Multimedia System

Lecture 4: Media Representation and Media Formats (Part 1)

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Overview

- Media is represented in various forms—text, images, audio, video, and graphics.
  - Images are commonly used to capture and represent a static visual snapshot of the world around us.
  - The world, however, is not static, but continuously changes in time.
    - To record this change, we need to capture the time evolution of changing images (video) and sound (audio).
  - Graphical illustrations and animation help to visually convey the changing information
- The digital media forms need to be represented and stored so that they can be viewed, exchanged, edited, and transmitted in a standard manner.
- This chapter deals with the representation of digital media and commonly used media formats.

Outlines

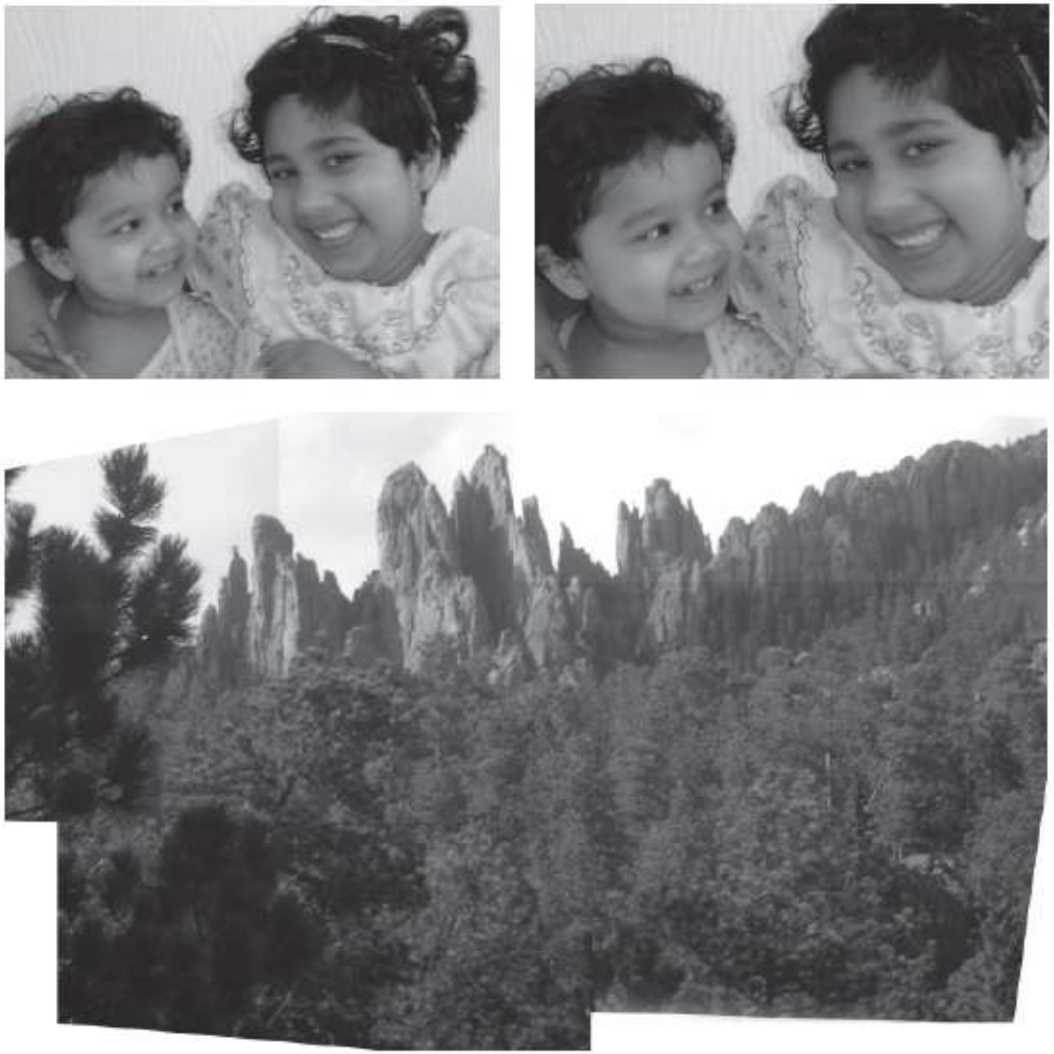
- Digital Images
  - Digital representation of Images
  - Color models
  - Aspect Ratios
  - Digital Image Formats
- Digital Videos
- Digital Audio
- Graphics

Digital Images

- "still" images
- Images are used in various forms for a variety of applications. These might be
  - photographs,
  - gray or color
  - used with text in documents
  - fax is another image representation used in communication.
  - Images can be combined to create interesting applications involving mosaics, panoramas, and stereo imagery.
  - Furthermore, images form the basic elements of video.

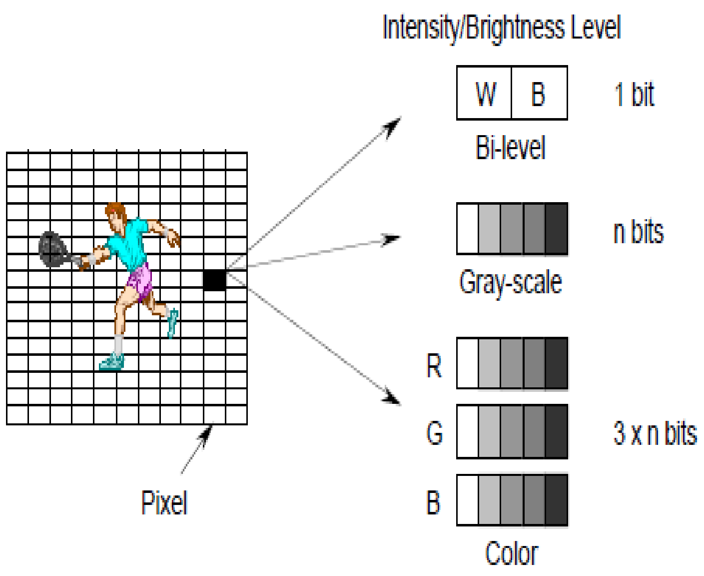
Digital Images (cont'd)

Figure 3-1 Example showing different types of images. The upper-left image shows a gray level image with each pixel represented by a single channel, whereas the upper-right image shows the same image in a color representation where each pixel is represented by three color channels. The bottom image shows a large mosaic created by combining different images.



Digital Representation of Images

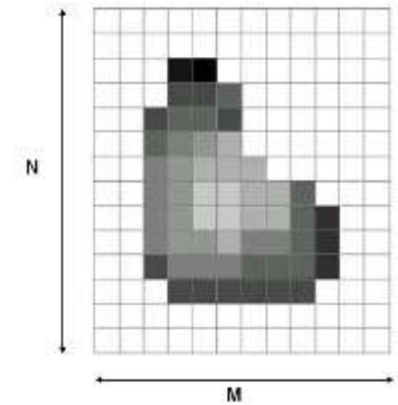
- Digital Image Definition:
  - An image may be defined as a two-dimensional function $f(x, y)$, where x, y: the spatial coordinate, f the amplitude of any pair of coordinate x, y is called the intensity or gray level of the image at that point.
  - Digital Image: x, y and f are all finite (discrete quantities).
  - Digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are called picture elements, image elements and pixels.



Digital Representation of Images (cont'd)

- An image is defined by image width, height, and pixel depth. The image
  - **width** gives the number of pixels that span the image horizontally (M)
  - **height** gives the number of pixels that span the image vertically(N)
  - **pixel depth** is the number of bits per pixel (k)
    - pixel depth is the same for all pixels of a given image.
  - Number of bits required to store a digitized image

