never exceed 96 dpi as this is the resolution of most monitors. For printing, 150 dpi tends to be a good resolution, even on printers capable of printing resolutions far in excess of this number.

Well, this serves as an introduction to the wacky world of graphic compression and quality. When next we meet, we will discuss how to actually edit an image using an industry standard image-editing program. Till then, be sure to keep the tape wrapped firmly on the bridge of your glasses!

Dana Braner, MD
Oregon Health and Sciences University
Doernbecher Children's Hospital
E-mail: branerd@ohsu.edu

Barry Markovitz, MD
St. Louis Children's Hospital
Washington University School of Medicine
E-mail: Markovitz@kids.wustl.edu

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