TECHNOLOGY BASICS

This chapter briefly discusses seven important technology basics in imaging: graphics, image types, resolution, legibility, file formats, image capture interfaces, and image drivers.

Graphics

Chapter 1, the overview chapter, differentiated between digital imaging and graphics. A more technical differentiation between digital imaging and graphics is made using the terms raster graphics and vector graphics.

Raster Graphics

In raster graphics (more appropriately termed raster imaging), an image is represented as a series of points. A raster unit is a distinguishable point on a screen. The simplest type of raster graphics consists of monochrome (bitmapped) images, in which a picture is represented as a two-dimensional array of dots, where each dot is either zero (representing white) or one (representing black). Most image capture devices—and all fax machines—use bitmapped raster imaging. In this context, resolution is the number of dots (called pixels) used to represent each inch of the picture; the more dots or pixels per inch, the more accurately the digital representation can portray the original image.

Vector Graphics

Vector graphics employ graphical objects such as lines and circles as basic building blocks and are heavily used in applications such as computer-aided design (CAD); they are not addressed in this study because that application constitutes what is popularly known as graphics.

Image Types

There are five main types of images (or in the arcane language of the field, bit-depth): One-bit black and white or bi-tonal, 4-bit grayscale, 8-bit grayscale, 8-bit color, and 24-bit color. (A 32-bit color is just beginning to emerge). A bit is the fundamental unit, with a single bit represented by either a 0 or a 1.

A 1-bit black-and-white image means that the bit can be either black or white. It is bi-tonal. There are no shades in between black and white. In practice, this type is used only for low-cost imaging of printed text without illustrations.

A 4-bit grayscale image encompasses 16 shades of gray, which is suitable for most printed books without illustrations. It's also suitable for older books that are nominally black and white, but which actually contain shading and varieties of ink density and paper tonality.

An 8-bit grayscale image encompasses 256 shades of gray. It is most commonly used for manuscripts and printed texts with considerable shading.

8-bit color is similar to 8-bit grayscale, except each bit can be one of 256 colors. It is used in lieu of 24-bit color only when economy is more important than quality. Now that storage has become inexpensive, it is not frequently used in scanning, but it is not uncommon in storing service copies.

24-bit color encompasses 16.8 million colors. It is the ideal image type for image capture by libraries and archives because it offers high quality at acceptable cost, with each bit having the potential to contain one of 16.8 million colors. The image looks more photo-realistic even if the original is not in color. Once captured in 24-bit color, an image can be copied to 8-bit color or grayscale for use, with the 24-bit color retained as an archival copy.

There now are 32- and 42-bit color options as well. They are used primarily by professional photographers and graphic artists.

Bit depth does not refer to solely to the number of colors the scanner can capture, but also to the maximum number of levels that can be enumerated. More bits generally result in better image reproduction even through the printer can't print or the screen can't display all the colors.

A capture device's theoretical capacity is rarely achieved. For example, a 24-bit capture device is represented to have the capacity to assign one of 16.8 million values to a color, but in fact, the best are limited to 262,144 color values—short of the dynamic range of a typical color photograph. For that reason, professional photographers have begun to use 32-bit capture devices, and even 42-bit capture devices.

Resolution

The resolution is determined by the number of dots per inch (dpi). The more dots per inch, the more information is being stored about the image. The higher the dpi, the larger the size of the file that must be stored. A 1-bit black-and-white image at 100 dpi requires only 10 Kb of storage; a 24-bit color image at 400 dpi requires 475 Kb of storage.

Now that 600-dpi capture devices and storage are quite inexpensive, little need exists to capture and store images at 100, 200, 300, or 400 dpi. The big issue is whether to scan at 600 or 1,200 dpi. Most of the well-known digitization centers—centers such as Cornell, Oxford, and Virginia—capture at 600 dpi, storing the master copies as offline storage on writable CD-ROMs and make 400-dpi copies for service use. But an increasing number of libraries and archives are capturing at 1,200 dpi when they are working with source documents that include color.

Legibility

Legibility results from a combination of bit depth and resolution. An 8-bit pixel captures more information than a 1-bit pixel, therefore, using a lower resolution with grayscale rather than with bi-tonal may be possible to achieve the same degree of legibility.

File Formats

There are four common image formats because they transfer to almost any platform or software system: TIFF, JPEG, GIF, and PDF.

