Digital Image Processing

Color Models

Preview

- **Motive**

- Color is a powerful descriptor that often simplifies object identification and extraction from a scene.
- Human can discern thousands of color shades and intensities, compared to about only two dozen shades of gray.

Preview

Preview

Preview

- **Color image processing is divide into two major area:**
  - *Full-Color* Processing

    The images are acquired by full color sensor like color scanner
  - *Pseudo-Color* Processing
  - A color is assigned to a monochrome intensity or range of intensities.

Color Fundamentals

The experiment of Sir Isaac Newton, in 1666.

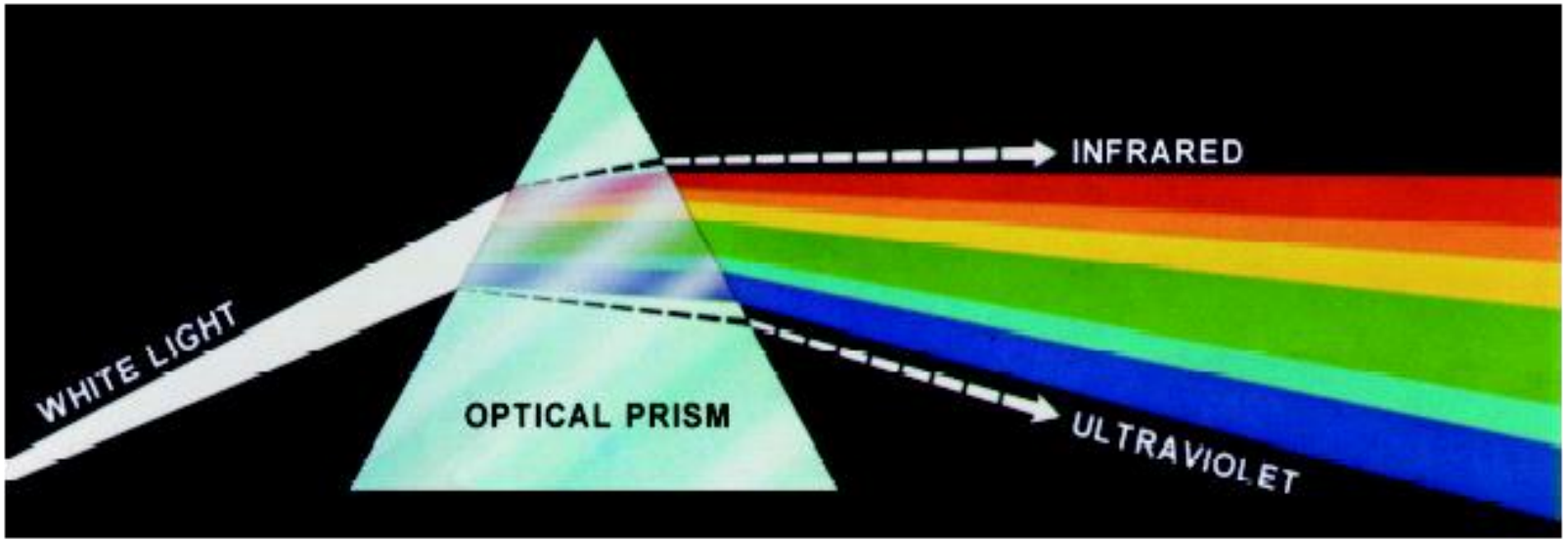


FIGURE 6.1 Color spectrum seen by passing white light through a prism. (Courtesy of the General Electric Co., Lamp Business Division.)

