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# *Digital Imaging Glossary*

Written by Jonathan Sachs  
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## **Additive Color Mixing**

Additive color mixing is the process of combining light of two different colors. For example, adding red and green light makes yellow.

## **Anaglyph**

An anaglyph is a pair of black and white stereo images prepared for viewing with special glasses that have a red filter for one eye and a cyan filter for the other eye. One image is printed in red and can be seen only by the eye with the red filter; the other image is printed in cyan and can be seen only by the eye with the cyan filter.

### **Antialiasing**

Smoothing out the jagged appearance of edges in an image by blending background color into the boundary pixels.



### **Aspect Ratio**

The ratio of width to height of a rectangle; an aspect ratio of 1.0 corresponds to a square.

### **Baud**

The baud rate of a modem is a measure of how quickly it can transmit information over a phone line. It is roughly equivalent to bits per second.

### **Binary image**

An image made up of pixels of only two colors (normally black and white). Each pixel in a binary image occupies a single bit of storage; thus 8 pixels can be stored in a single byte of memory.

### **Bit**

A bit is the smallest piece of information that can be represented in a computer.

### **Bitmap**

A bitmap is a representation of a digital image in memory.

### **BMP files**

The BMP or bitmap file format is the standard method within Microsoft Windows for representing image data. BMP files are normally uncompressed.

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## **Byte**

A byte is a unit of computer memory consisting of eight bits. When interpreted as a number, a byte can represent a range of values from 0 and 255.

## **Cast**



A cast is an excess of one color in an image. For example, an image that is too red is said to have a red cast. Color casts can occur in a digital image as a result of degradation of film over time, reciprocity failure, problems in film handling or processing, use of incorrect lighting for a given film type, improper scanning, or many other causes.

## **CCD**

Charged Coupled Device. A specialized light-sensitive integrated circuit that can capture a digital image directly. CCDs are commonly used in camcorders, digital cameras, and scanners to convert images into digital form.

## **CCITT**

CCITT (International Telegraph and Telephone Consultative Committee) produces and promotes communications standards, particularly for facsimile (FAX) transmission.

## **CD-R**

CD-R stands for Compact Disk Recordable. A CD-R is a compact disk that can be written (but not rewritten) once using a special CD-R drive by using a laser to burn pits in a thin gold film embedded in the plastic disk. Once created, CD-R disks can

be read by standard CD-ROM drives and are useful for storing large quantities of data or mastering CD-ROMs. This is the process used to create Photo CDs.

### **CD-ROM**

CD-ROM stands for Compact Disk Read-Only Memory. A CD-ROM is a compact disk similar to an audio CD but used to store computer data. Once data is written on a CD it cannot be erased (hence read-only). Mass produced CD-ROMs are manufactured by stamping disks from a glass master.

### **CD-RW**

CD-RW stands for Compact Disk Read-Write. A CD-RW is a compact disk that can be rewritten many times using a special CD-RW drive that stores information on the disk magnetically. Once created, CD-RW disks can be read by many but not all standard CD-ROM drives.

### **Chrominance**

The part of a video signal that contains color information (as opposed to Luminance which is the black and white component of the video signal).

### **CIE**

The Commission Internationale de l'Éclairage. An international standards organization.

### **Cloning**

Cloning is a technique for freehand retouching of digital images. Cloning involves copying small patches of one image over other parts of the same or a different image.

For example, to remove a dust speck from a photography of the sky, you could copy a small patch of the sky from right next to the dust speck over the speck to remove it. More ambitious cloning techniques can be used to repair damaged images, eliminate larger objects from the background, or to copy image elements from one place to another.

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## CMYK

CMYK (Cyan, Magenta, Yellow, Black) is the color space used by four-color printing presses to reproduce color photographs in newspapers, magazines, and other printed materials. The fourth color, black, is required to create rich blacks since the printing inks are slightly impure and do not combine to create a good black.

## Color Depth

Color depth (sometimes also called bit depth) refers to the number of bits used to represent each pixel in a digital image. The common values for color depth and the number of possible colors each pixel can represent are given in the following table:

bits	possible colors
1	2
4	16
8	256
15	32,768
16	65,536
24	16,777,216

The more bits are used by each pixel, the more closely a digital image can approximate a photograph (and the more memory the image occupies).

## Color Gamut

A color gamut is the range of colors that can be display, printed, or captured by a particular monitor, film, printer, scanner or other device that deals with color images. The larger the color gamut, the more closely a device can approximate the full range of colors visible to the human eye.

Since all colors are generated by combining primary colors, the color gamut of a device is mostly determined by the primary colors in use. For a monitor, the primary colors are determined by the physical properties of the red, green, and blue phosphors embedded in the face of its picture tube (CRT). For film, the color gamut depends on the dyes contained in the different layers of the emulsion. For printers, the color gamut depends on the colors of the inks that are combined and deposited on the paper.

## **Color Management**

Color management is the process of making colors look the same on two or more different color image input or output devices. For example, color management can be used to make the prints created by a digital color printer match the same images displayed on a computer screen.