$$b = M \times N \times k$$

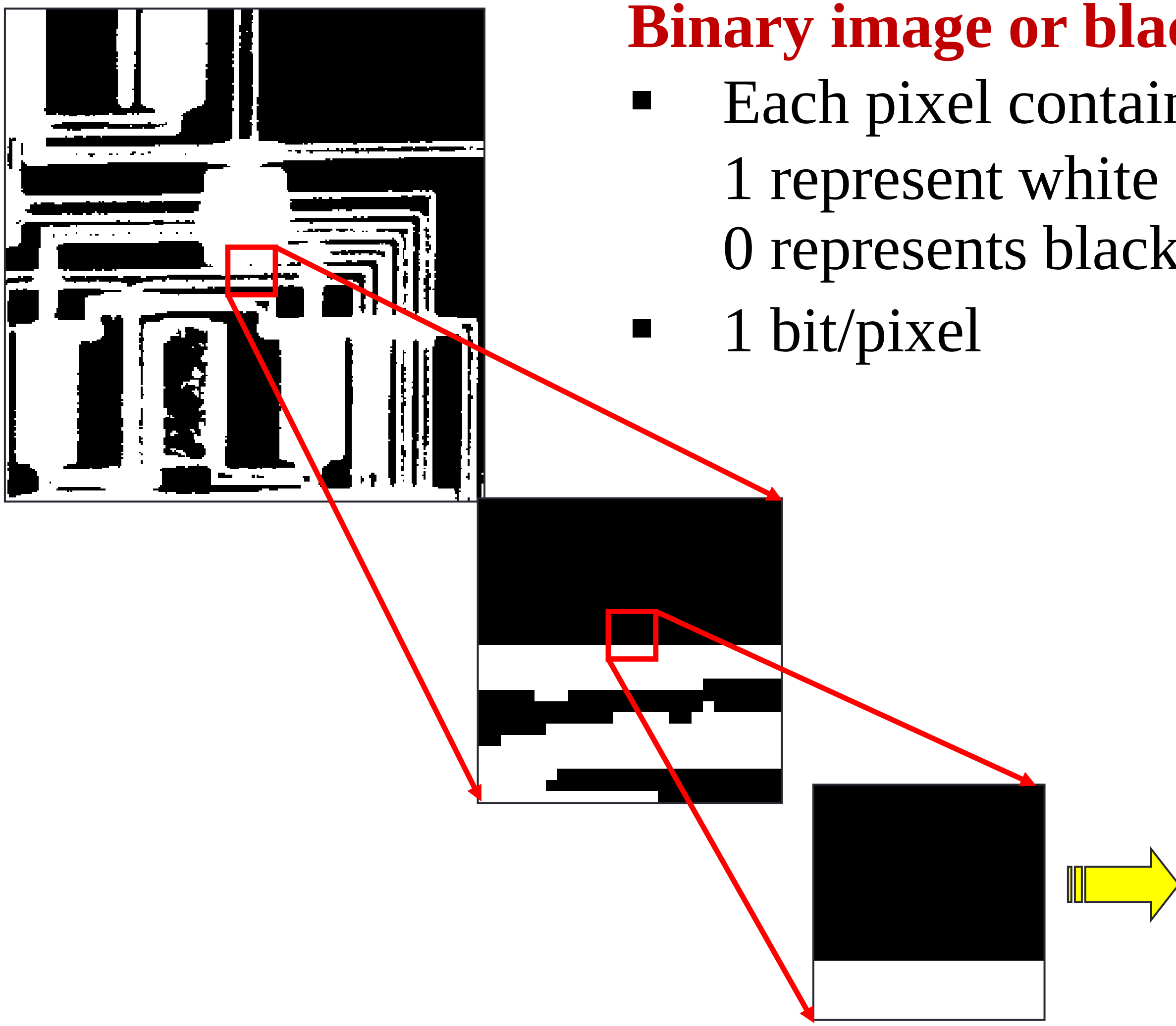


- The number of bits used per pixel in an image depends on the color space representation (gray or color) and is typically segregated into channels.
  - In grayscale images, the gray-level value is encoded on 8 bits for each pixel.
  - In color images, each R, G, B channel may be represented by 8 bits each, or 24 bits for a pixel.

Binary Images

Binary image or black and white image

- Each pixel contains one bit :
  1 represent white
  0 represents black
- 1 bit/pixel



Binary data

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

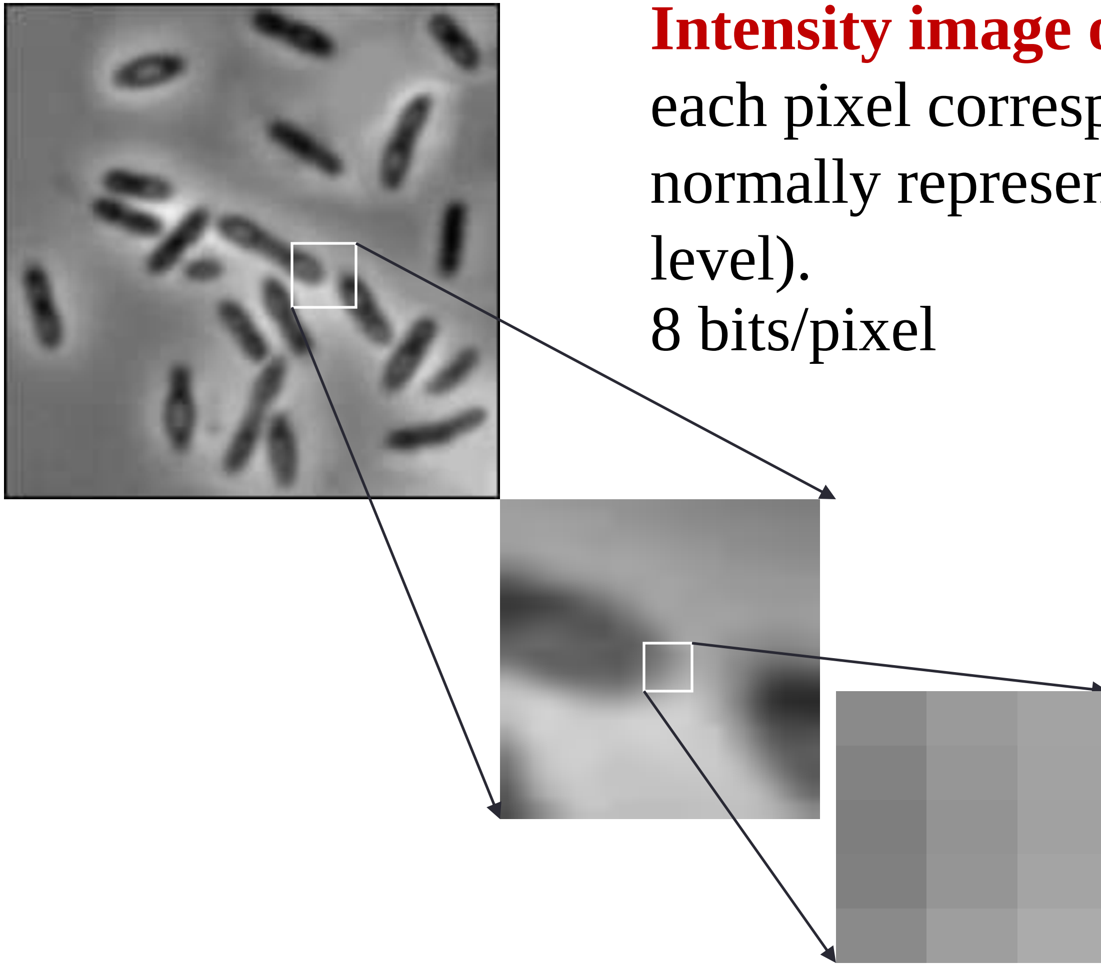
Binary Images (cont'd)

- 640×480 monochrome image requires 38.4 kilobytes (kB) of storage (= 640×480/8).

$$640 \times 480 \times 1\ (bit) = 307{,}200\ bits$$
$$307{,}200/8 = 38{,}400\ bytes$$
$$38400/1000 = 38.4\ kB$$

- Called 1-bit monochrome image since it contains **no color**.
- Monochrome 1-bit images can be satisfactory for pictures containing only simple graphics and text.
- Efficient in terms of storage Document processing, handwriting, fingerprint

8-bit gray level image



Intensity image or monochrome image

each pixel corresponds to light intensity normally represented in gray scale (gray level).

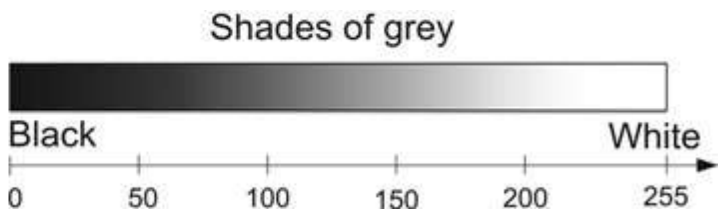
8 bits/pixel

Gray scale values

$$\begin{bmatrix} 10 & 10 & 16 & 28 \\ 9 & 6 & 26 & 37 \\ 15 & 25 & 13 & 22 \\ 32 & 15 & 87 & 39 \end{bmatrix}$$

8-bit gray level image (cont'd)

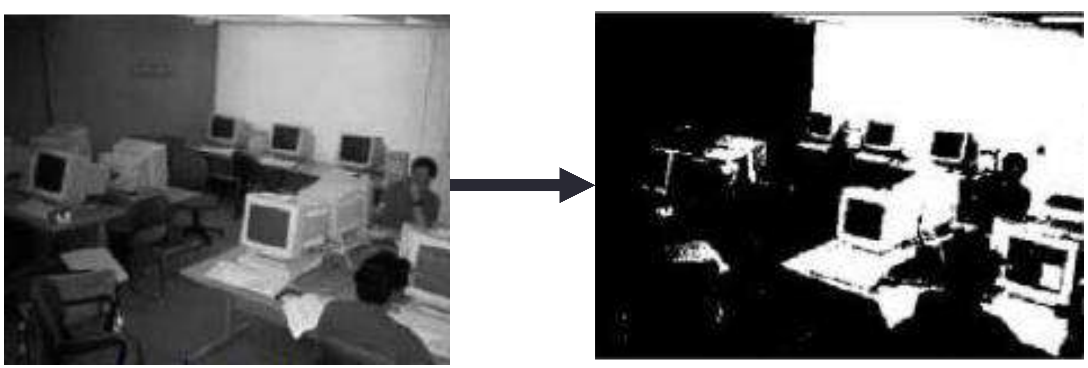
- Each pixel has a gray-value between 0 and 255.
- Each pixel is represented by a single byte; it is visualized as a shade of gray denoted a *gray-scale value* or *gray-level value* ranging from black (0) to white (255).



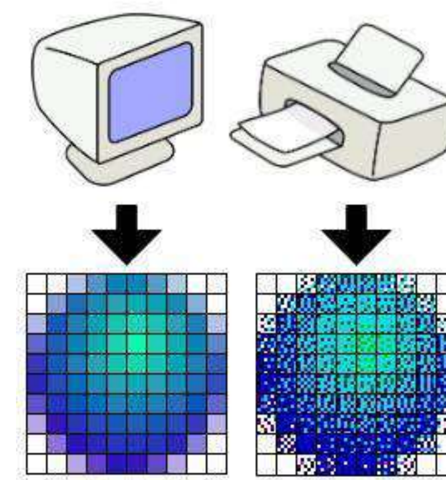
- Each pixel is usually stored as a byte (a value between 0 to 255), so a 640 × 480 grayscale image requires 300 Byte of storage (640 ×480×(1) byte = 307,200 byte).

How to print multi-level images (8-bit) on 2-level (1-bit) printers

- Images that are captured using digital devices, such as cameras and scanners, are normally colored.
- However, when these color or continuous tone images are printed, printing technologies often prefer to print halftone images where the number of colors used is minimized to lower printing costs.
- The halftone printing process creates ranges of grays or colors by using variable-sized dots.