Color Fundamentals (con't)c

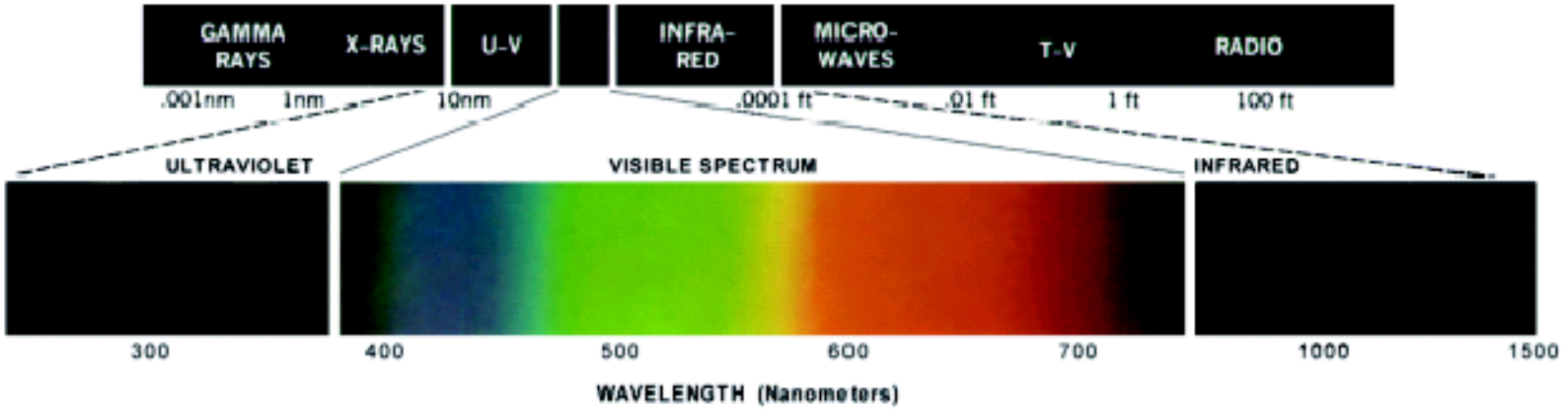


FIGURE 6.2 Wavelengths comprising the visible range of the electromagnetic spectrum. (Courtesy of the General Electric Co., Lamp Business Division.)

Color Fundamentals

- **Basic quantities to describe the quality of light source:**
  - Radiance: Total amount of energy that flows from the light source (in W).
  - Luminance: A measure of the amount of energy an observer perceives from the light source (in lm(lumens))
  - Brightness: A subjective descriptor that embodies the achromatic notion of intensity and is practically impossible to measure.

Color Fundamentals (con't)

Standard wavelength values for the primary colors. 6 to 7 million cones in human eye.65% are sensitive to red light,33% to green and 2% to blue.

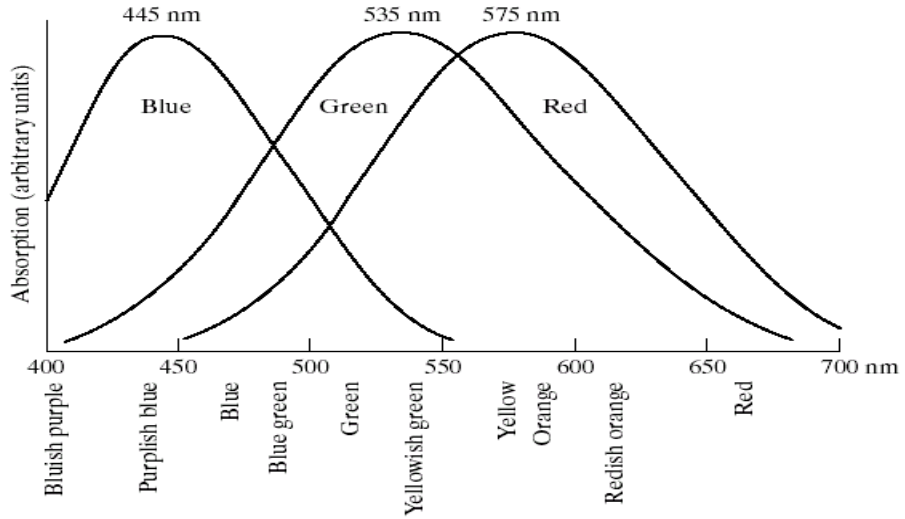
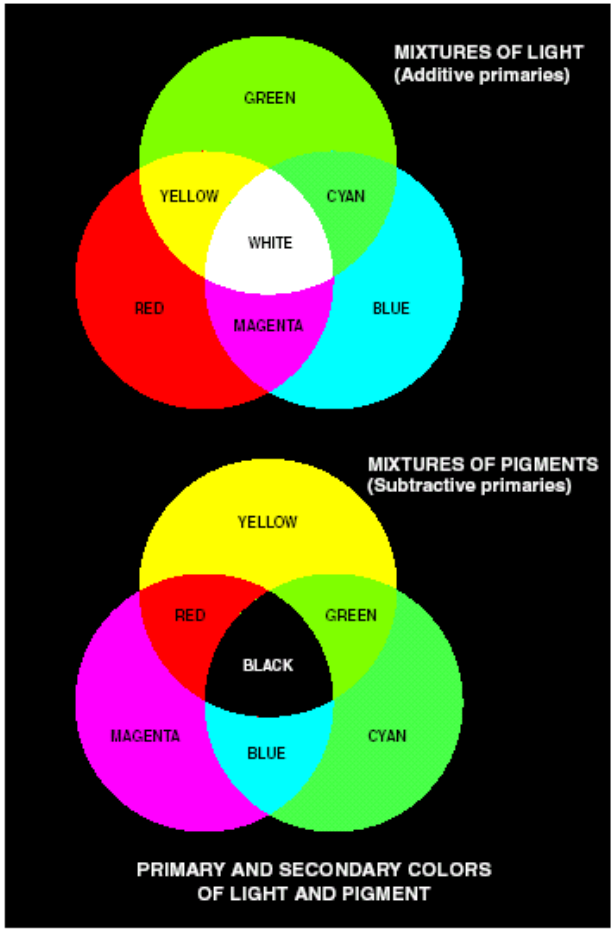