Accurate color management requires that all devices in the system be calibrated (adjusted to standard settings) and characterized (have a systematically measured color response). Then sophisticated software is used to alter the colors so they will match as closely as possible. Perfect color matching is usually impossible due to differences in the characteristics of the devices.

## **Color Spaces**

Every visible color can be specified by a set of three numbers. There are many different schemes for classifying all the possible colors. The three schemes that Picture Window uses are RGB, HSV, and HSL.

### *RGB (Red Green Blue)*

The RGB color space breaks colors down according to the amount of each of the three primary colors they contain. Red, green, and blue are called additive primary colors because light of these colors can be mixed in different proportions to make any other color. Most computer equipment is based on the RGB color space and it is therefore the easiest for a computer to work with. Unfortunately, humans do not naturally interpret colors according to this system. The space of all colors in the RGB system is a cube.

### *HSV (Hue Saturation Value)*

The HSV color space categorizes colors by their hue, saturation, and brightness (sometimes called value).

*Hue* corresponds to the colors around the outside of the color wheel. Hues run from red to yellow to green to cyan to blue to magenta, and back to red.



Varying hue while keeping saturation and value at 100%

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*Saturation* refers to the intensity of a color. A fully saturated color is very pure and deep; as you reduce their saturation, colors become progressively more washed out until at a zero saturation they become shades of gray.



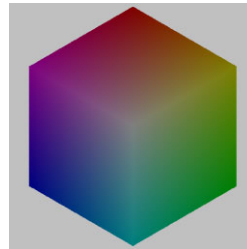
Varying saturation with 0% hue and 100% value

*Value* refers to the overall brightness of a color. All colors with a value of zero, regardless of their hue or saturation, are black. As you increase value, colors become progressively brighter. The brightest, most saturated colors are those with the maximum value.

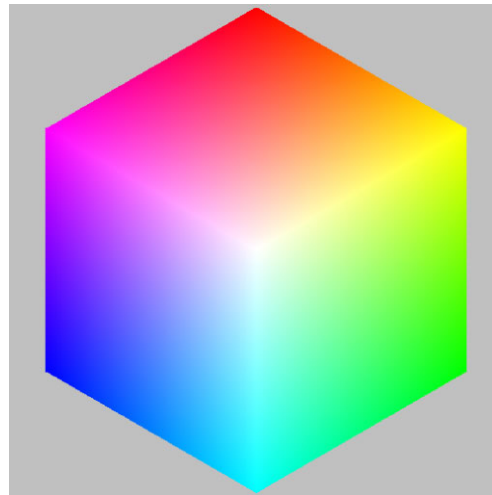


Varying value with 0%hue and 100%saturation

The space of all colors in the HSV system can be thought of as a hexagonal cone with black at the vertex. The following pictures are cross-sections through the hex-cone at 50%, and 100% value. At 0%, it converges to a black point.



V = 50%



V = 100%

*HSL (Hue Saturation Lightness)*

The HSL color space categorizes colors by their hue, saturation, and lightness. As in the HSV color space, Hue corresponds to the colors around the outside of the color wheel and Saturation refers to the intensity of a color.



Varying hue with 100% saturation and 50% lightness



Varying saturation with 0% hue and 50% lightness

The term Lightness refers to the brightness of a color. All colors with a lightness of zero, regardless of their hue or saturation, are black. As you increase lightness, colors become progressively brighter. The brightest, most saturated colors are those with a lightness of 50%. As lightness increases toward 100%, colors become increasingly whiter. All colors with a 100% lightness are white.



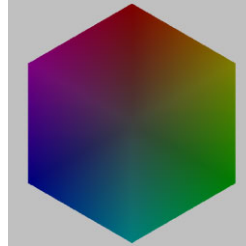
Varying lightness with 0% hue and 100% saturation



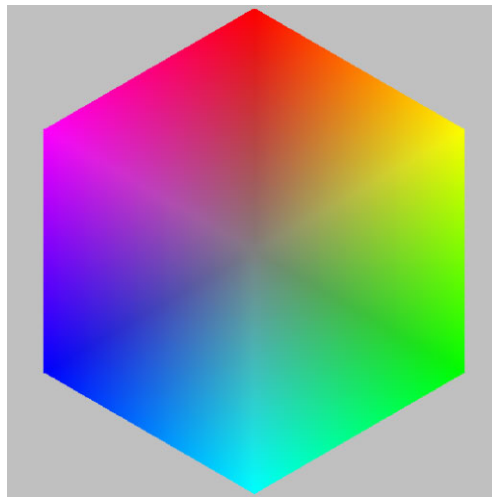
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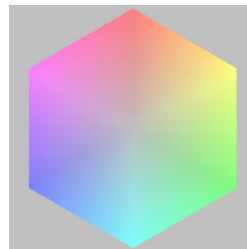
The space of all colors in the HSL system can be thought of as a double-ended hexagonal cone with black at one vertex and white at the other. The following pictures are coruscations through the double hexcone at 25%, 50%, and 75% lightness. At 0%, it converges to a black point and at 100% it converges to a white point.