256 - level   2 - level



How to print multi-level images (8-bit) on 2-level (1-bit) printers

Dithering

- For printing on a 1-bit printer, dithering is used to calculate larger patterns of dots, such that values from 0 to 255 correspond to pleasing patterns that correctly represent darker and brighter pixel values
- The main strategy is to replace a pixel value by a larger pattern, say 2 × 2 or 4 × 4, such that the number of printed dots approximates the varying-sized disks of ink used in analog, in **halftone printing** (e.g., for newspaper photos).
  - Half-tone printing is an analog process that uses smaller or larger filled circles of black ink to represent shading, for newspaper printing.
  - If we use a 2 × 2 dither matrix, we can represent $n^2 + 1$ or $2^n + 1$ levels of intensity resolution. For example, if we use a 2 × 2 **dither matrix**

$$\begin{pmatrix} 0 & 2 \\ 3 & 1 \end{pmatrix}$$

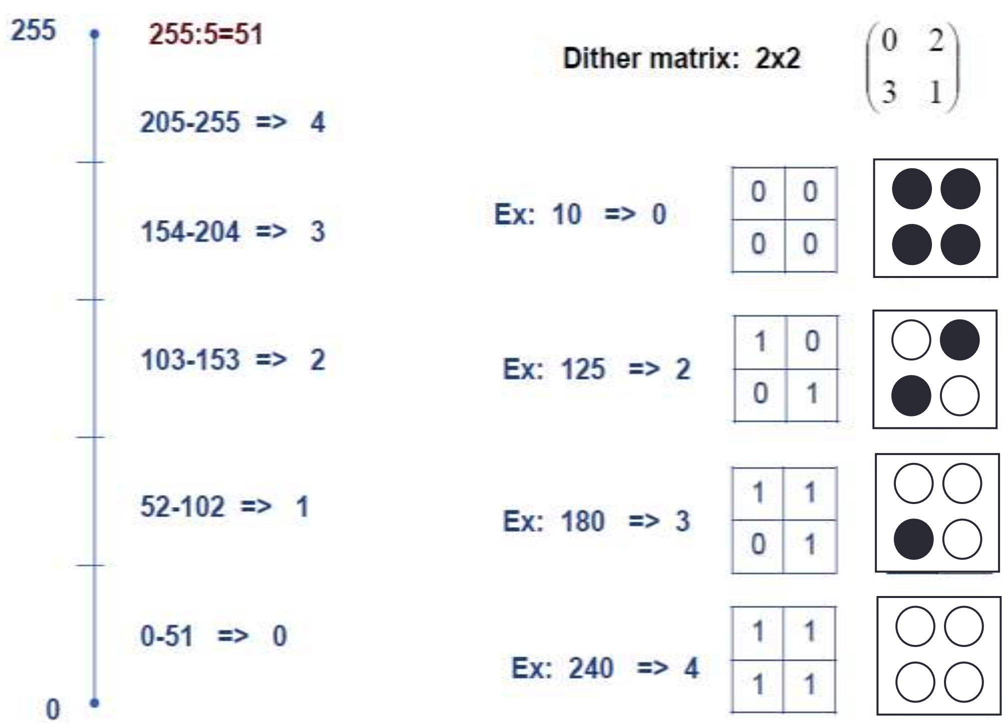
    - We can first re-map image values in 0..255 into the new range 0..4 by (integer) dividing by 256/5.
    - Then, e.g., if the pixel value is 0 we print nothing, in a 2 × 2 area of printer output. But if the pixel value is 4 we print all four dots. As shown in following figure.

How to print multi-level images (8-bit) on 2-level (1-bit) printers

Dithering (cont'd)

- The rule is:

  If the intensity is > the dither matrix entry then print an ***on*** dot at that entry location: replace each pixel by an $n \times n$ matrix of dots.



How to print multi-level images (8-bit) on 2-level (1-bit) printers

Dithering (cont'd)

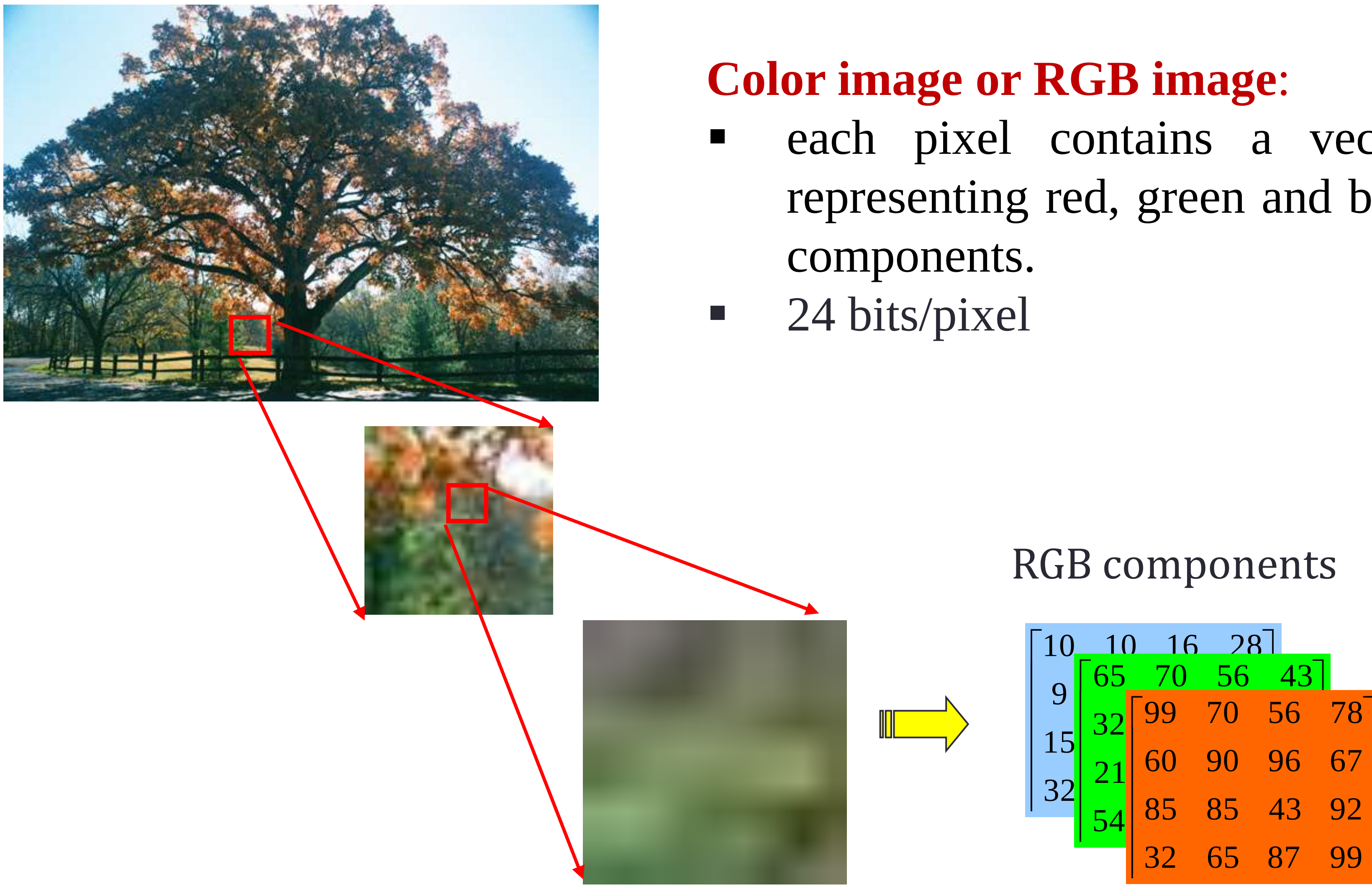
- The following figure show the result of dithering process.

- Note that the image size may be much larger, for a dithered image, since replacing each pixel by a 4 × 4 array of dots, makes an image $4^2 = 16$ times as large.
- In contrast, if we **increase the number** of effective intensity levels by increasing the **dither matrix** size, we also increase the size of output image.

24-bit color image

Color image or RGB image:

- each pixel contains a vector representing red, green and blue components.
- 24 bits/pixel



24-bit color image (cont'd)

- This format provide a method of **representing and storing** graphical image information in RGB color space where very large number of colors can be displayed.
  - Supports 256 × 256 × 256 possible combined colors, or a total of 16,777,216 possible colors.
  - However such flexibility does result in a storage penalty: A 640 × 480 24-bit color image would require 921.6 kB of storage without any compression.

- **An important point**: many 24-bit color images are actually stored as 32-bit images, with the extra byte of data for each pixel used to store an *alpha* value representing special effect information (e.g., transparency).

24-bit color image (cont'd)

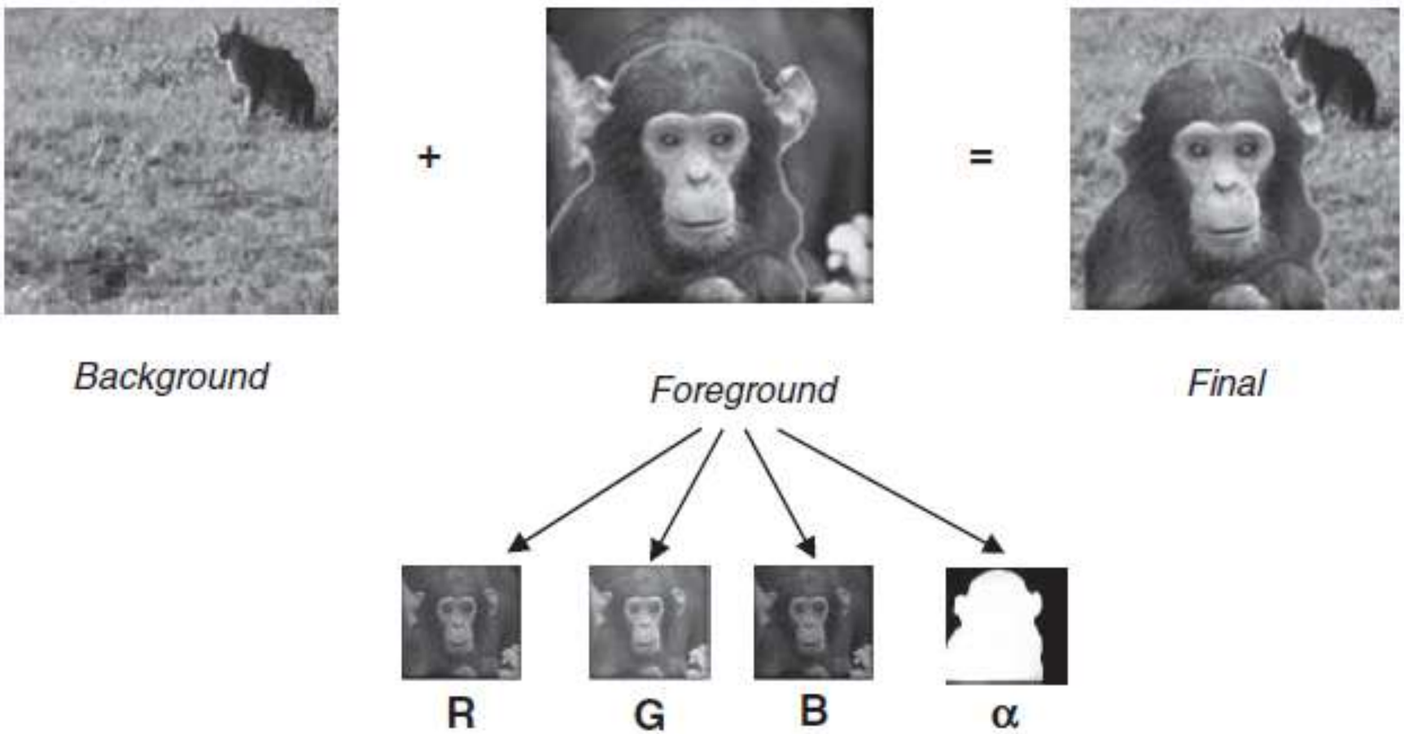
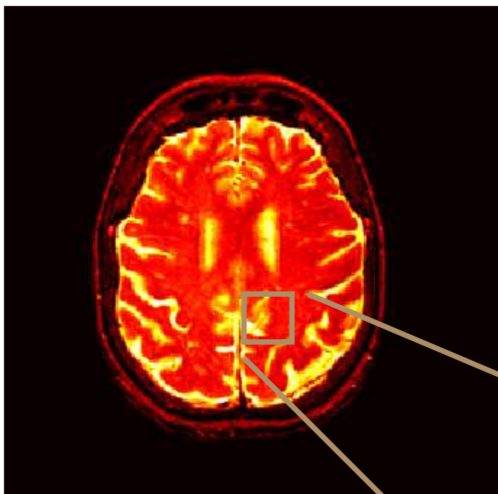


