Raster Graphics

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Overview

- Display hardware
  o How are images displayed?

- Raster graphics systems
  o How are imaging systems organized?

- Color models
  o How can we describe and represent colors?

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Display Hardware

- Video display devices
  o Cathode Ray Tube (CRT)
  o Liquid Crystal Display (LCD)
  o Plasma panels
  o Thin-film electroluminescent displays
  o Light-emitting diodes (LED)

- Hard-copy devices
  o Ink-jet printer
  o Laser printer
  o Film recorder
  o Electrostatic printer
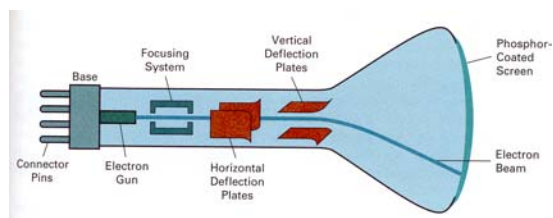 o Pen plotter

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Cathode Ray Tube (CRT)

Figure 2.4 from H&B
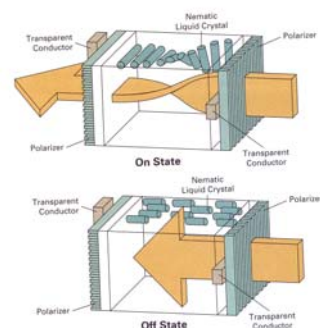

Liquid Crystal Display (LCD)

Figure 2.16 from H&B

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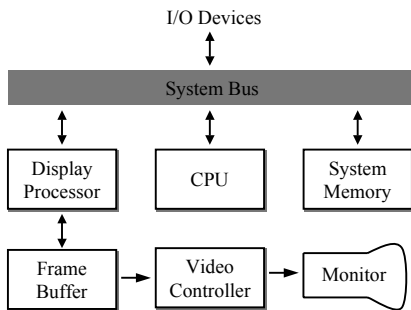 - o How can we describe and represent colors?

Raster Graphics Systems
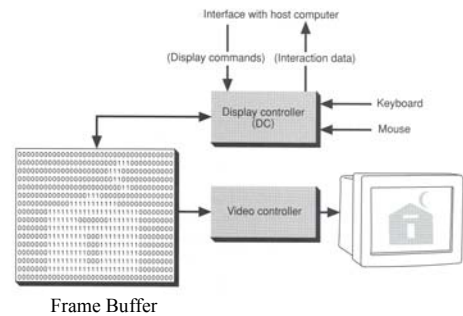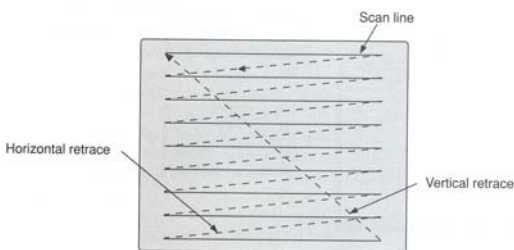

Figure 2.29 from H&B

Frame Buffer

Frame Buffer

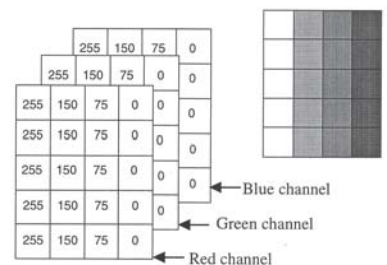Figure 1.2 from FvDFH

Frame Buffer Refresh

Refresh rate is usually 30-75Hz

Figure 1.3 from FvDFH

Color Frame Buffer
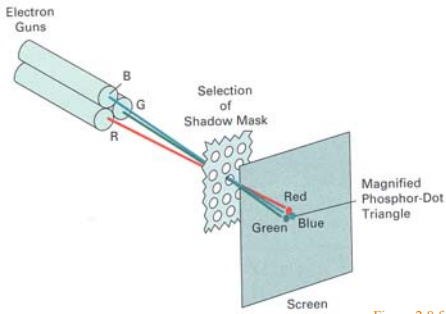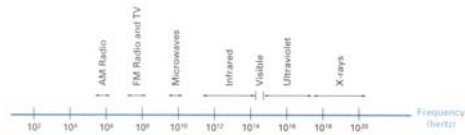
Color CRT

Figure 2.8 from H&B

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Electromagnetic Spectrum

- Visible light frequencies range between ...
  - o Red = 4.3 x 10^{14} hertz (700nm)
  - o Violet = 7.5 x 10^{14} hertz (400nm)

Figures 15.1 from H&B

Visible Light

- The color of light is characterized by …
  - o Hue = dominant frequency (highest peak)
  - o Saturation = excitation purity (ratio of highest to rest)
  - o Lightness = luminance (area under curve)
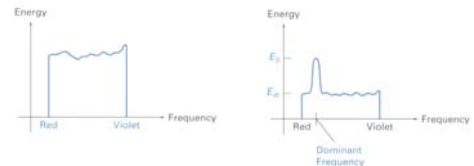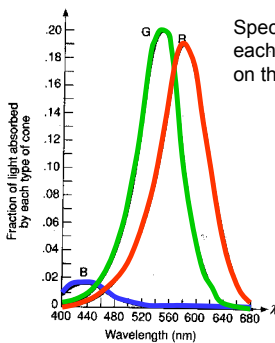

White Light   Orange Light

Figures 15.3-4 from H&B

Color Perception

Spectral-response functions of each of the three types of cones on the human retina.
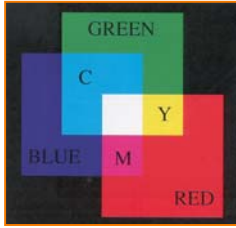
Tristimulus theory of color