L = 25%



L = 50%

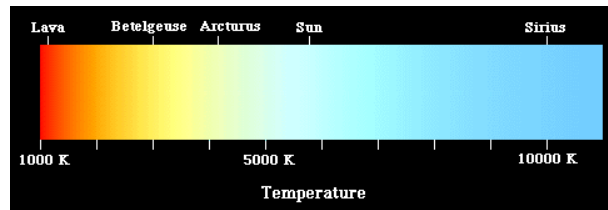


L = 75%

## Color Temperature

Color temperature is a term generally used to describe the color of a light source or the maximum white that a monitor can produce. For accurate color matching between an image viewed on a monitor and a print or transparency, the color temperature (white point) of the monitor must be adjusted to match the color temperature of the light used to view the print or transparency.

Color temperatures are normally measured in degrees based on the black body radiation curve which describes the color change of objects when they are heated. Low temperature light sources light incandescent and quartz halogen lamps (around 3000 degrees) are somewhat orange. Standard daylight is around 5500 degrees. A typical uncorrected color monitor is rather blue (around 9300 degrees).



## Complementary Color

The complement of a color is the color you must add to it to get a neutral gray. You can find the complement of a color by locating the point on the color wheel an equal distance on the other side of the center. The following primary colors are complements of each other:

Red and Cyan

Green and Magenta

Blue and Yellow

## Compression

Compression techniques are used to reduce the size of digital images.

There are two kinds of compression: lossless and lossy. Lossless compression techniques reduce the storage space required by image (or other) files so that when the files are decompressed, the original file is reproduced with no loss of information. Lossy compression reduces image size with some loss of information.

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Lossless compression techniques are quite limited in their ability to reduce image sizes. For typical photographic images, compression factors of more than two are difficult to achieve.

Lossy compression techniques such as JPEG let you trade off image quality against amount of compression; JPEG compression can compress typical images by factors of five to ten while retaining very high image quality.

### **Continuous tone images**

In a continuous tone image, each pixel can reproduce any visible shade of gray or color. This is in contrast to bilevel or halftone images where gray levels or colors are reproduced as clusters of pixels selected from a limited palette of colors.

### **Convolution**

Convolution is a mathematical process for modifying a signal or image by applying a so-called kernel which is really just a set of weights. Each pixel in the output image is computed by taking the weighted average of the neighboring pixels in the input image. By using different kernels, convolution can be used to perform many different operations such as blurring, sharpening, and edge detection.

### **CRT**

Cathode Ray Tube. The picture tube in a computer monitor or television set.

### **Densitometer**

A densitometer is a device for measuring the density of a piece of film or a print. Densitometers contain a light source and a light detector, similar to a light meter. Densitometers that measure film density are called transmission densitometers because they measure how much light passes through the film at a particular location. Densitometers that measure prints are called reflection densitometers because they measure how much light is reflected off the surface of the print at a particular location.

### **Density**

Density is a measure of how much light can pass through a piece of film (or how much light is reflected from a print). Density is measured using a logarithmic scale;

a density of zero corresponds to clear film (or white paper) and the darker the image, the higher the density.

Density,  $D$ , is computed as  $D = -\log(T)$ , where  $T$  is the fraction of light transmitted by a piece of film (or reflected from a print). Thus a piece of film that transmits 10% of the light that falls on it has a density of 1.0; 1% transmission gives a density of 2.0, and so on.

### **Digital camera**

A digital camera captures digital images directly and stores them internally. Digital cameras generate an image using conventional optics, but instead of using film to capture the image, most digital cameras use a light sensitive detector called a CCD. Once the image is captured and digitized, it is stored inside the camera until it can be transferred to a computer.

Most portable digital cameras use a 2-dimensional CCD which has thousands or even millions of tiny light sensors arranged in a rectangular array. Other cameras use a linear CCD which is swept across the image.

There are various schemes for capturing color. Some cameras use beam splitters and 3 separate CCDs while others use a single CCD where some of the sensing elements are covered with colored filters. While 3 CCD cameras have better color fidelity and image detail, single CCD cameras are usually more sensitive and less expensive and bulky.

### **Digital image**

#### *Color Images*

Color images are made up of color pixels, each of which is represented internally in the computer as three bytes (24 bits) defining its red, green, and blue values. This means that a color image 1000 pixels wide and 1000 pixels high occupies 3MB of memory.

#### *Black and White Images*

Black and white images are made up of gray pixels each of which is represented internally as a single byte (8 bits) whose value describes its brightness. Thus a black and white image uses three times less memory than a color image of the same dimensions.

#### *Binary Images*

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Binary images are made up of pixels that are either black or white; each binary pixel is represented as a single bit. Binary images use eight times less memory than black and white images. While Picture Window supports importing and using binary images, they are not very useful for representing photographic images.