Figure 3-3 Usage of alpha channels for compositing. The foreground color image is represented by three color channels and one alpha channel. The alpha channel is used to composite the pixels of the foreground with the background image, producing the final image on the far right. See the color insert in this textbook for a full-color version of this image.

8-bit color image

Index image

- Each pixel contains index number pointing to a color in a color table.
- 8 bits/pixel



$$\begin{bmatrix} 1 & 4 & 9 \\ 6 & 4 & 7 \\ 6 & 5 & 2 \end{bmatrix}$$

Index value

Color Table

Index No.	Red component	Green component	Blue component
1	0.1	0.5	0.3
2	1.0	0.0	0.0
3	0.0	1.0	0.0
4	0.5	0.5	0.5
5	0.2	0.8	0.9
…	…	…	…

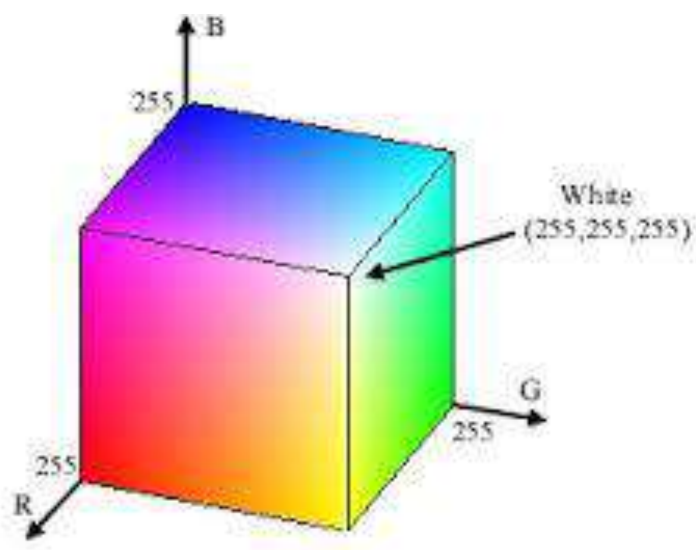
8-bit color image (cont'd)

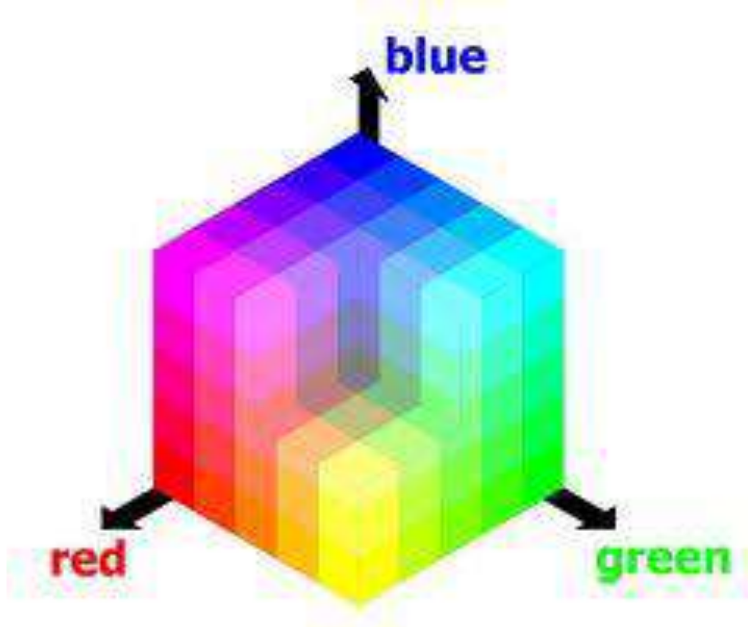
- Many systems can make use of 8 bits of color information (the so-called "256 colors") in producing a screen image.
- Such image files use the concept of a **lookup table** to store color information.
  - Basically, the image stores not color, but instead just a set of bytes, each of which is actually an index into a table with 3-byte values that specify the color for a pixel with that lookup table index.
- Note the great savings in space for 8-bit images, over 24-bit ones: a 640 × 480 8-bit color image only requires 300 kB of storage, compared to 921.6 kB for a color image (again, without any compression applied).
- Image file needs to **store the color table** along with the **actual image data** but the image data itself can be smaller by a **factor of three**.

8-bit color image (cont'd)

Covert Color 24 bit image to 8-bit color image

- The Basic strategy for LUT generation
  - The most straightforward way to make 8-bit look-up color out of 24-bit color would be to divide the RGB cube into equal slices in each dimension.





8-bit color image (cont'd)

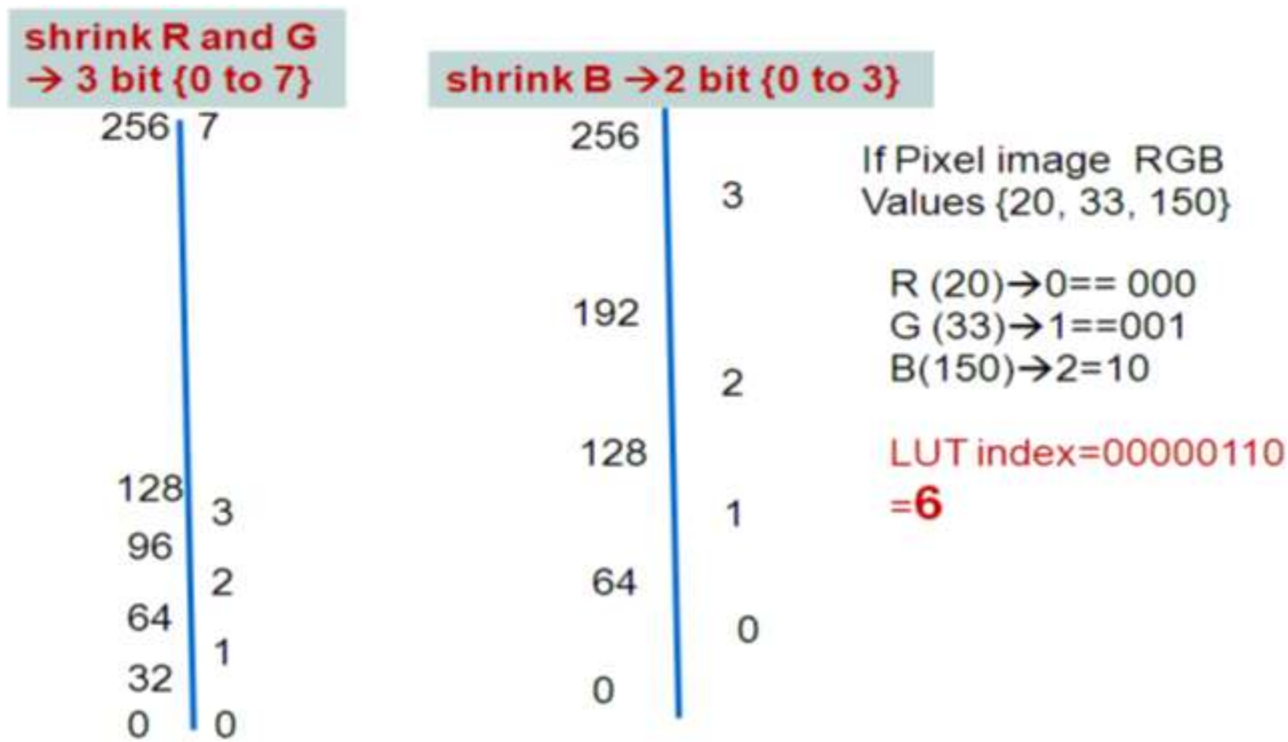
Covert Color 24 bit image to 8-bit color image

- The Basic strategy for LUT generation
  - The most straightforward way to make 8-bit look-up color out of 24-bit color would be to divide the RGB cube into equal slices in each dimension.
    1. The centers of each of the resulting cubes would serve as the entries in the color LUT, while simply scaling the RGB ranges 0..255 into the appropriate ranges would generate the 8-bit codes.
    2. Since humans are more sensitive to R and G than to B, we could shrink the R range and G range 0..255 into the 3-bit range 0..7 and shrink the B range down to the 2-bit range 0..3, thus making up a total of 8 bits.
    3. To shrink R and G, we could simply divide the R or G byte value by (256/8)=32 and then truncate. Then each pixel in the image gets replaced by its 8-bit index and the color LUT serves to generate 24-bit color.

