Mustek®

Image Capture

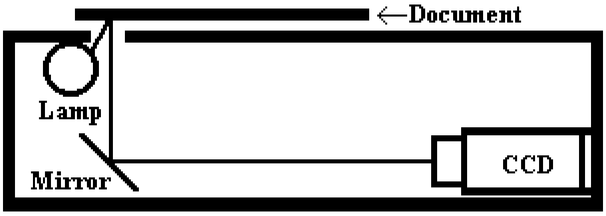
Scanner Mechanics

This section explains the basic mechanism of a flatbed scanner.

For simplicity, we will discuss flatbed scanners in this document. The same basic principle can be applied to both hand-held and sheetfed scanners as well.

As you begin the scanning process, the scanhead will begin reading the first line of data from your document. After the first line of data is collected, the motor inside your scanner will then move the scanhead to the next line. You will notice a fluorescent light moving inside your scanner's chassis.

This light is projected from the lamp, located at the top of the scanhead. Though the clear glass, the light reaches your document and is reflected back to the bottom of the scanhead. This light is then collected by a CCD (Charged Coupled Device), located at the bottom of the scanhead.



Scan Mode

The CCD will then analyze this incoming light. All the information contained in this light will then be transferred, from the scanner to the computer, as an array of numbers ranging from 0 to 255. Your computer will then take this information and display the image on the screen.

There are four different modes under which images can be scanned. Images can be scanned into computers under four different modes, Line Art, Halftone, Grayscale, and Color. All images scanned under these four modes are saved as bitmap-based image files.

Below are four versions of the same picture scanned under four different modes.

			
Line Art (1-bit)	Halftone (1-bit)	Grayscale (8-bit)	Color (24-bit)

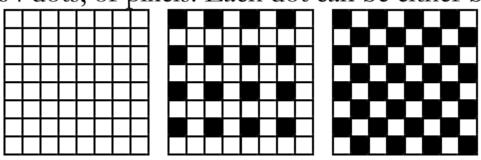
Line Art

The Line Art format requires the least amount of memory for storing the image. Since only black and white information is stored (without any shade of gray), the computer display the color black using 1 bit of memory while leaving the color white as "blank". In other words, an image under the Line Art format consists of only 1-bit of data. This format is most useful when scanning text or line drawings.

Photographs and images containing continuous shades of gray do not scan well under the Line Art mode.

Halftone

While computers can manipulate and display images with continuous shades of gray, many printers are still unable to print them. A technique called, halftoning, solves this problem. Halftone images are displayed as patterns of solid dots, fooling the eyes into seeing continuous shades of gray. This type of image is most commonly found in newspapers. Each of the three squares below are made of 64 dots, or pixels. Each dot can be either black or white.



By manipulating the arrangement of these dots, various shades of gray can be achieved. In the examples below from left to right, the three squares represent 100% white, 25% gray, and 50% gray respectively.

Grayscale

A grayscale image is equivalent to a black and white photograph. Computers display a grayscale image by assigning a number value, ranging from 0 to 255, to every pixel of that image. The number value, 0, represents the color, black. The number value, 255, represents the color, white. All numbers from 1 to 254 represent various shades of gray.

Since there is the possibility for each pixel to be assigned to any of the 256 (0 ~ 255) color values, each pixel in a grayscale image takes up 8 bits of memory. The bit size is calculated by the equation: 256 = (2)8 where the number "8" determines the number of bits.

Color

Color images are the largest and most complex images to store. TV's and computer monitors mix the colors red, green, and blue to display all the colors visible to the human eye. If you were to look at your computer screen right now through a high powered magnifying glass, you would see that the white background of this page is actually made up of high intensity red, green and blue pixels arranged like the diagram below. Each pixel is made of a group of three dots, one of each color.

Because the dots are very small, your eyes blend them together and see the color, white.

The monitor's internal electronics can vary the intensity of each color dot to 256 different levels of intensity. At the 0 intensity level, the dots are completely off and the screen appears black. If the red and green intensity is 0 and the blue intensity is 255, you see a rich blue color. By varying the intensity of each color dot between 0 and 255, there are 16.77 million different combinations.

Each combination appears as a different color. If the intensity of each dot is set to an equal value, say 128, the color shown on the monitor would appear to be 50% gray. Similar to the idea behind grayscale images, each of the three colors (red, green, and blue) requires 8 bits of memory to store its color information within one single pixel. Thus, for images under color mode, each pixel requires 24 bits of memory (8 bits x 3) to fully represent the entire color spectrum.

How to determine file size

This section explains how one determines the file size of a scanned image. If you're curious about how to determine the size of a scanned image, here is the formula that you may use for an approximation.

File Size = (Resolution x Horizontal Size) x (Resolution x Vertical Size) x Scan Mode

Where Scan Mode = 1/8 for both Line Art and Halftone, 1 for Grayscale and 3 for Color.

Here are the file sizes for a 4" x 4" photo scanned under four different scan modes and resolutions. Notice the grayscale files are about 8 times as large as the line art files. The color files are about 24 times as large as the line art files and about 3 times as large as the grayscale files.

4" x 4" image:

	100 dpi	150 dpi	300 dpi	600 dpi
Line Art	19.5 Kb	44Kb	156 Kb	469 Kb
Halftone	44 Kb	44Kb	352 Kb	1 Mb
Grayscale	175 Kb	352Kb	1.37 Mb	4.12 Mb
Color	703 Kb	1Mb	5.5 Mb	16.5 Mb

Interpolation

This section explains the difference between Hardware Interpolation and Software Interpolation.

The resolution of a scanner is determined by the Optical Resolution of the CCD and the Stepping Speed of the scanner's motor. A 300 x 600 dpi scanner has a 300 dot per inch CCD and a motor that goes slow enough to scan 600 lines per inch as it travels the length of the bed. If you scan at 300 dpi on such a scanner, the motor runs twice as fast as a scan at 600 dpi. If you scan at 600 dpi on such a model, the motor runs slower and the scanner's hardware interpolates the horizontal data from 300 dpi up to 600 dpi. In this case, an integrated circuit chip inside the scanner would generate new data through an algorithm by averaging the color of adjacent dots. These newly created dots would fill in the gap and make up for the inability of a 300 dpi CCD to scan at 600 dpi. This type of interpolation, utilizing an IC chip to generate supposedly missing data, is called, Hardware Interpolation. It allows a low-resolution scanner to scan at higher resolution.

Besides utilizing an IC chip, computer software can also be used to achieve roughly the same, or sometimes even better, result. Software Interpolation is performed by the Twain driver and calculated by the computer's CPU. This type of interpolation increases the amount of data in a scanned image. It is roughly equivalent to scaling an image to make it larger.