FIGURE 6.3 Absorption of light by the red, green, and blue cones in the human eye as a function of wavelength.

Color Fundamentals (con't)



a
b

FIGURE 6.4 Primary and secondary colors of light and pigments. (Courtesy of the General Electric Co., Lamp Business Division.)

Color Fundamentals

- **The characteristics generally used to distinguish one color from another are Brightness, Hue, and Saturation.**
  - Hue: Represents dominant color as perceived by an observer.
  - Saturation: Relative purity or the amount of white light mixed with a hue

- **Hue and saturation taken together are called *Chromaticity*, and therefore, a color may be characterized by its Brightness and Chromaticity.**

Color Models

- The purpose of a color model (also called color space or color system) is to facilitate the specification of colors in some standard, generally accept way.
- **RGB** (red,green,blue) : monitor, video camera.
- **CMY**(cyan,magenta,yellow),**CMYK** (CMY, black) model for color printing.
- and **HSI** model,which corresponds closely with the way humans describe and interpret color.

The CMY and CMYK Color Models

- Cyan, Magenta and Yellow are the secondary colors of light
- Most devices that deposit colored pigments on paper, such as color printers and copiers, require CMY data input.

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

The HSI Color Models

- **Converting colors from RGB to HSI**

$$H = \begin{cases} \theta & \text{if } B \le G \\ 360 - \theta & \text{if } B > G \end{cases}$$

$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{1/2}} \right\}$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)]$$

$$I = \frac{1}{3}(R+G+B)$$

The HSI Color Models

- **Converting colors from HSI to RGB**
  - **RG sector :** $0^\circ \le H < 120^\circ$

$$B = I(1-S)$$

$$R = I\left[1+\frac{S\cos H}{\cos(60^\circ - H)}\right]$$

$$G = 3I-(R+B)$$

The HSI Color Models

- **Converting colors from HIS to RGB**
  - **GB sector :** $120^\circ \le H < 240^\circ$

$$H = H - 120^\circ$$

$$R = I(1 - S)$$

$$G = I\left[1 + \frac{S\cos H}{\cos(60^\circ - H)}\right]$$

$$B = 3I - (R + G)$$

The HSI Color Models

- **Converting colors from HIS to RGB**
  - **BR sector :** $240^\circ \le H < 360^\circ$

$$H = H - 240^\circ$$

$$G = I(1 - S)$$

$$B = I\left[1 + \frac{S\cos H}{\cos(60^\circ - H)}\right]$$

$$R = 3I - (G + B)$$

Pseudocolor Image Processing

- **Pseudocolor (also called false color) image processing consists of assigning colors to gray values based on a specified criterion.**

- **The principal use of pseudocolor is for human visualization and interpretation of gray-scale events in an image or sequence of images.**