Raster Graphics

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Overview

- Display hardware
  - How are images displayed?
- Raster graphics systems
  - How are imaging systems organized?
- Color models
  - How can we describe and represent colors?

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Display Hardware

- Video display devices
  - Cathode Ray Tube (CRT)
  - Liquid Crystal Display (LCD)
  - Plasma panels
  - Thin-film electroluminescent displays
  - Light-emitting diodes (LED)
- Hard-copy devices
  - Ink-jet printer
  - Laser printer
  - Film recorder
  - Electrostatic printer
  - Pen plotter

Cathode Ray Tube (CRT)

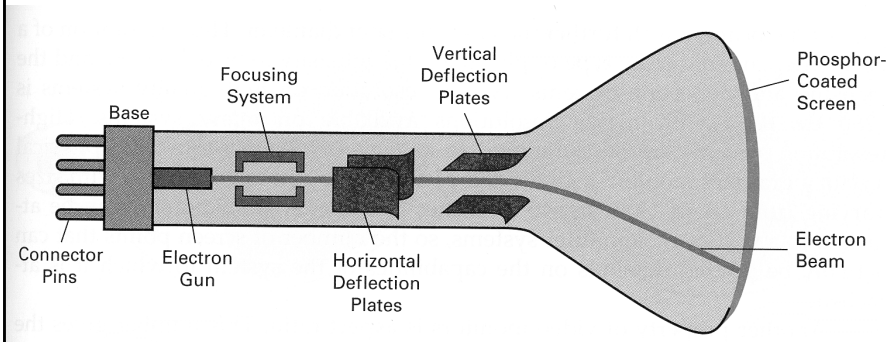

Figure 2.4 from H&B

Liquid Crystal Display (LCD)

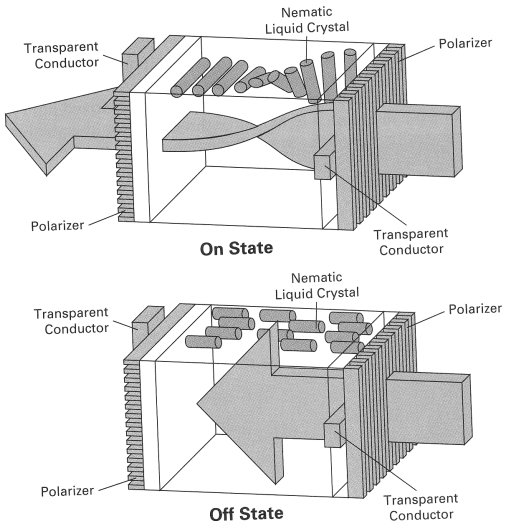

Figure 2.16 from H&B

Display Hardware

- Video display devices
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  - » Liquid Crystal Display (LCD)
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- Hard-copy devices
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Raster Graphics Systems