8-bit color image (cont'd)

Covert Color 24 bit image to 8-bit color image

- The Basic strategy for LUT generation
  - Example



Outlines

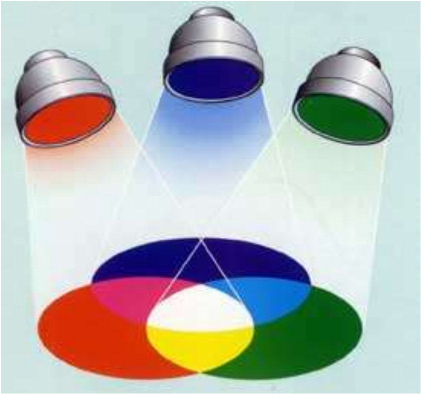
- Digital Images
  - Digital representation of Images
  - Color models
  - Aspect Ratios
  - Digital Image Formats
- Digital Videos
- Digital Audio
- Graphics

Color Models

- Color is one of the most important image characteristics, used for stored, displayed, and printed images.
- It is generally invariant to translation, rotation, and scaling.
- "Color model is an orderly system for creating a whole ranges of color from a small set of primary color".
- A **color model** is an abstract mathematical model describing the way **colors** can be represented as **tuples** of numbers, typically as three or four values or color components.
- The color image can be modeled using various color systems.
- The next few sections explain where color comes from and how colors are displayed on a computer monitor.
  - RGB
  - CMYK
  - HSV

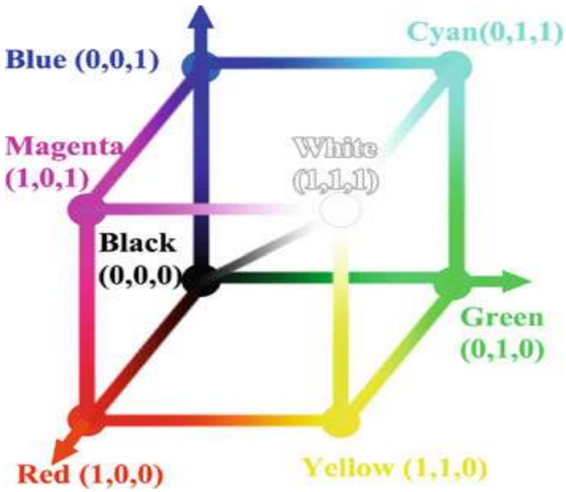
RGB color model

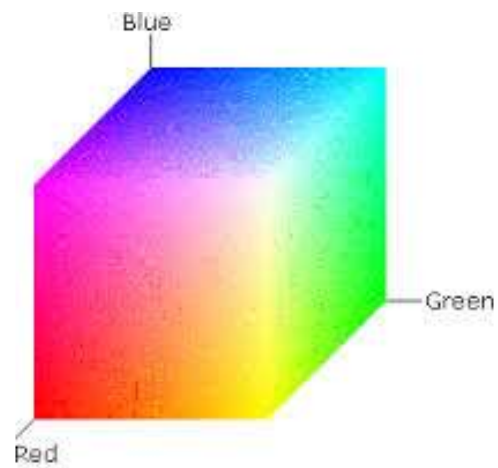
- The RGB color model is one of the commonly used color systems.
- The **RGB color model** is an **additive color model** in which **red**, **green** and **blue** light are added together in various ways to reproduce a broad array of **colors**.
- The name of the model comes from the initials of the three **additive primary colors**, red, green and blue.
- The main purpose of the RGB color model is for the sensing, representation and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography.
- The color model RGB is used in hardware applications like PC monitors, cameras and scanners,
- It is used for Web graphics, but it cannot be used for print production.



RGB color model (cont'd)

- It can be represented by the color cube as shown in following Figure. The gray level is defined by the line $R = G = B$.

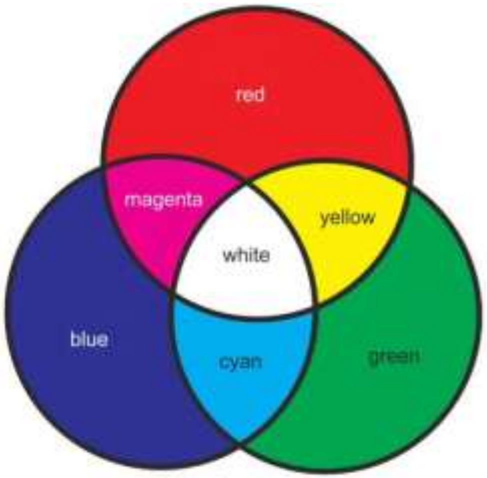




- This model is called additive, and the colors are called primary colors.
- The primary colors can be added to produce the secondary colors of light - magenta (Red + Blue), cyan (Green + Blue), and yellow (Red + Green).
- The combination of red, green, and blue at full intensities makes white.

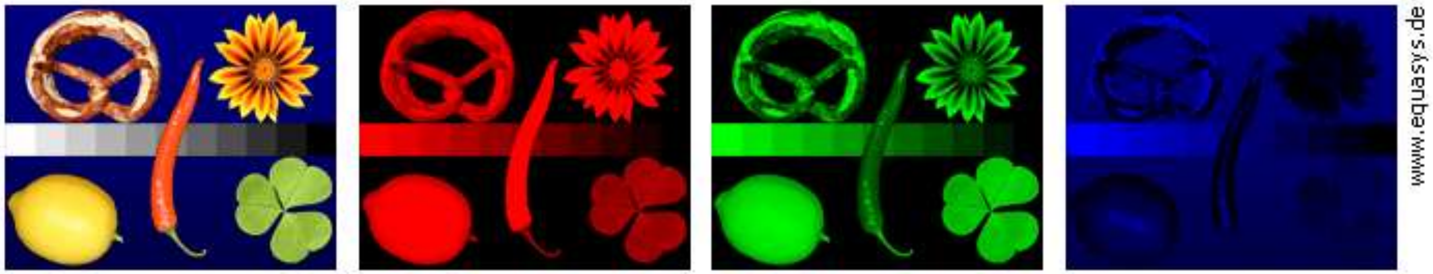
RGB color model (cont'd)

- A size of an RGB digital image depends on how many bits we use for quantization. For example, for $n = 8$ bits, the values range from 0 to 255.
- In the RGB model, the value 0 (coordinate = 0) means the absence of color, while the value 255 (coordinate = 1) denotes the color with maximum intensity. Thus, we conclude that (0,0,0) represents black and (1,1,1) represents white.
- When converting a color image to a grayscale one, the luminescence is calculated as the mean value of the RGB components.



RGB color model

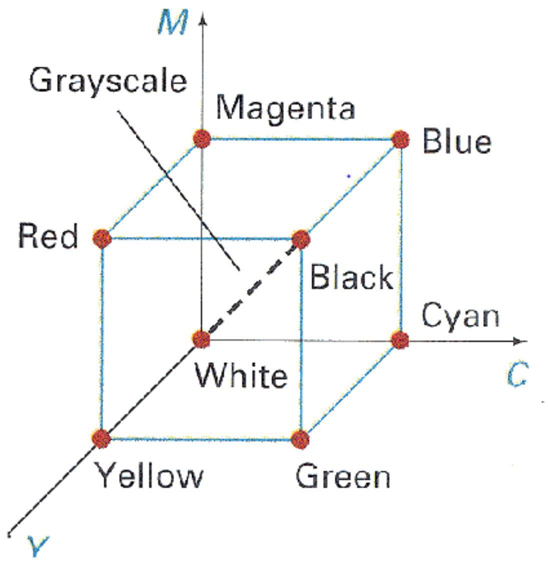
RGB color model (cont'd)

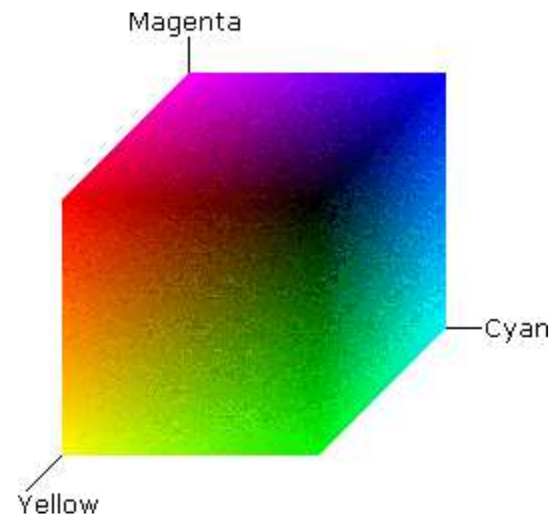


Original Image | Red Color Component | Green Color Component | Blue Color Component

CMY color model

- The **CMY color model** is a **subtractive color model**, used in **color printing**, and is also used to describe the printing process itself.
- **CMY** refers to the three inks used in some color printing: **cyan**, **magenta**, and **yellow**.
- Thus, if we choose the basis vectors as follows: C – Cyan, M – Magenta and Y – Yellow, the CMY color model is obtained.





