



McCord Web Design

2254 Ravenna Court • Waldorf • MD 20603-4966

Office: 301.705.7303 • Fax: 301.705.7302

E-mail: Info@McCordWeb.com

Digital Photography Made Easy

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Michael McCord, P.E.

In the past few years, the digital photography market has seen tremendous growth and many consumer and business users have traded in their traditional film-based cameras for digital cameras. The purpose of this tech note is to extend the reader's understanding of film/print photography and how they relate to their digital counterparts. In this tech note, we will examine digitizing film and prints, choosing the right resolution, file compression, color compensation, image editing, and file sharing.

Understanding your 35 mm film properties

For the past two decades we have been using 35 mm cameras that have served their purposes well for making standard 4x6 inch prints. When we purchased our first digital camera we settled on an Olympus model with 4 megapixels (MP) of resolution. It was immediately apparent that the color quality and image resolution of the digital camera were significantly improved over our best film camera, a Canon EF 35-mm SLR with f/1.4 lens. To determine the extent of this improvement, I took pictures of scenes with our new digital camera and compared them with pictures of similar scenes taken with the Canon SLR. With the aid of a Hewlett-Packard S20 film scanner, I digitized the film images and compared them with the digital images.

For the comparison, I used Kodak Gold 200 print film and scanned the negatives at 2400 dots per inch (dpi) resolution. Using Microsoft's Photo Editor (an Office suite product), similar scenes were compared at 800x. The film-based image grain was visible and indicated by uneven color transitions while the digital image had more consistent color definition and transitions. In recent years, Kodak Gold 200 print film has been an excellent general-purpose film with a fairly fine grain structure. Although finer details will be captured for scan resolutions of 2400 dpi, I have found that scanning at 1200 dpi is adequate for most applications. For more information on scanning resolution and film grain, please read my tech note "Sharing Your Digital Photographs". A brief summary on this topic follows.

Images captured on film are limited in resolution by the grain structure of the chemicals deposited on the base. Grain in film cameras translates to pixel resolution in digital cameras. So, to translate film images to digital images, your scanner only needs to digitize at a resolution on the order of the film's grain structure. What this means is that by scanning the negative at 1200 dpi, your 36x24 mm (1.42x0.94 inch) film image will translate to a digital image of approximately 1700x1134 pixels. Multiplying the horizontal and vertical pixel counts yields the image size, in this case 1.93 MP.

Using an image viewer on a computer, the digitized film image (1.93 MP) above can be "blown up" to the extent that individual pixels can be examined. At 800x magnification, you will see that the pixel resolution is approaching the grain structure of the film. Scanning at a higher resolution, such as 2400 dpi will only provide marginal improvement of the image quality because it is inherently limited by the film's grain structure. Fine-grain professional films and top-of-the-line camera equipment will support scanning at higher pixel counts (dpi settings) and well-established sources place the upper limit at about 25 MP. However, good results will be achieved when scanning at 1200 dpi (1.93 MP) and marginally improved results achieved when scanning at 2400 dpi (7.7 MP). This is because it is only necessary to scan at the level of detail captured on the film image. All film grains vary in size and any particular film type can be defined by its average (technically the root mean square, or rms) grain size. That is, some grains are large, some small, but the average grain size sets the nominal resolving power of the film. Higher resolution scans will pick up areas of detail around the finer grains, but good results will be achieved when

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scanning at the average level of detail information that is contained on the film. For Kodak Gold 200, it has been my experience the film's average grain size is comparable to about 1600 dpi.

Another way to look at film grain structure is to calculate the required image quality for a standard print size, say 6x4 inches. Using 300 dpi as acceptable for color print quality, simply multiply width by height by dpi to get the digital image requirement. In this case, 6x300x4x300 yields 2.16 MP. Comparing to the 1200 dpi (1.93 MP) resolution of the scanned film image, you can see why 35 mm film is well suited to making 6x4 prints and why enlargements only marginally improve the image resolution.

Digital cameras with resolutions on the order of 4 MP or more offer significantly improved detail quality for larger prints such as the popular 5x7 and 8x10 inch formats. So, use the resolution setting that best suits your intended use for the images.

Digital Image File Size

High-resolution digital images are great for super fine-grain pictures but the file size can quickly grow to 12 megabytes (MB) or more. Since each pixel requires three bytes to define its color, a 4 MP image results in a 12 MB file. Three-byte color granularity is known as 24-bit color because there are 8 bits to the byte. It is also known as 16.7 million colors since 2 raised to the 24th power is 16.8 million. Using our previous example, a 1.93 MP image will result in a 5.8 MB file size. A straightforward image matrix of this size is commonly referred to as a bit-mapped image, which, in standard format, has a .BMP file extension.

To digitize an entire roll of film (say 24 images) of bit-mapped files would require 140 MB of disk storage space. Although the storage capacity of an 80 GB hard disk drive is immense, you would run out of disk storage space with 13,700 images. For 4 MP images, this same disk would be full with 6,600 images. This seems like a lot of storage space but when archiving photos you'd be surprised how quickly your hard disk drive space fills up.

To reduce image file size, compression techniques are used. Popular compression formats such as JPG and GIF dramatically reduce file size without sacrificing image quality. The JPG format is quite flexible in that the compression factor can be adjusted to suit your needs. High quality JPG compression using a quality factor of 100% will reduce file size by about 75%. That is, our 1.93 MP photo (5.8 MB) can be reduced to about 1.5 MB of storage space.

If the quality factor is decreased, the file size can be further reduced at the expense of image quality. What you need to know is that for quality factors less than 100% the JPG compression algorithm selectively throws out pixels. The lower the quality factor, the more pixels are thrown out; pixels that are not recovered when the image is decompressed. The advantage is that our 1.93 MP photo can be compressed to a file size of approximately 50-100 kilobytes (KB). The disadvantage is that the quality decrease is more noticeable as the compression factor goes up.