## **Display adapter**

A display adapter is the part of your computer that connects to your monitor. Normally, this is a card that plugs into your computer although in some cases it may be built into the motherboard. The display adapter is responsible for generating the video signal that creates the screen image.

Different display adapters have different characteristics and, depending on the driver that comes with the display adapter, your adapter may be capable of running in several different modes.

### *Resolution*

Resolution is normally 640x480, 800x600, 1024x768, or greater. The higher the screen resolution, the finer the detail and the more images you should be able to view at once, subject to the limitations of your monitor's screen size and dot size. While Picture Window is perfectly usable at 640x480, higher resolutions are definitely better. Display adapters that support higher resolutions are more expensive because they contain more memory and must access that memory faster.

### *Number of Colors*

Display adapters typically support 16, 256, 32,000, 65000, or 16 million colors. This corresponds to 4, 8, 15, 16, or 24 bits per pixel of color information. To view photographic images with the highest possible quality, you will need to set your display adapter to 24-bit color (16 million colors).

### *Refresh Rate*

Better display adapters support higher refresh rates. A refresh rate of 70Hz or greater is required to avoid annoying screen flicker. Older monitors may limit the refresh rate of the display adapter.

### *Acceleration*

Better display adapters are accelerated. This makes Microsoft Windows run much faster when it is displaying information on the screen.

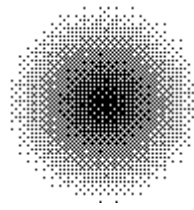
## Dither

Dithering is a technique for representing continuous tone images using a limited palette of colors. Different shades of gray or color are replaced by patterns of pixels whose color approximates that of the original image. For example, dithering is often used to display 24-bit color images on a display adapter that can only display 256 different colors.

There are many different dithering techniques, each of which has its own distinctive appearance. Some of the most common dithering techniques are ordered dither and error diffusion. The following examples show how a continuous tone image that varies smoothly from black to white can be approximated using only black and white pixels.



Original



Ordered Dither



Error Diffusion

## Dye sublimation printer

Dye sublimation printers use a thermal print head to evaporate tiny dots of colored dyes from a special ribbon and then fuse them to a paper (or transparency film) backing. Some printer use three-color ribbons (cyan, magenta, and yellow) while others use four-color ribbons which have a separate black.

The printer makes one complete pass over the page to lay down each color. Dye sublimation printers are particularly good at reproducing photographic images because, by varying the heat used to evaporate dye from the ribbon, each dot can be made to have a precisely controlled amount of each primary color. This makes a very smooth, continuous tone image that looks just like a photograph. Some dye sublimation printers also spread a protective coating over the image -- this makes its surface more durable and improves its permanence.

## Dynamic range

The extent of the range of brightness levels in an image between the darkest to the lightest pixel.

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### **EPS or EPSF files**

EPS stands for Encapsulated PostScript. This file format is commonly used by illustration and page layout programs. An EPS or EPSF file is a file that contains PostScript commands with a special header. If an EPS file contains only a single image, it may be possible to read it using an image editing program. More complex EPS files can contain lines, arcs, text, and other elements that require a PostScript rasterizer (or RIP) to interpret.

### **Facsimile, or FAX**

A system for the transmission of images over telephone lines.

### **Film recorder**

A film recorder is a device that records digital images onto film. As the computer sends the digital image to the film recorder, it is displayed on a special internal CRT and photographed by a conventional camera whose shutter and film advance are controlled by the computer.

### **FITS Files**

FITS is an image file format introduced used to define multidimensional data sets. A 2-dimensional version of this format is sometimes used to store black and white images. The FITS format supports either 8-bit or 16-bit images. FITS is mostly popular as a format for exchanging scientific data.

### **FlashPix Files**

FlashPix is an image file format introduced by Kodak and used by some digital cameras. FlashPix files store their image data in a tiled hierarchy of different resolutions. This format is particularly efficient when only part of an image needs to be accessed. FlashPix files may either be lossless or they can optionally incorporate JPEG image compression. After some initial interest, this file format is now considered obsolete.

### **Frame grabber**

A device that can digitize and store a single frame from the video signal from a camcorder, still video camera, television signal, or VCR. The quality of the images captured by a frame grabber is limited by the nature of the video signal.

### **Gamma**

Gamma is a technical term that refers to the curve that relates the RGB component values of a pixel to the actual intensity, as measured off the face of the monitor by a photometer. Since the human visual response is not linear, it is desirable to set the gamma curve to roughly match that of the eye. This is approximated by using a mathematical relationship called a power law where gamma is the exponent. The standard gamma value used in television sets, Photo CD, and most PC monitors is approximately 2.2.

### **Gaussian Blur**

Gaussian blurring is a technique for blurring an image that closely models what happens in an optical system when an image is defocused. Gaussian blur, as normally implemented in image editing programs, can create very strong blurring by choosing a large radius setting.

### **GIF files**

The GIF (Graphics Interchange Format) file format was created by CompuServe for distributing images on-line. The GIF file format supports a maximum of 256 colors per image and is therefore not well suited to representing color photographic images accurately.