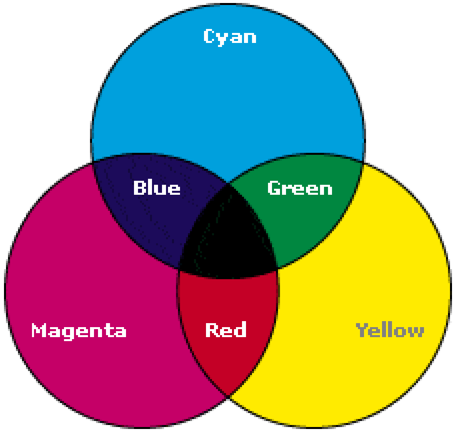
CMY color model (cont’d)

- This model is basically the most commonly used in printers, because the white is obtained by the absence of colors.
- Even though, black is obtained by combining all three colors, the printers usually have a separate cartridge for the black color.
- The CMY model including the black color is called the CMYK color model. K is used to refer to the black color. The connection between the CMY and RGB models is evident from the color cube:

$$C = 1 - R, \qquad M = 1 - G, \qquad Y = 1 - B$$

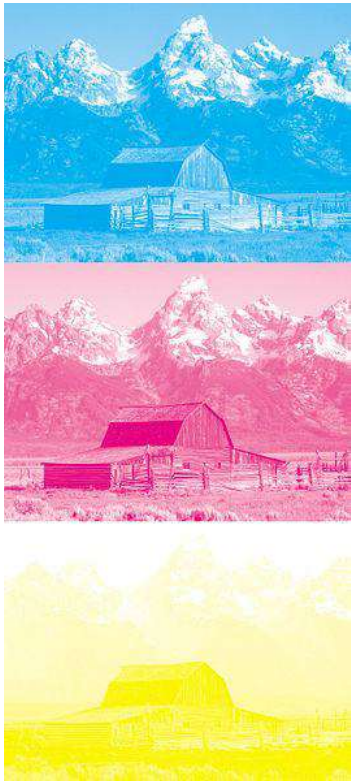
- while the CMYK model can be obtained as:

$$K = \min(C, M, Y), \qquad C = C - K, \qquad M = M - K, \qquad Y = Y - K$$



CMY color model (cont’d)

A color photograph of the Teton Range.



Separated for printing with process cyan, magenta, and yellow inks.

Separated with maximum black, to minimize ink use.

Transformation from RGB to CMY

- Given our identification of the role of inks in subtractive systems, the simplest model we can invent to specify what ink density to lay down on paper, to make a certain desired RGB color, is as follows:

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

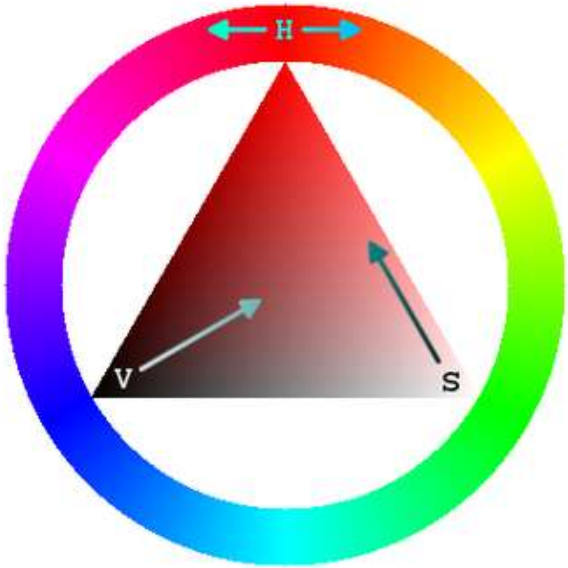
- Then the inverse transform is

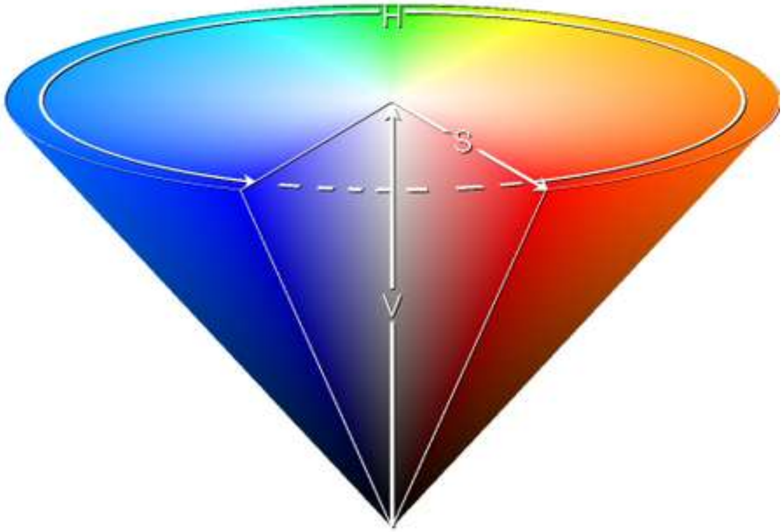
$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$

- **Q: How to obtain CMYK model from RGB model?**

HSV Color Model

- HSV color system that is more oriented towards the perceptual model.
- HSV is represented by a cylindrical coordinate system as shown in following Figure .



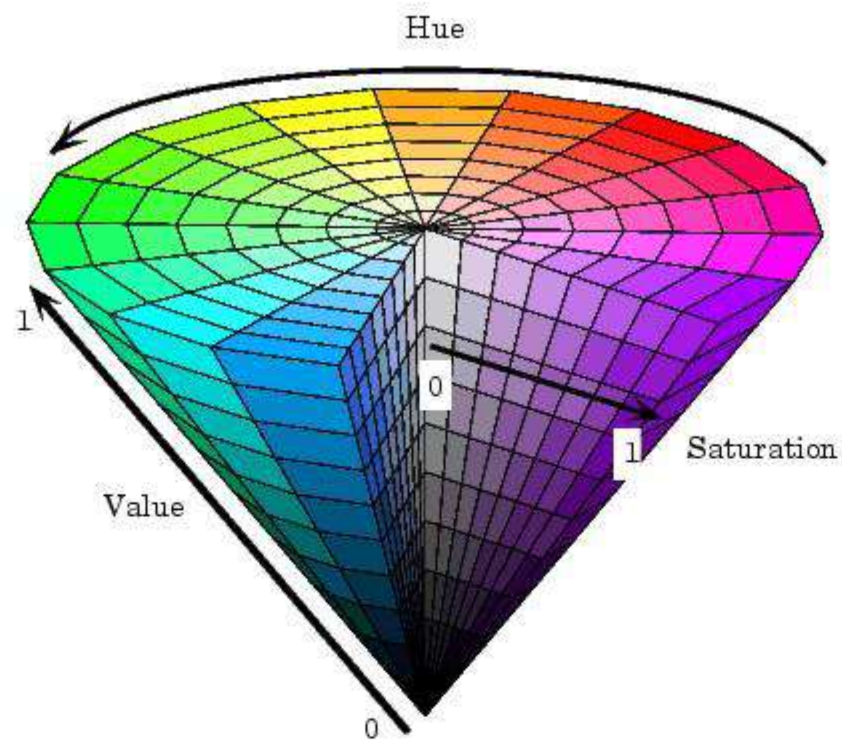


HSV Color Model (cont'd)

- Each color is specified in terms of Hue (H), Saturation(S) and Value (V).
  - H is a measure of the spectral composition of color
  - S provides information about the purity of color, or more accurately, it indicates how far is the color from the gray level, under the same amount of luminescence.
  - V is a measure of the relative luminescence.
- **As hue (H) varies**, the corresponding colors vary from red, through yellow, green, cyan, blue, and magenta, back to red.
- Saturation(S) is **the intensity of a hue from gray tone** (no saturation) to **pure** (high saturation).
- Value(V) is the **maximum brightness** value of its three color values, Brightness is the relative **lightness** or **darkness** of a particular color, from black (no brightness) to white (full brightness).
- The HSV color model is commonly used in image processing and editing software.

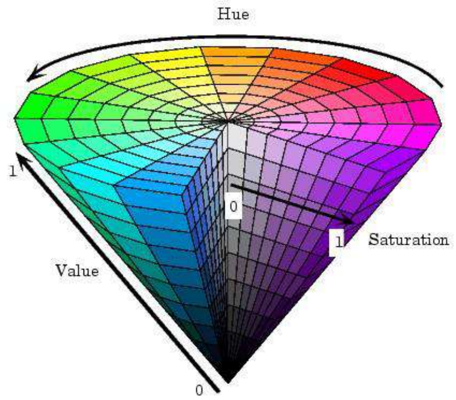
HSV Color Model (cont'd)

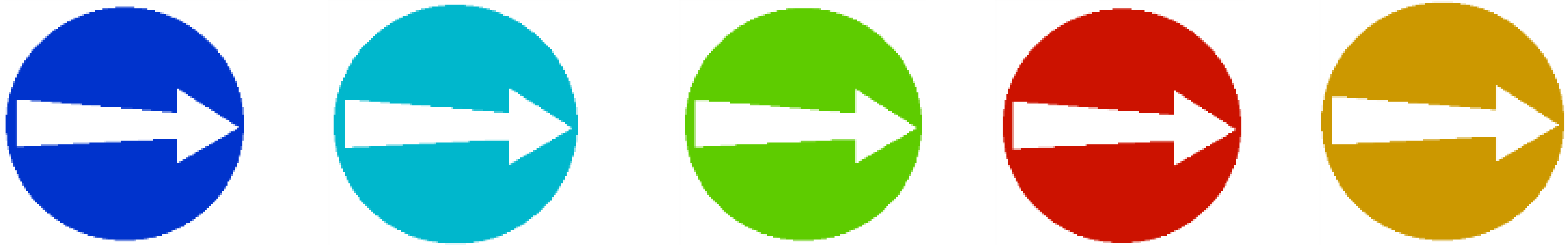
- Generating tones with hue, value and saturation
  - Start with a hue
    - This is the base color
  - The value of S is the purity of the color
    - A value of 1 is pure
    - A value of 0 is grayscale
  - The value of V is the amount of black added to the color
    - A value of 1 means no black added
    - A value of 0 means the color will be black



HSV Color Model (cont'd)

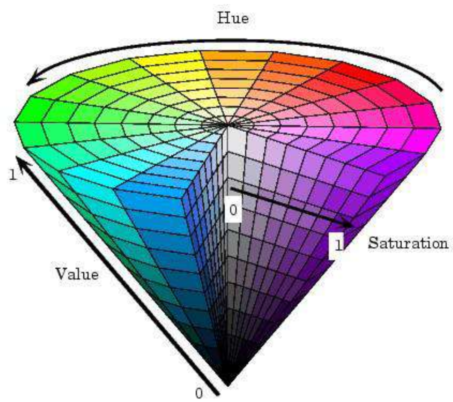
- As **hue** varies, the corresponding colors vary from red, through yellow, green, cyan, blue, and magenta, back to red.