Images inserted into word processing documents usually will not require high resolution. Many photo editing software packages will support reducing the pixel resolution, or desampling, to reduce the image file size. I have found that using an image desampled to 150 dpi and using a quality factor of 30% yields excellent visual quality for document insertion. This is also an excellent technique for sending photos via e-mail and adding photos to a digital photo album.

Summary: For electronic document insertion and e-mail attachments, copy your archive images, and decrease their pixel density and quality factor to best suit the application.

Color Compensation

What you see is not necessarily what you get. For example, select an image and print it on 8.5x11 inch photo paper. Then size the image on the screen to match your 8.5x11 print. Examine both images closely and notice the differences in color tints and brightness. If your system is well calibrated, the monitor display and your hard copy will be in close agreement. However, if there is any noticeable difference, there are several ways to compensate for color balance, brightness, and contrast including monitor adjustments and color profile adjustments.

Note: This is a good time to think about upgrading to a high-quality LCD or CRT monitor. Presently, I prefer my CRT monitor, a professional flat screen model from CTX that works well for digital image processing. However, comparable LCD technology is available on the market and prices are coming down.

Setting your monitor and color profile to match your prints is an important part of image processing. One profiling method that works fairly well is the gamma calibration application that comes with Adobe PhotoShop. It quickly enables you to set the monitor's contrast and brightness, and then it sets the color profile for your display. Gamma calibration applications (under various trade names) are gaining in popularity and are available from a number of sources including monitor manufacturers. For more information on monitor calibration, please read my tech note "Advanced Digital Photography and Color Compensation".

Once calibrated, your monitor will be set to the industry standard for digital imaging. Modern photo-quality printers are calibrated to the same standard so your printed images should closely match those on your display. In my experience, images from our camera, film scanner, and flatbed scanner tended to be color shifted toward blue. Uncompensated, the printed images also tended toward blue. To achieve more natural-looking images, I use a photo editing program to manually adjust color tint.

Image editing

The first thing to check is whether or not your photo editing software removes the embedded photo information. Try editing a copy of an image file, save it, and check the file properties to ensure information such as camera model, shutter speed, f-stop, etc. is preserved. For Windows operating systems, use Windows Explorer to locate the file, right click on the file name and select properties from the menu, then select summary, then select advanced. Camera model and exposure settings will be listed under the Image header. It isn't necessary to keep the photo information, but you'll want to be aware if it is being removed.

Three steps to editing and archiving photo images:

Step 1. Touch up for chemical blobs, scratches, and dust. (Skip this step if the image source is a digital image.) If the image source is film, you'll need to touch up film blemishes picked up by the scanner. Although many photo editing programs claim to do these features automatically, you will give up a degree of image quality in the process.

As a personal preference, I use Adobe photo editing software to clean up blemishes using their "clone" tool. First blow up the picture to 100-200%. Then place the clone source point adjacent to the blemish. Click and drag your cursor on the blemish and watch it turn to the same color as the pixel(s) under the source point. With a little practice you can remove blobs, scratches, dust, etc. and retain the image's overall detail quality.

Step 2. Adjust image size and resolution. (Skip this step if the image source is a digital image.) First make sure the image aspect ratio (width:height) is locked – most programs provide a check box for this function. If your image source is film, use a photo editing program to set the width for a landscape photo to 6 inches (or the height for a portrait photo to 6 inches). At the same time set the resolution to 300 dpi. This is arbitrary, but these are my personal favorite settings. Save the image in JPG format and select 100% quality factor. This step will slightly increase a 1.93 MP image to 2.16 MP.

Step 3. Adjust the color tint, contrast, and brightness. Rather than entrust this process to an automatic feature of a program, I prefer to use the manual process (e.g. Microsoft's Photo Editor is my personal favorite). The manual process allows you to control the color adjustments to suit your personal preferences. Save the image in JPG format and select 100% quality factor.

To insert images into documents or slide shows, make a copy of your archived image and use your photo editing software to reset the copy to a lower pixel resolution (e.g. 150 dpi) and save as a JPG file with 30% quality factor. This step will reduce a 2.16 MP image to 540 kP. Reducing the JPG quality factor will further reduce the file size to about 75-150 kB.

Photo Archives

Microsoft's default directory structure may be used to store your photographs under \Documents and Settings\Nancy\Nancy's Pictures\, etc. However, it may be more convenient to create a directory called \Photos on

your C: or D: drive. Then place image files in folders arranged in a year-month directory structure something like this:

\Photos\2004\January

\Photos\2004\February

etc.

Rename your photo image to something that makes sense but don't change the file extension! Renaming the photo image will not take away any embedded photo information. Renaming the file extension will remove your operating system's ability to associate that file with an image viewing program. For file name, I recommend a date-based convention that automatically sorts by date in a directory listing:

YYMMDDNN.JPG

YY – last two numbers of the year (e.g. 04)

MM – month (e.g. 05)

DD – day (e.g. 25)

NN – sequential number for that date (e.g. numbered 01 to 99)

Print out thumbnail images of your photos and place them in a 3-ring binder so your archives are easy to browse through, e.g. something like 15-16 images per page. Some programs will print the file name under each photo, otherwise take the time to hand write each file name.

Conclusion

Digital cameras have revolutionized photography and make a most welcome complement to any home or small business computer system. A good understanding of their features and limitations will equip you with the skills necessary to share and employ your images.

Photography, like any art, may be subjectively interpreted so please use this tech note as a guide and use your own creativity to find a technique that suits your style.