### **Halftoning**

The process of representing continuous tone images using a small palette of colors, usually performed in connection with printing. Black and white images are typically halftoned to a pattern of black and white dots; Color images are usually halftoned using cyan, magenta, yellow, and black dots. Different shades of gray or color are created by placing clusters of dots together. There are many different styles of halftoning which have different visual appearances.

### **High Color or HiColor**

This term normally refers to a color depth of 16 bits per pixel.

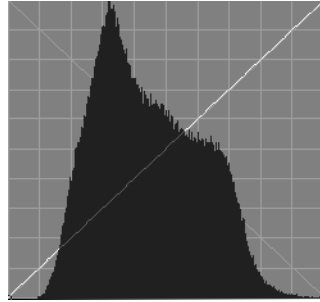
### **Histogram**

The histogram of an image is a graphical representation of how many times each possible brightness level in the image occurs. It is computed by looking at each



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pixel of the image, computing its brightness, and then counting how many times that brightness value occurs.



The shape and smoothness of a histogram can be used to gauge the overall quality of an image as well as its brightness, contrast, and dynamic range. A predominantly dark image will have a histogram that peaks at lower brightness values; a predominantly light image will peak at higher values. An image with a full spread of tonal values will have a histogram that extends all the way from one end of the brightness scale to the other.

## **ICC**

ICC stands for International Color Consortium, a group of companies active in the digital imaging industry. They have created the ICC Profile standard for characterizing different color output devices. These profiles facilitate the reproduction of color images in a consistent manner regardless of the device being used.

## **Indexed Color**

Indexed color is a technique for storing color images using a limited palette of colors, usually 256. Each pixel in the image contains an index into this fixed palette of colors, something like a paint-by-numbers kit. For indexed color to work well, the palette of colors must be carefully matched to the colors in the image.

## **Inkjet printer**

An inkjet printer works by spraying paper with minute dots of ink from a very fine nozzle. By using very closely spaced dots, colored inks, and various dithering patterns, inkjet printers can reproduce photographic images.

**Interlace**

Interlacing is a technique using by some monitors whereby a complete image is displayed in two sweeps, each one of which displays only the even or odd raster lines. When viewing certain types of images using an interlaced display an annoying flickering can result. For this reason, non-interlaced displays are preferable.

**Interpolation**

Interpolation is a technique for computing data between measured values. When applied to digital images, interpolation can be used to resample an image from one resolution to another. While interpolation does not add any new information to the image, it can be used to change the size of the image to match a specific printer or other output device.

**JPEG**

JPEG stands for Joint Photographic Experts Group, an association that has defined a standard image compression technique and file format that is supported by many different image editing programs. JPEG allows for adjustable levels of compression -- image quality goes down as you increase compression. Amazingly, the JPEG compression technique can reduce the size of an image by a factor of 5 to 10 with little or no visible image quality degradation.

JPEG compression works by breaking up your image into 8x8 pixel squares, analyzing each one using a mathematical technique called a Discrete Cosine Transform, and discarding frequency components that fall below a certain threshold based on the compression level you select. The remaining data are compressed using Huffman coding and stored in the output file. JPEG files are decompressed using a similar technique.

**Landscape Orientation**

Landscape orientation or landscape mode refers to an orientation of an image where the width is greater than the height.

**Laser printer**

A laser printer uses a dry toner xerographic process to reproduce images on paper. This is the same process used by copiers except the computer writes the original image onto a drum using a laser. Like inkjet printers, laser printers create images

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out of dots; thus some form of dithering is required to reproduce photographic images.

### **Luminance**

The black and white component of a video signal or the perceived brightness of a pixel. The luminance of a pixel is computed as a weighted average of its red, green, and blue components, based on the relative sensitivity of the eye to each color:

Color	Weight
Red	30%
Green	59%
Blue	11%

### **Mask**

A mask is a black and white image used to isolate part of another image of the same dimensions. Masks can be used to protect part of an image from the effects of an operation.

### **Maximize**

Maximizing a window means expanding it to fill the entire screen.

### **Minimize**

Minimizing a window means reducing its to an icon that can be expanded later by double clicking on it.

### **Modem**

A modem (short for Modulator/Demodulator) is a device that permits two computers to communicate over a phone line. It does this by converting data into audible tones at one end and converting the sound back to data on the other end.

### **Moiré pattern**

An interference pattern caused by the interaction of two different patterns of dots or lines. Moiré patterns commonly occur when you attempt to scan halftoned images

using a flatbed scanner. In this case, the moiré pattern results from interference between the regularly spaced halftone dots and the scanning grid.

### **Monitor**

A monitor is another name for the display screen on your computer. The face of a color monitor is covered with clusters of tiny red, green, and blue dots. The phosphors in the dots give off light when struck by a beam of electrons which sweeps across the screen in a raster pattern, from left to right and from top to bottom.