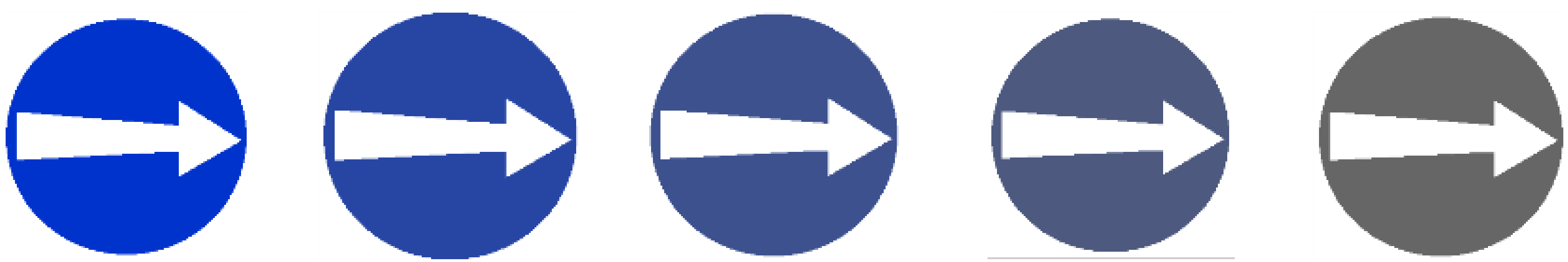




HSV Color Model (cont'd)

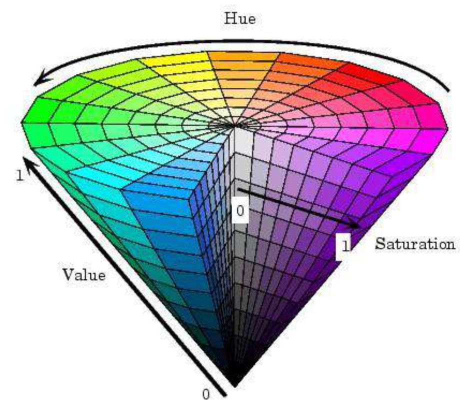
- **Saturation** is the intensity of a hue from gray tone (no saturation) to pure, (high saturation).





HSV Color Model (cont'd)

- **Value(V)**: maximum brightness value of its three color values
- **Brightness** is the relative lightness or darkness of a particular color, from black (no brightness) to white (full brightness).
- Brightness is also called **Lightness** in some contexts **Understanding**



HSV Color Model (cont'd)

- RGB data is converted into the HSV color space as follows: assuming R,G,B are in 0..255

$$M = \max\{R, G, B\}$$
$$m = \min\{R, G, B\}$$
$$V = M$$
$$S = \begin{cases} 0 & \text{if } V = 0 \\ \left(V - m\right)/V & \text{if } V > 0 \end{cases}$$
$$H = \begin{cases} 0 & \text{if } S = 0 \\ 60(G - B)/(M - m) & \text{if } (M = R \text{ and } G \geq B) \\ 60(G - B)/(M - m) + 360 & \text{if } (M = R \text{ and } G < B) \\ 60(B - R)/(M - m) + 120 & \text{if } M = G \\ 60(R - G)/(M - m) + 240 & \text{if } M = B \end{cases}$$

where M and m denote the maximum and minimum of the (R, G, B) triplet.

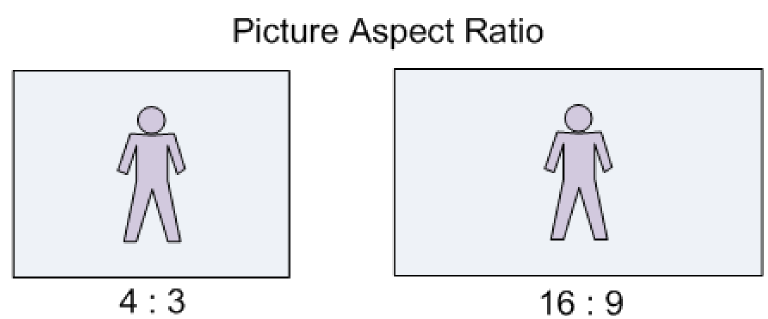
→ Question: Find the equivalent HSV color for the following RGB one (100, 32, 66)

Outlines

- Digital Images
  - Digital representation of Images
  - Color models
  - Aspect Ratios
  - Digital Image Formats
- Digital Videos
- Digital Audio
- Graphics

Aspect ratio

- Image aspect ratio refers to the width/height ratio of the images
- Different applications require different aspect ratios. Some of the commonly used aspect ratios for images are
  - 3:2 (when developing and printing photographs),
  - 4:3 (television images),
  - 16:9 (high-definition images)
  - 47:20 (anamorphic formats used in cinemas)



Aspect ratio (cont’d)

***Top**: An image that uses a 4:3 aspect ratio. **Middle**: The same image captured in a 16:9 image format. **Bottom**: The same image cropped to an anamorphic format.*

Aspect ratio (cont'd)

- The ability to change image aspect ratios can change the perceived appearance of the pixel sizes, also known as the *pixel aspect ratio* (PAR) or *sample aspect ratio* (SAR).
- Most image capture instruments have the same sampling density in the horizontal and vertical directions.
  - The resulting image has square pixels even though the number of samples in the horizontal direction (width) and vertical direction (height) might vary.
  - A square pixel has a PAR of 1:1.
- If the image aspect ratio is changed, the pixel aspect ratio will need to change accordingly to accommodate the change in area, thus making the image appear stretched in one direction.
- This problem is common with image and video applications, where images using one aspect ratio standard are viewed on television screens supporting a different format.
- In such cases, the image appearance changes and pixels appear to stretch.

Aspect ratio (cont'd)

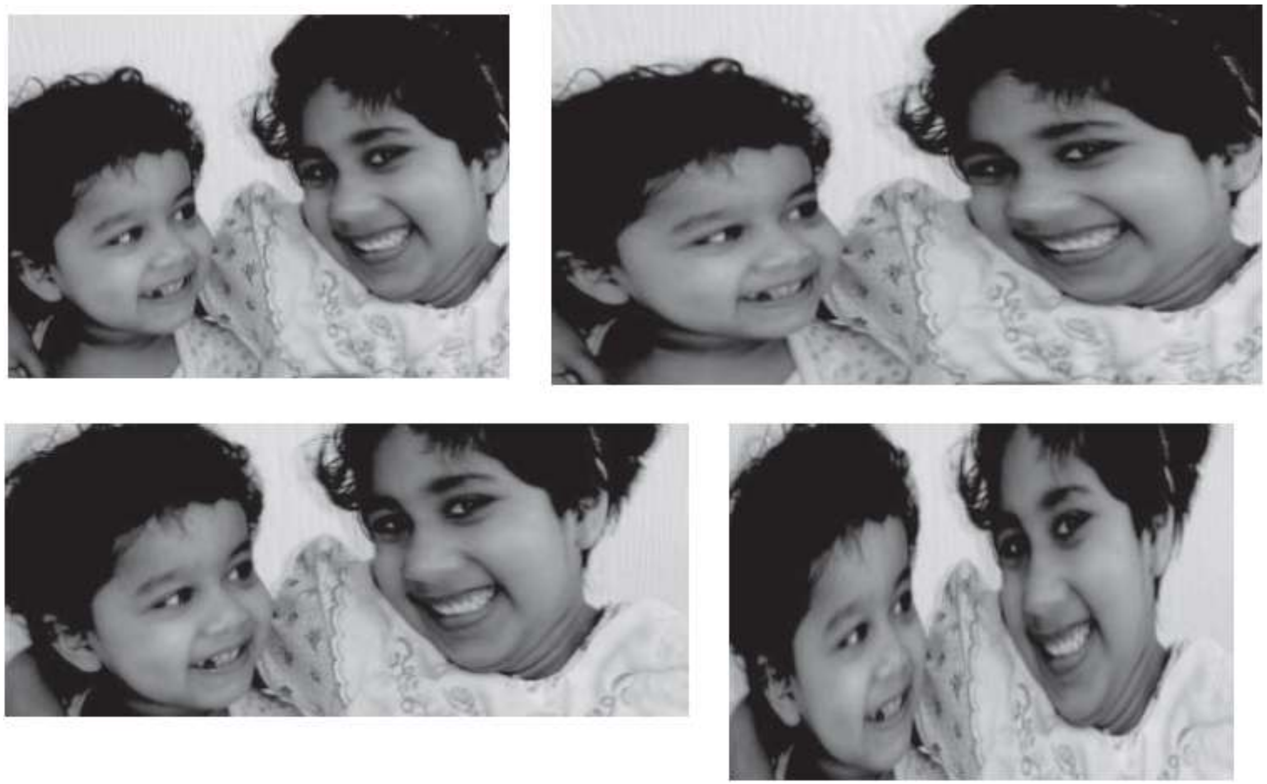
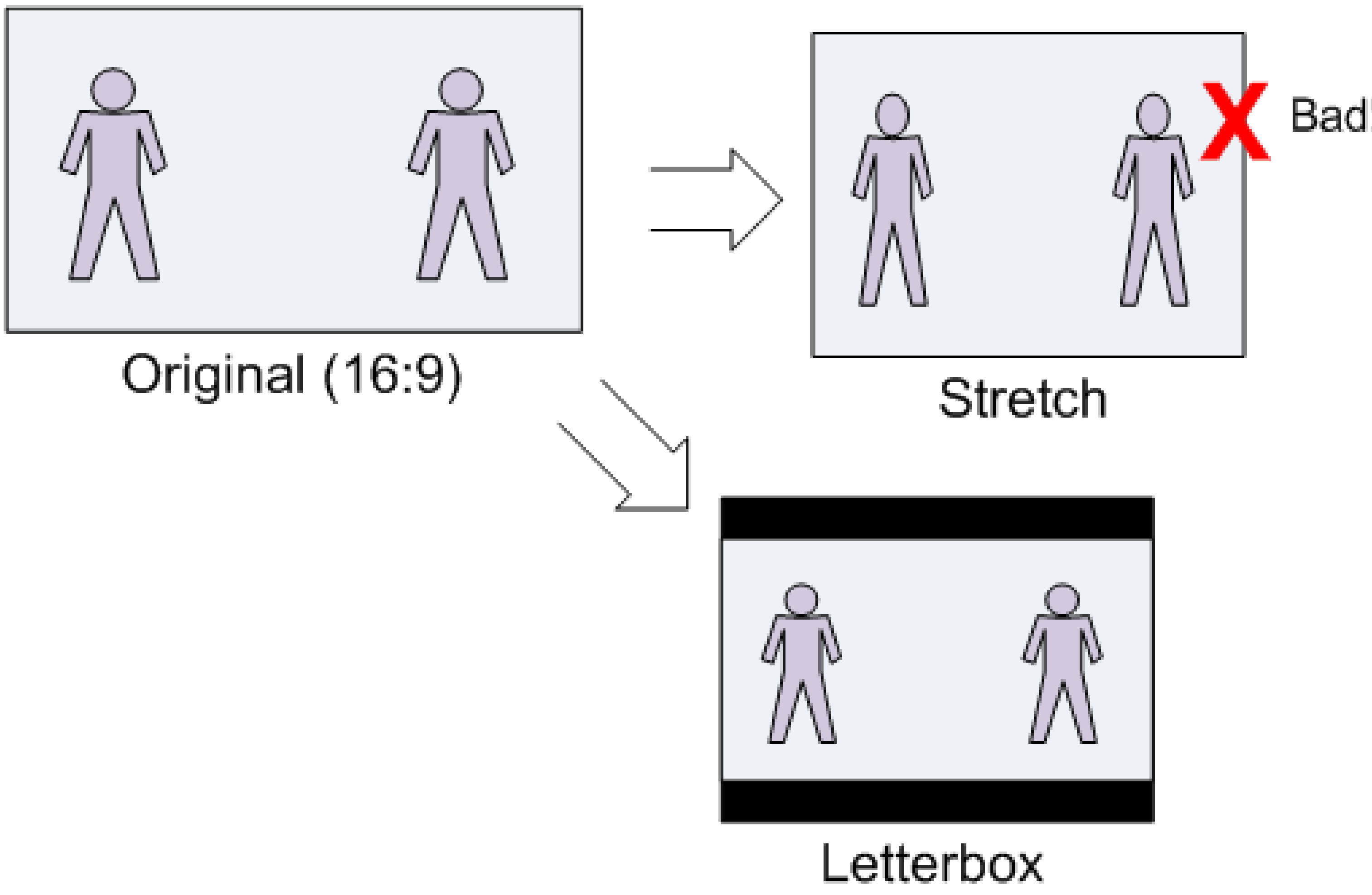