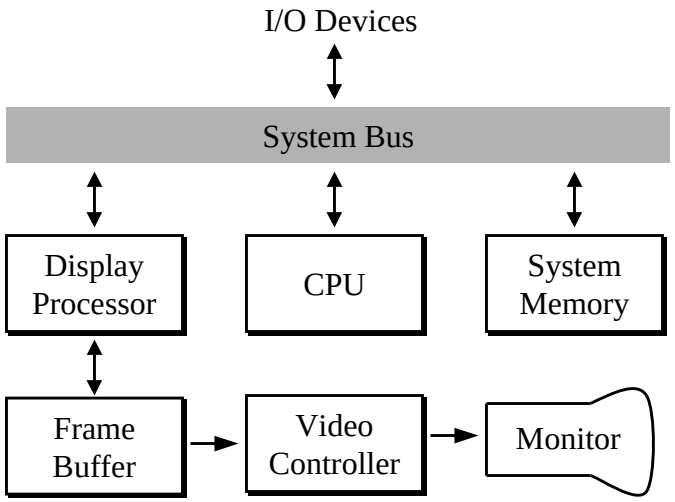


Figure 2.29 from H&B

Frame Buffer

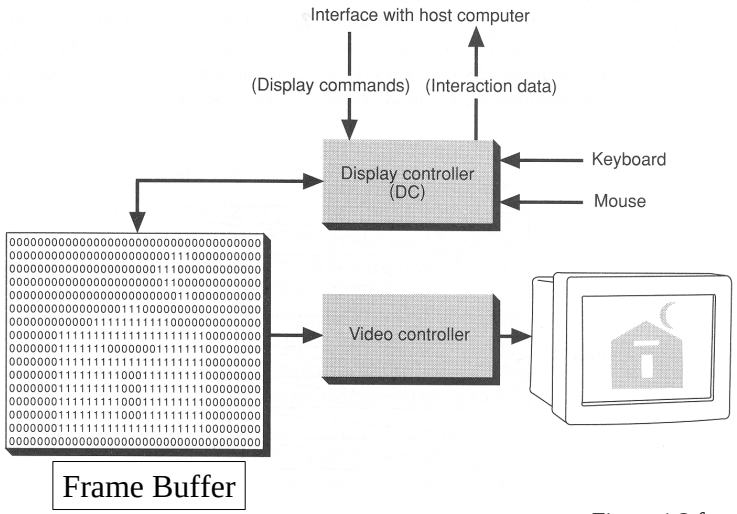
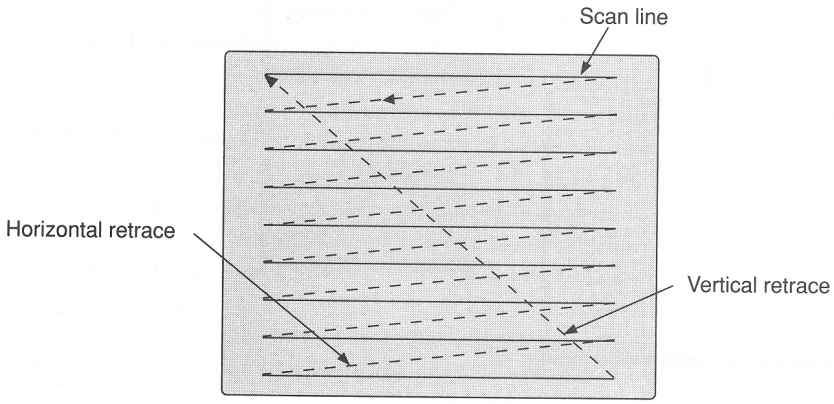