Monitors vary in size, usually measured by their screen diagonal. Other important characteristics are maximum resolution, refresh rate, and dot size. More expensive monitors can display high resolution images (1024x768 and above) at high refresh rates. Refresh rates less than about 70Hz cause visible flicker which is not only annoying but can lead to eye strain. High resolution in itself does not necessarily mean the image is sharp. Dot size, which is mainly related to size of the holes in the shadow mask on the face of the screen, is really a better indicator of image sharpness. The smaller the dot size, the better the image quality.

Good monitors have low distortion, good color purity, and produce even illumination and sharp focus across the entire screen.

### **Monochrome**

Monochrome simply means black and white. For example a monochrome monitor is one that can only display different shades of gray. Similarly, a monochrome image is black and white only.

### **NTSC**

National Television Standard Committee. The standard for video signals in North America, Central America, and Japan.

### **OCR**

OCR stands for Optical Character Recognition. OCR is a technology used primarily to read text from scanned images. This lets you scan a document, typically on a flatbed scanner, and then convert it to a text file by recognizing each of the characters in the image.

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## **PAL**

The standard for video signals in Europe, Australia, and New Zealand.

## **Palette**

A limited set of colors used to represent a digital image.

## **PCX files**

This image file format is now mostly obsolete. It was originally created for use by a program called PC Paintbrush which is no longer available.

## **PDF files**

PDF stands for Portable Document Format. PDF files are created by a program called Adobe Acrobat. PDF files are designed for publishing electronic documents. The Acrobat PDF files can be viewed on-screen or printed using the free Acrobat Readers that are available for a number of platforms including Windows, Macintosh, and UNIX. PDF files contain their own fonts, images, and page layout information, so they are totally self-contained. In addition, the information is highly compressed.

## **Phosphor**

A phosphor is a chemical compound which emits visible light when bombarded by an electron beam. The phosphors on the inside surface of a computer screen are responsible for generating the visible image on the monitor. Color monitors use three separate phosphors for red, green, and blue.

## **Photo CD**

Photo CD is a system developed by Kodak for digitizing and storing 35mm negatives or slides on compact disks. If it is equipped with a compatible CD-ROM drive, your computer can read images from these disks.

### *Creating Photo CDs*

You can either have a Photo CD made from your film at the same time it is developed or you can have a disk made from a set of slides or cut negatives. You can also have images added to an existing Photo CD; this creates a so-called multi-session disk. Although most newer CD-ROM drives are multi session compatible, some

older drives only read single session disks. Photo CD services are available worldwide from a range of providers.

### *Image Resolution*

Each Photo CD can hold approximately 100 high quality color images, and each image is stored on the compact disk in resolutions from 128x192 pixel low resolution thumbnails all the way up to 2048x3072 high resolution images. Each increasing step in resolution has 4 times as many pixels as the one before, so the memory size of these images increases rapidly.

The most useful resolution for most amateur photographers is probably 1024x1536. Images of this resolution are around 4.5MB, but still contain enough information to make very good 8x10 prints. The next lower resolution, 512x768 can make good 4x5 prints and uses only around 1.25MB. The highest resolution images, 2048x3072, are almost 19MB each. These images are difficult to work with unless you have a very fast computer with lots of RAM, and the increased quality is barely visible in an 8x10 print.

### *Professional Photo CD*

Kodak has released a professional version of its Photo CD mastering equipment that can handle transparencies and negatives up to 4x5s. The Pro Photo CD format supports a new super-high resolution of 4096x6144 which uses 75MB per image. Pro scanning is both labor intensive and slow and consequently is much more expensive than normal scanning.

### *Photo CD Permanence*

Kodak has taken special precautions to ensure that Photo CDs will not deteriorate. They predict a useful lifetime of around 100 years.

## **Photomultiplier tube**

A specialized light-sensitive vacuum tube. Photomultiplier tubes (PMTs) are commonly used in the expensive drum scanners used by the graphic arts industry to convert film or prints into digital form. By contrast, most home and office scanners used CCDs to digitize images.

## **Pixel**

The term pixel is derived from Picture Element. A pixel is a tiny dot of solid color; photographic images are made up of thousands or even millions of these dots arranged in evenly spaced rows and columns. Whether being displayed on your

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computer screen or printed on film or paper, digital images are made up the same rows and columns of pixels. By zooming an image in to a high magnification factor, you can see its individual pixels.

#### *How digital images are displayed or printed*

To view a digital image, whether on a computer screen, as a transparency, or as a print, its digital data must be converted back to a physical color image.

In the case of a display screen this is done by illuminating tiny clusters of red, green, and blue dots on the face of the picture tube, one for each pixel, in proportion to that pixel's red, green, and blue values.

To create a transparency, a film recorder photographs an internal screen which exposes the film one raster line at a time.

Digital photographic printers use a variety of different technologies to create photographic images on paper. These include:

Dye sublimation printers which use a thermal print head to evaporate tiny dots of colored dyes from a special ribbon onto the paper.

Inkjet printers which work by spraying the paper with minute droplets of colored dyes.