***Illustration of pixel aspect ratio changes.** The **top** two images show the 4:3 image (left) converted to a 16:9 format. The pixels appear horizontally stretched. The **bottom** two images show the anamorphic image resized to fit the 16:9 format (left) and a 4:3 format (right). The images appear stretched vertically because of irregular sampling in both dimensions causing non square pixels.*

Aspect ratio (cont'd)



Outlines

- Digital Images
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  - Digital Image Formats
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Digital Image Formats

- Images can be acquired by a variety of devices.
  - Most of the time, they are captured by a digital camera or a scanner, or even created by using many commercially used packages such as Adobe Photoshop, or a combination of the two.
- Standard formats are needed to store and exchange these digital images for viewing, printing, editing, or distribution.
- A variety of such formats are described in this section.

Digital Image Formats (cont'd)

- These and many file types are used to encode digital images. The choices are simpler than you might think.
- Part of the reason for the plethora of file types is the need for ***compression***. Image files can be quite large, and larger file types mean more disk usage and slower downloads.
  - Compression is a term used to describe ways of cutting the size of the file. Compression schemes can by *lossy* or *lossless*.
- Another reason for the many file types is that images differ in the number of colors they contain. If an image has few colors, a file type can be designed to exploit this as a way of reducing file size.
- There are different types of image File format:
  - GIF
  - JPEG
  - PNG
  - TIFF
  - Windows BMP
  - EXIF

Digital Image Formats (cont'd)

- GIF
  - GIF, stands for *Graphics Interchange Format,* is the first graphic file type recognized by early web browsers.
  - GIF standard is limited to 8-bit (256) color images only, which, while producing acceptable color images, is best suited for images with few distinctive colors (e.g., graphics or drawing).
    - Therefore, GIF files employ a technique called indexed color to reduce the number of bytes used to store the value of each pixel.
  - GIF is most suitable for graphics, diagrams, cartoons and logos with relatively few colors.
  - GIF is still the chosen format for animation effects.
  - Compared to JPEG, it is lossless and thus more effective with compressing images with a single color, but pales in detailed or dithered pictures.
    - In other words, GIF is lossless for images with 256 colors and below. So for a full color image, it may lose up to 99.998% of its colors.

Digital Image Formats (cont'd)

- GIF (cont'd)
  - One edge of the GIF image format is the interlacing feature, giving the illusion of fast loading graphics.
    - When it loads in a browser, the GIF first appears to be blurry and fuzzy, but as soon as more data is downloaded, the image becomes more defined until all the date has been downloaded.
  - **Pros of GIF:**
    - Can support transparency
    - Can do small animation effects
    - "Lossless" quality–they contain the same amount of quality as the original, except of course it now only has 256 colors
  - **Cons of GIF:**
    - Only supports 256 colors
    - File size is larger than PNG
  - **GIF actually comes in two versions:**
    - **GIF87a**: The original specification.
    - **GIF89a**: The later version. Supports simple animation via a Graphics Control Extension block in the data, provides simple control over delay time, a transparency index, etc.

Digital Image Formats (cont'd)

- JPEG
  - **JPEG (Joint Photographic Expert Group)** created by a working group of the International Organization for Standardization (ISO).
  - JPEG is the most important current standard for image compression.
    - The human vision system has some specific limitations and JPEG takes advantage of these to achieve high rates of compression.
  - JPEG files are very 'lossy', meaning so much information is lost from the original image when you save it in JPEG file.
    - This is because JPEG discards most of the information to keep the **image file** size small; which means some degree of quality is lost.
  - JPEG is very web friendly because the file is smaller
  - **Pros of JPEG:**
    - 24-bit color, with up to 16 million colors
    - Most used and most widely accepted image format
    - Compatible in most OS (Mac, PC, Linux)
  - **Cons of JPEG:**
    - They tend to discard a lot of data
    - After compression, JPEG tends to create artifacts
    - Cannot be animated
    - Does not support transparency

Digital Image Formats (cont’d)

- PNG
  - **PNG format**, stands for **Portable Network Graphics**, is a recently introduced format
  - It is an image format specifically designed for the web.
  - PNG is, in all aspects, the superior version of the GIF.
    - Just like the GIF format, the PNG is saved with 256 colors maximum but it saves the color information more efficiently. It also supports an 8 bit transparency.
  - **Pros of PNG:**
    - Lossless, so it does not lose quality and detail after image compression
    - PNG often creates smaller file sizes than GIF
    - Supports transparency better than GIF
  - **Cons of PNG:**
    - Not good for large images because they tend to generate a very large file, sometimes creating larger files than JPEG.
    - Unlike GIF however, it cannot be animated.
    - Not all web browsers can support PNG.

Digital Image Formats (cont'd)

- TIFF
  - **TIFF (Tagged Image File Format) format** was developed by the Aldus Corporation in the 1980's and was later supported by Microsoft.
  - TIFF is recommended especially for text and black and white images. Though it is not widely supported by web browsers, it remains the standard format for printing, scanned documents and Optical Character Recognition.
  - TIFF is not compatible for all systems.
  - TIFF is very flexible; it can be lossy or lossless.
  - **Pros of TIFF:**
    - Very flexible format, it supports several types of compression like JPEG, LZW, ZIP or no compression at all.
    - High quality image format, all color and data information are stored
  - **Cons of TIFF:**
    - Very large file size – long transfer time, huge disk space consumption, and slow loading time.

Digital Image Formats (cont'd)

- Windows BMP
  - Windows Bitmap (BMP) specific to the **Windows operating system** and compatible in all Windows OS and programs (**platform dependent**).
  - These files are large and uncompressed, but the images are rich in color, high in quality, simple and compatible in all Windows OS and programs.
  - Might an **8-bit, 16-bit or 24-bit** image but 24 bits-per pixel BMP files are great quality images.
  - **Disadvantages of BMP:**
    - **Does not compress** well.
    - **Very huge image files** making it not web friendly.
    - **No real advantage** over other image formats

  - **Many sub-variants within the BMP standard, PAINT and PICT**
    - PAINT was originally used in the MacPaintprogram, initially only for 1-bit monochrome images.
    - PICT format is used in MacDraw (a vector-based drawing program) for storing structured graphics

Digital Image Formats (cont'd)

- EXIF
  - **EXIF** (Exchange Image File) is an image format for digital cameras. Compressed EXIF files use the baseline JPEG format.
  - A variety of tags (many more than in TIFF) are available to facilitate higher quality printing, since information about the camera and picture-taking conditions (flash, exposure, light source, white balance, type of scene, etc.) can be stored and used by printers for possible color correction algorithms.
  - The EXIF standard also includes specification of file format for audio that accompanies digital images.

Digital Image Formats (cont'd)

Consideration of File Format selection

- **Print graphics:**
  - **TIFF** is the best and only choice to support CMYK and YcbCr.
- **Web graphics:**
  - **PNG, JPEG** and **GIF** are the most web friendly image formats.
  - **JPEG** is great when you need **small size** if you **don't mind** quality
  - If you keep **small size** but retain **image quality** use **PNG.**
  - **GIF is worst** choice if you want to add animation **use GIF**.
- **Hardware compatibility:**
  - If you are using PC shifting from **one system** to another, **JPEG is best** for PC and Mac computability.
- **Logos and line art:**
  - **JPEG** is the worst choice add **artifacts** and **no transparency.**
  - **GIF** is good choice but not as **TIFF and PNG** as they are **lossless**.
- **Clip art:**
  - **GIF** is the best image for clipart and **drawn graphics**.

Outlines

- Digital Images
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- Digital Videos
  - Digital representation of Images
  - Analog Video and Television
  - Types of Video Signals
  - YUV subsampling Schemes
  - Digital Video Formats
- Digital Audio
- Graphics

Digital Videos

- **Next week !!**

Thank You