Figure 1.2 from FvDFH

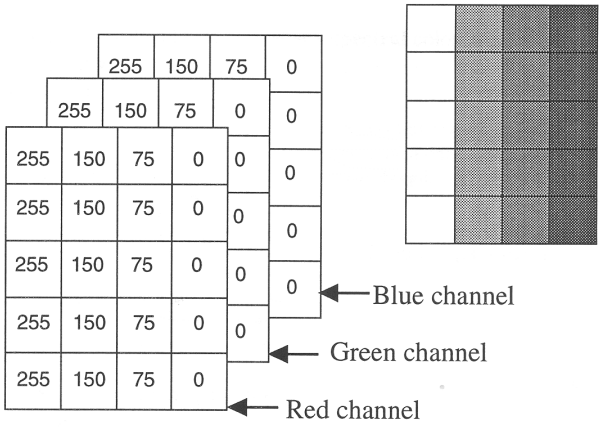
Frame Buffer Refresh



Refresh rate is usually 30-75Hz

Figure 1.3 from FvDFH

Color Frame Buffer



Color CRT

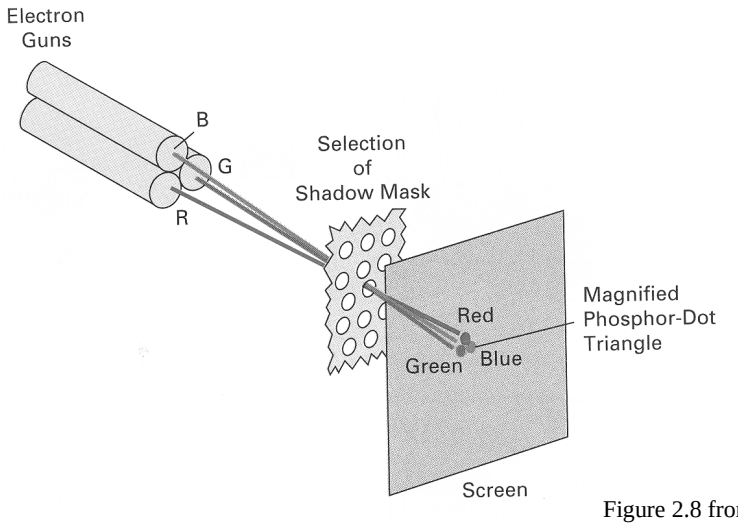


Figure 2.8 from H&B

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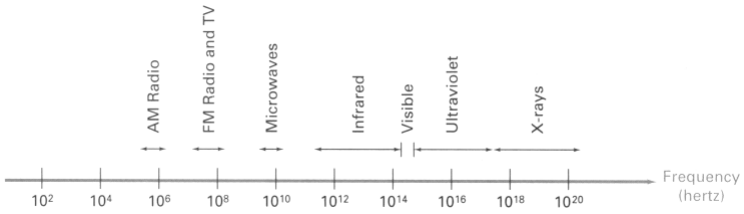
Electromagnetic Spectrum

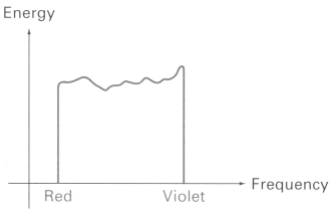
- Visible light frequencies range between ...
  - Red = 4.3 x 10^{14} hertz (700nm)
  - Violet = 7.5 x 10^{14} hertz (400nm)



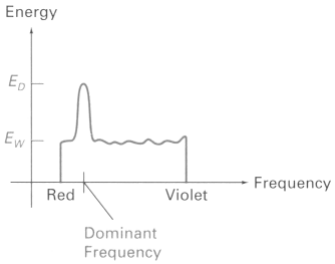
Figures 15.1 from H&B

Visible Light

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



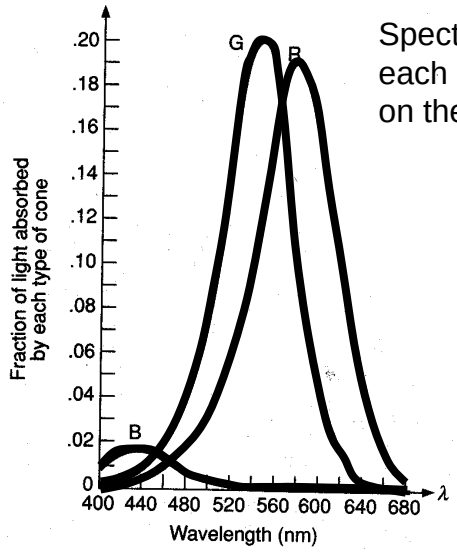
White Light



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.

