Color Models

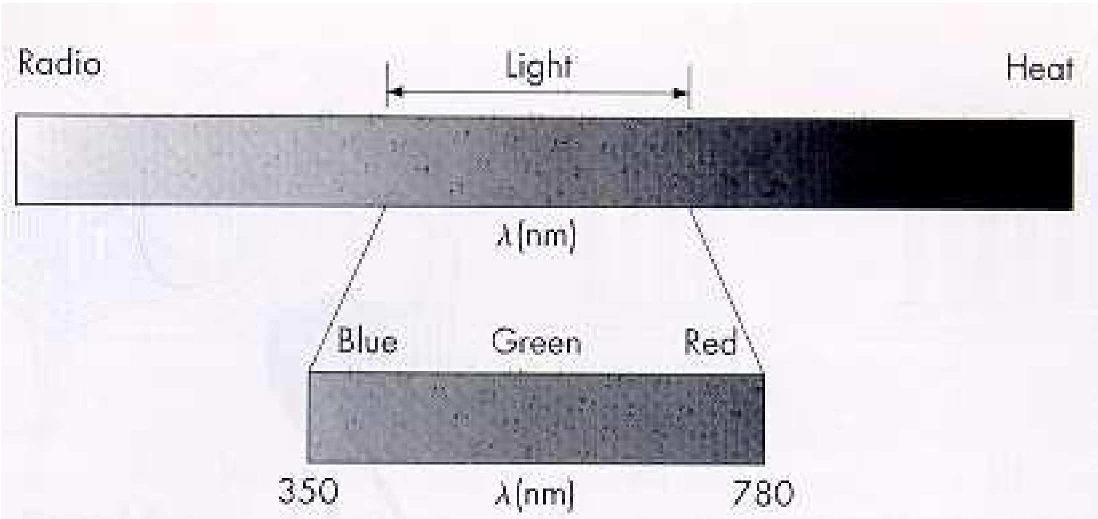
- **What is light ?**

  - Light is a form of electromagnetic radiation

  - Electromagnetic energy travels as waves that can be characterized by their *wavelengths* or their *frequencies*

  - Visible spectrum (light): wavelengths in the range of 350 to 780 nanometers (nm)

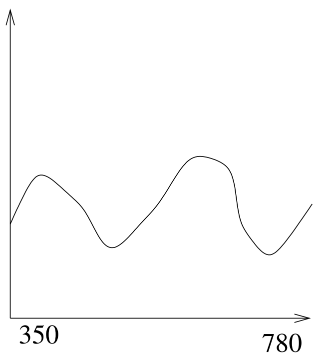
  - A laser emits light at a single wavelength while a lamp over a range of wavelengths



- **What is color ?**

  - Colors are combinations of wavelengths

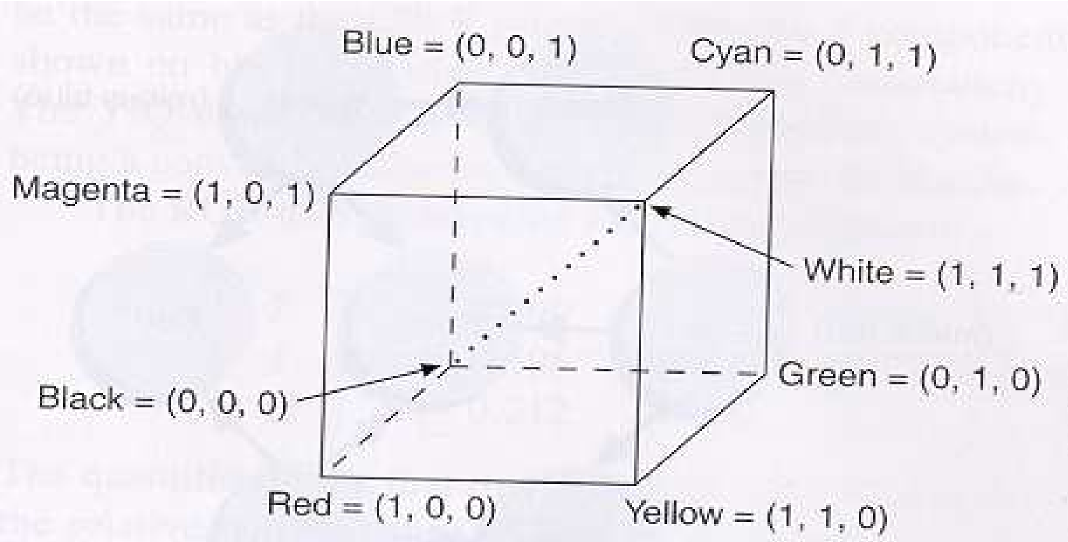
  - Each color is characterized by a function $C(\lambda)$



- **The three color theory (RGB)**

  - Colors are being formed from three primary colors that are mixed to form the desired color

$$C = T_1 R + T_2 G + T_3 B$$



- **The RGBA model**

  - The fourth component (A) is an *opacity* (A=0) or *transparency* (A=1) value

- **Indexed color**

  - Each color is represented by 8 bits (needs a 24 bits frame buffer, 2^{24} colors)

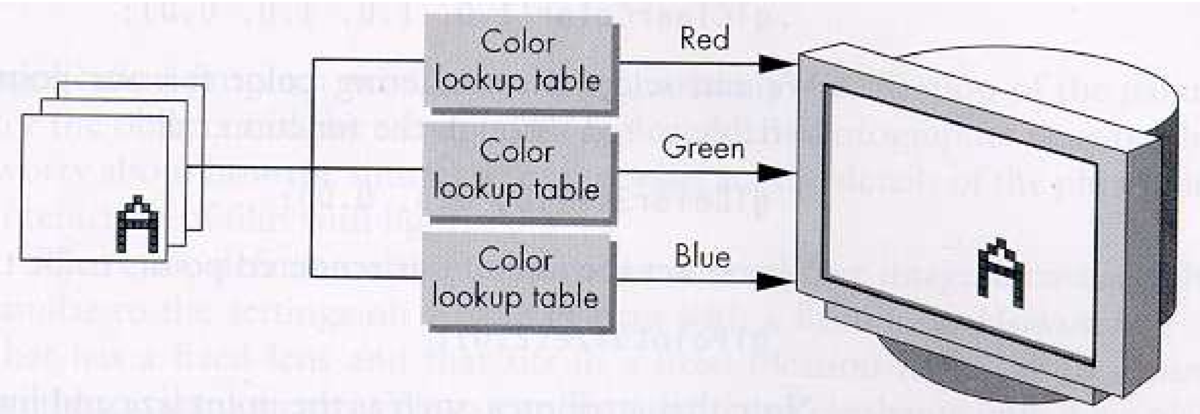
  - Many systems have frame buffers that are limited in depth (e.g., 16, 12 or 8 bits)

  - Idea: use color-lookup tables

    * Select a small number of colors from the set of all possible colors

    * Interpret the color values as indices to the color-lookup table

Input	Red	Green	Blue
0	0	0	0
1	$2^m - 1$	0	0
·	0	$2^m - 1$	0
·	·	·	·
·	·	·	·
$2^k - 1$	·	·	·
	m bits	m bits	m bits



- **The CMY model**

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

- Used in commercial printing and painting

- **The YIQ model**

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.528 & 0.311 \end{bmatrix} . \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

- Used in commercial color-TV broadcasting

- The Y component corresponds to luminance while chromaticity is encoded in the I and Q components

- **The HSV model**

  - HSV stands for *Hue*, *Saturation* and *Value* (brightness)

  - More consistent with human color perception