TIFF (Tagged Image File Format) files are widely used for the master copy of a file. Once saved, a TIFF file can be retrieved and read by a computer with a different hardware and software system. TIFF images are easy to manipulate. When compressed, no information is lost (lossless compression).

JPEG (Joint Photographic Experts Group) files are widely used for Web viewing and transfer through systems that have space restrictions. The compression is lossy, meaning that as a file is compressed, it loses bits of information. However, this does

TIFF is the abbreviation for tagged image file format.

JPEG is the abbreviation for Joint Photographic Experts Group.

GIF is the abbreviation for graphic interchange format.

PDF is the abbreviation for portable document format.

not mean that the image markedly decreases in quality. If it has been scanned at 24-bit color, the loss is not visible to the human eye. JPEG images cannot be enlarged without loss of quality. Although JPEG images are not popular for archiving, they are popular as service copies. Creating both TIFF and JPEG files is common when scanning as is making JPEG copies from TIFF files.

GIF (Graphic Interchange Format) is an older format limited to 256 colors. Like TIFFs, GIFs use a lossless compression format, but they require less storage space.

Although all the foregoing image formats are based on international standards, PDF (Portable Document Format) is a proprietary format developed by Adobe. PDF is widely used on the Web because of the attractive features of the Adobe Acrob at reader, so it is becoming a popular format for imaging systems.

Image Capture Interfaces

An image capture device, typically a scanner, has to be interfaced with a PC just as any other peripheral. There are many options: IDE, SCSI, SCSI-2, SCSI-3, USB, and Firewire.

IDE

IDE is the most common interface between a PC and its peripheral components. Its main virtue is its low cost, but it offers the poorest seek time of all the options. When working with images, which contain far more bytes than the data usually manipulated on a PC, the lower cost is more than offset by the poorer productivity that results when the data moves slowly from the image capture device to the PC.

SCSI

SCSI is the abbreviation for small computer system interface.

USB is the abbreviation for universal serials bus.

SCSI comes in several flavors: SCSI, SCSI-2, and SCSI-3. All offer faster seek times than IDE, but all cost more and are more difficult to set up. Nevertheless, SCSI is a better choice for an imaging application.

Most products with SCSI interfaces come with SCSI-2, also known as Ultra2. It moves data at 40 Mb per second. SCSI-3 or Ultra3 moves data at 160 Mb per second. Almost all image capture devices support either SCSI-2 or SCSI-3.

USB

USB, the universal serials bus, is still in its infancy. It is substantially slower than either SCSI-3 or FireWire, transferring data at a maximum speed of 15 Mb per second. It was designed to connect keyboards, mice, tablets, modems, telephones, CD-ROM drives, printers, and other low- to moderate-speed external peripherals in a tiered star topology. Its main advantages are the ease of setup and the elimination of many tangled cables behind a PC. Although suitable for consumer model image capture devices, it is not suitable for use with professional models.

IEEE 1394

The standard, adopted and maintained by IEEE, was initially developed by Apple. FireWire, a name often incorrectly applied to the standard, is Apple's implementation of the standard. IEEE 1394, currently in version IEEE 1394b, provides for data transfer at rates up to 3.2 Gb per second—many times faster than SCSI. The top data transfer rate can be achieved only with the use of twin-fiber cabling. Standard 4-pair cable supports up to 200 Mb per second. Not all PCs support IEEE 1394.

Image Drivers

An image driver is required for an image capture device to communicate with software applications. There are standards for such a driver, ISIS and TWAIN. Without an image driver, to move a captured image to a workstation for enhancement or storage, you have to leave the application in which you are working, locate and open a hardware driver, set the device options, acquire the image, save it to disk, close the hardware driver, return to the application, then locate and read in the image file from disk.

ISIS

ISIS is a proprietary product developed by Pixel Translation, a subsidiary of Cornerstone Corp. Until recently, almost all professional level image capture devices supported only ISIS, and Pixel Translation collected a royalty on almost all imaging products sold. In the past two years many scanner, software, and board vendors came together to create a standard that would be available to everyone in the industry to incorporate into their products without the payment of royalties. They then approached the TWAIN Working Group, a group that was overseeing the TWAIN image driver protocol used in many consumer-level scanners.

TWAIN

The TWAIN protocol for professional level image capture devices, designated TWAIN 1.7, was adopted in 1999. In only a few months most people brought their current product lines into conformity with TWAIN. Although a few offer ISIS as an option, TWAIN is the current standard.