Printers which expose photographic paper directly from a laser or internal screen and then process the paper by conventional means.

### **PNG Files**

The PNG (Portable Network Graphics) file format was introduced as a replacement for the GIF file format when it turned out that GIF incorporates a form of file compression patented by Sperry Univac. The PNG format is actually a considerable improvement on GIF but its popularity remains limited.

### **Portrait Orientation**

Portrait orientation or landscape mode refers to an orientation of an image where the height is greater than the width.

### **Posterization**

Posterization is the process of representing a continuous tone image using a small number of different grays or colors. For example, a very high contrast image is a 2-color posterized representation of an original. Less radical forms of posterization

use intermediate grays or colors. Posterization refers to the process of creating images for posters that are printed using a small number of different inks.



### **PostScript**

PostScript is a language developed by Adobe Systems for using in printing documents. It supports the use of mixed fonts, images, rotated text, drawings, and many other advanced features. Viewing or printing PostScript requires software called a RIP (raster image processor) that can convert the PostScript data to a raster image.

### **RAM**

RAM stands for Random Access Memory; it refers to the main memory installed in your computer. This memory is used to run the operating system, run programs, and hold the data you are currently working on. The more RAM your computer has, the more programs and information it can access quickly.

RAM is normally measured in megabytes (MB) a megabyte is roughly one million bytes.

### **Raster**

A raster line is a horizontal line of pixels in a digital image or a single horizontal line on a television screen. Raster image data means data organized into rows and columns of pixels.

### **RGB**

RGB stands for Red, Green, and Blue, the additive primary colors. Any color can be created by adding red, green, and blue light in the correct proportions. Computer monitors use this technique to display images. The red, green, and blue component values define a color in the RGB color space.



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## **Red Eye**

Red eye is a red disk that commonly appears in the center of their eyes in certain flash photographs:

This phenomenon is caused by using an on-camera flash to photograph a subject looking directly into the camera. The red disk in the pupil of the eye is actually a reflection of the flash from the back of the eye. Some cameras attempt to reduce this reflection by prefiring the flash just strongly enough to get the subject's pupils to contract before taking the photograph.

## **Resampling**

Resampling is the process of increasing or decreasing the number of pixels in an image.

## **Resolution**

The resolution of a digital image refers to the amount of detail it can hold. This in turn depends on the number of rows and columns of pixels in the image. The more pixels an image contains, the higher its resolution and the more detail it can reproduced. This concept is similar to that of film grain where finer grained films can capture more image detail.

Sometimes resolution is also used to indicate how densely pixels are packed within an image of a fixed size. In this case, resolution is normally given in dots per inch (dpi). This indicates how closely spaced the pixels are in the image. The more dots per inch, the higher the resolution of an image. Images displayed on a computer screen typically have a resolution of 60 to 100 dpi. An image printed on paper using a continuous tone printer at 200 to 300 dpi approaches photographic quality. When printing the same image using a conventional printing press, a resolution of 1200 to 2400 dpi is required to obtain roughly equivalent results.

## **Scanner**

A scanner is a device for digitizing images. It does this by measuring the color of the image at each pixel location and stores this information as three numbers representing the amounts of each of the three primary colors: red, green, and blue. Each color component is normally stored as 8 bits of data which gives a range of values from 0 to 255 for each color. A color pixel therefore consists of 24 bits of data; this means that each pixel can represent any of about 16.7 million colors. When scan-

ning a black and white image, a single gray value typically between 0 and 255 is recorded for each pixel.

Depending on how fine a grid image measurements are taken over, a scanner can capture an image in varying levels of detail. This scanning resolution is normally given in dots per inch (dpi); the higher the resolution at which an image is scanned, the more pixels it will contain and the more storage space it will require.

There are two main types of scanners -- flatbed scanners and film scanners.

Flatbed scanners are good for scanning prints, documents, or flat objects. A flatbed scanner is a little like a copier. You place your print on a glass plate, close the cover, and initiate a scan. A light source and CCD pass over the image reading off the colors at each point. Typical flatbed scanners have resolutions of 300 to 1200 dpi.

Film scanners are made for scanning slides or negatives. Once you insert the film in the scanner, a lamp shines light through the slide where it is picked up by a CCD. Normally, the film moves while the CCD remains fixed. Because of the relatively small size of a 35mm frame, transparency scanners typically scan at higher resolutions than flatbed scanners. Typical film scanners have resolutions of 1000 to 4000 dpi.

Most scanners scan at a fixed optical resolution determined by the spacing between its light sensing elements. Some manufacturers provide software with their scanners that can increase image resolution through a technique called interpolation. However, since an interpolated image does not contain any information that was not already present in the original image, this technique simply makes the image file larger and thus less convenient to work with. Thus when evaluating scanners the optical resolution is much more important than the interpolated resolution.

## **Screen Saver**

A screen saver is a program that runs automatically when your computer has been idle for some length of time. You can select and configure a screen saver from the Window control panel.