Figure 13.18 from FvDFH

Color Models
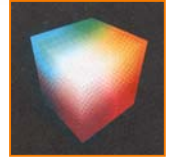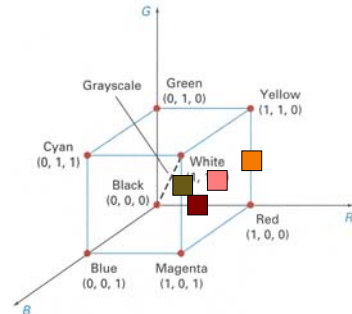
- RGB
- XYZ
- CMY
- HSV
- Others

RGB Color Model

Colors are additive

R	G	B	Color
0.0	0.0	0.0	Black
1.0	0.0	0.0	Red
0.0	1.0	0.0	Green
0.0	0.0	1.0	Blue
1.0	1.0	0.0	Yellow
1.0	0.0	1.0	Magenta
0.0	1.0	1.0	Cyan
1.0	1.0	1.0	White
0.5	0.0	0.0	?
1.0	0.5	0.5	?
1.0	0.5	0.0	?
0.5	0.3	0.1	?

Plate II.3 from FvDFH

RGB Color Cube

RGB Spectral Colors

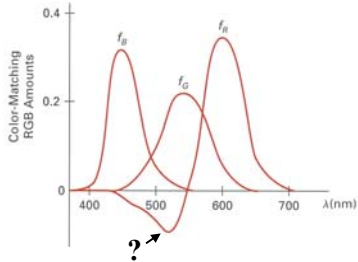Amounts of RGB primaries needed to display spectral colors

Figure 15.5 from H&B

XYZ Color Model (CIE)

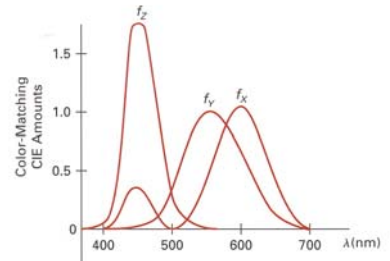Amounts of CIE primaries needed to display spectral colors

Figure 15.6 from H&B

CIE Chromaticity Diagram

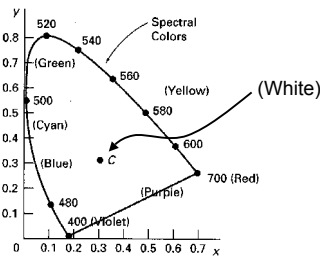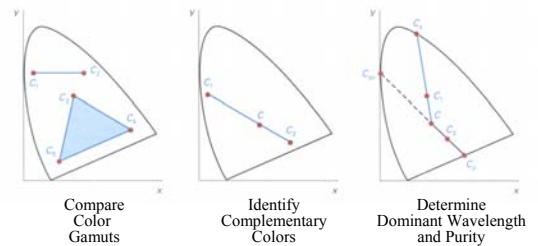Normalized amounts of X and Y for colors in visible spectrum

Figure 15.7 from H&B

CIE Chromaticity Diagram

Compare Color Gamuts

Identify Complementary Colors

Determine Dominant Wavelength and Purity

RGB Color Gamut

Color gamut for a typical RGB computer monitor
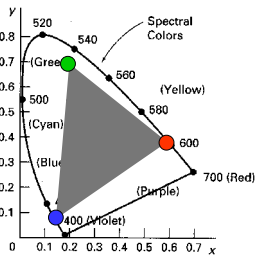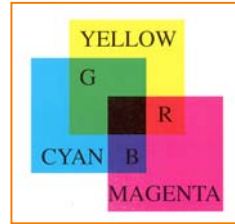
CMY Color Model

Colors are subtractive

C	M	Y	Color
0.0	0.0	0.0	White
1.0	0.0	0.0	Cyan
0.0	1.0	0.0	Magenta
0.0	0.0	1.0	Yellow
1.0	1.0	0.0	Blue
1.0	0.0	1.0	Green
0.0	1.0	1.0	Red
1.0	1.0	1.0	Black
0.5	0.0	0.0	
1.0	0.5	0.5	
1.0	0.5	0.0	

CMY Color Cube
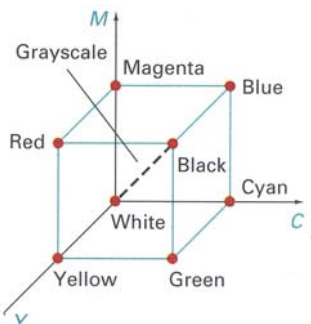
HSV Color Model
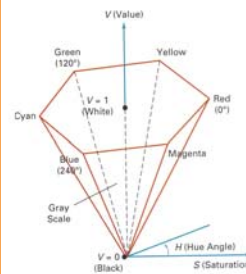
H	S	V	Color
0	1.0	1.0	Red
120	1.0	1.0	Green
240	1.0	1.0	Blue
*	0.0	1.0	White
*	0.0	0.5	Gray
*	*	0.0	Black
60	1.0	1.0	
270	0.5	1.0	
270	0.0	0.7	

Summary

- Display hardware
  - o Monitors: CRTs, LCDs, etc.
  - o Hard-copy: printers, plotters, etc.

- Raster graphics systems
  - o Display processors
  - o Frame buffers
  - o Video controllers
  - o Devices cannot display all visible colors

- Color models
  - o Tristimulus theory of color
  - o Different color models for different devices, uses, etc.