Originally screen savers were designed to avoid wearing out parts of the display screen from burning in the same information over a long period of time. Modern monitors are more robust and this is no longer a problem, but screen savers have become a way to personalize your computer.

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## **Scroll**

Scrolling is the process of moving a viewing window across a document or image that is too large to fit in the window.

## **SCSI**

SCSI stands for Small Computer Systems Interface. The SCSI interface standard permits the connection of multiple devices to a computer in a configuration called a bus. Each device must be assigned a unique SCSI ID (normally a number between 0 and 7). Each SCSI device has two connectors. The first device is cabled to the SCSI card in the computer using one of its connectors and the other connector is cabled to the next device. A terminator is placed in the empty connector of the last device on the bus.

SCSI is commonly used to attach external disk drives and scanners to personal computers since it supports high speed data transfers between the computer and the devices on the bus.

## **SECAM**

The standard for video signals in France, Iran, Poland, Russia, and Saudi Arabia.

## **Subtractive Color Mixing**

Subtractive color mixing is the process of combining inks or pigments of two different colors. For example, adding magenta and yellow makes red.

## **Subtractive Primary Colors**

Cyan (a blue-green), Magenta (a red-blue), and Yellow are the subtractive primary colors you were taught about in grade school. You can mix any other color by combining paints or inks of these colors. The subtractive primary colors are just the complements of the additive primary colors, red, green, and blue.

## **Swap File**

An area on your hard disk that is used by a virtual memory system to store data or programs that are not currently being used.

### **Targa files**

This image file format is now mostly obsolete. It was originally created for use with a family of professional frame grabber cards called Targa cards.

### **TIFF files**

TIFF stands for Tagged Image File Format -- the most widely supported image file format. If you want to create image files that can be used on Macintosh or UNIX computers as well as PCs, TIFF is usually the best choice.

TIFF files are normally not compressed, although various compression options are available.

### **True Color**

This term normally refers to a color depth of 24 bits per pixel.

### **TrueType**

TrueType is a technology developed jointly by Apple and Microsoft for defining digital fonts. TrueType fonts can be scaled to any desired point size.

### **TWAIN**

TWAIN is a standard jointly created by a consortium of companies involved in image capture, processing, and display to provide a standard interface to scanners, frame grabbers, digital cameras, and any other input devices capable of generating digital images. In TWAIN terminology, image input devices are called a sources.

When you purchase a TWAIN-compatible scanner or other device, it comes with its own TWAIN driver and instructions. Once you install the TWAIN driver, the source becomes available to any program that supports the TWAIN interface standard. Since the appearance and controls used to operate the scanner are specific to each TWAIN driver, you must refer to the instructions that accompany the driver for an explanation of its use.

### **Undo**

The Undo command in most programs is used to reverse the effect of the most recent command. Some programs permit the user to undo multiple actions.

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## **Unsharp Mask**

Unsharp masking is a versatile sharpening technique that is related to Gaussian Blur. Unsharp masking works by first blurring an image and then comparing the original version to the blurred version. Where the difference exceeds a specified threshold value, the image is sharpened by exaggerating the difference between the original and blurred versions.

## **Virtual Memory**

Virtual memory is a technique for extending the memory capacity of a computer. It involves writing unused portions of memory to a swap file on your hard disk and reading it back later when it is needed. Your computer first uses up all the normal memory (RAM) in your system; when that runs out, it starts to swap inactive data or programs to the swap file. If the data that is swapped out is needed at a later time, it is swapped back in.

The larger the swap file, the more data you can handle without getting Out of Memory errors. However, if you do not have enough normal memory to hold the active information you are working on, something called thrashing may occur which is a condition where memory is continually being swapped in and out and the computer grinds to a crawl. The more RAM you have, the larger the amount of information you can work on without thrashing.

## **White Point**

The white point of a monitor refers to the color of the brightest white it can generate. If uncorrected, most computer monitors have a white point that is somewhat blue compared to normal daylight or artificial illumination. To achieve an accurate match between images on a monitor and prints, the color temperature of the monitor must be matched to that of the illumination used to view the prints.

## **YCC**

YCC is a color space defined by Kodak for use in storing Photo CD images. It is closely related to the YIQ color space used to encode the standard television standard. The Y component represents the luminance (black and white part) of the image and the two C components represent the chrominance (color part) of the image.

## **YIQ**

The YIQ color space is the standard used to encode color video signals. The Y component represents the luminance (black and white part) of the image and the I and Q components represent the chrominance (color part) of the image.

## **Zoom**

Zooming is the process of altering the magnification factor for a viewing window for a document or image. Zooming in increases the magnification; zooming out reduces the magnification.

The degree of magnification (or reduction) is generally given as a zoom factor. When an image is displayed at a zoom factor of 1:1 each pixel in the image is displayed as a single pixel on the screen. At 2:1, each pixel in the image is enlarged to a 2x2 square of pixels, thus magnifying it by a factor of two; at 1:2, every other pixel is displayed, causing the image to shrink in size by a factor of 2.