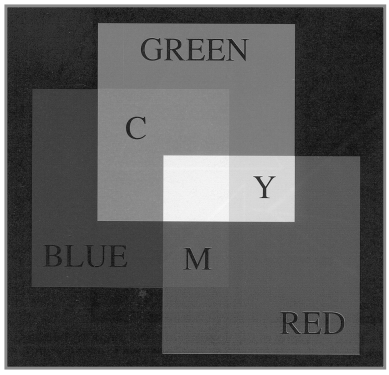
Tristimulus theory of color

Figure 13.18 from FvDFH

Color Models

- RGB
- XYZ
- CMY
- HSV
- Others

RGB Color Model

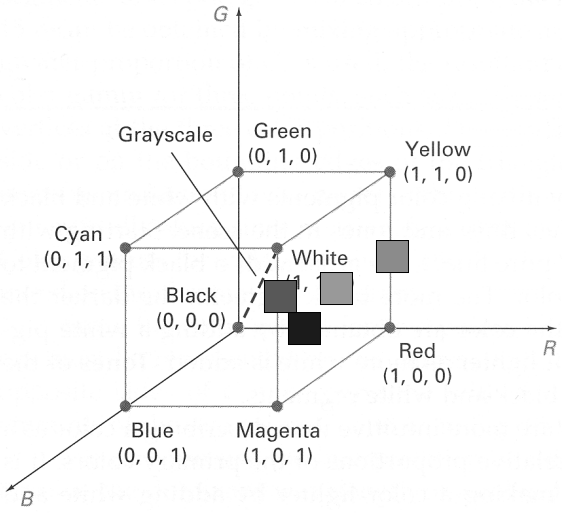


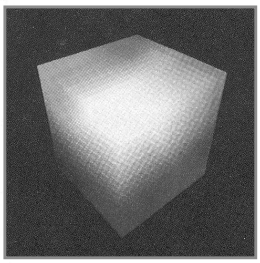
Colors are additive

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





Figures 15.11&15.12 from H&B

RGB Spectral Colors

Amounts of RGB primaries needed to display spectral colors

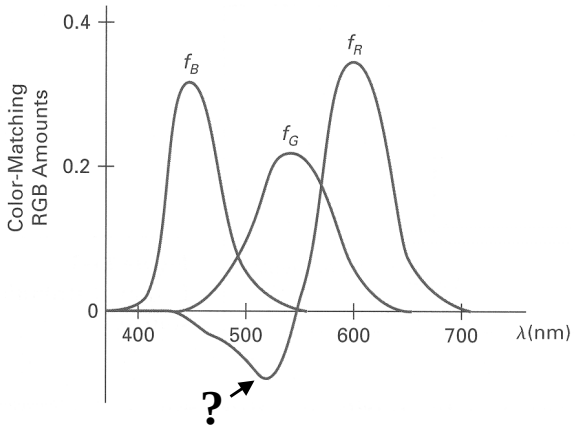
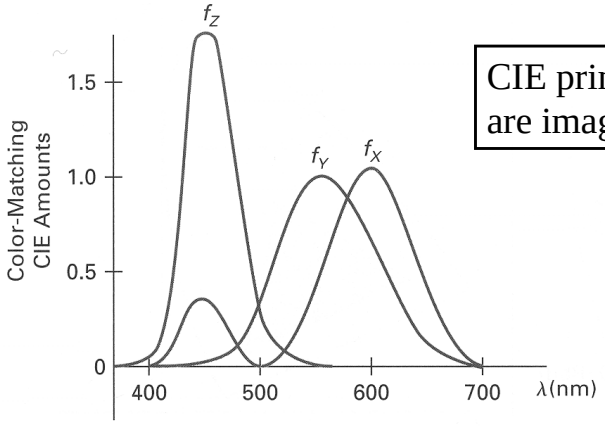


Figure 15.5 from H&B

XYZ Color Model (CIE)

Amounts of CIE primaries needed to display spectral colors



CIE primaries are imaginary

Figure 15.6 from H&B

CIE Chromaticity Diagram

Normalized amounts of X and Y for colors in visible spectrum

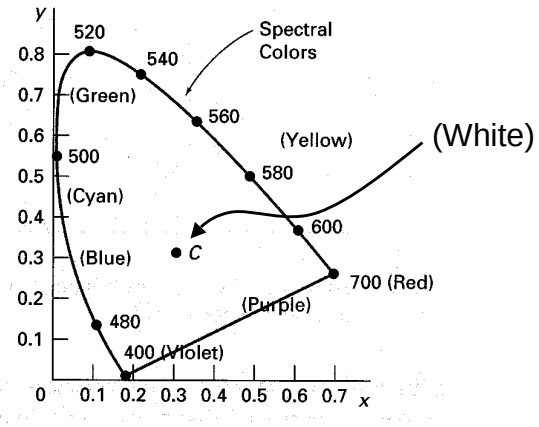
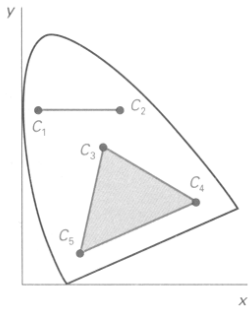
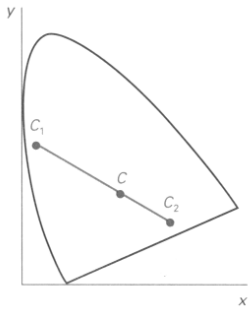


Figure 15.7 from H&B

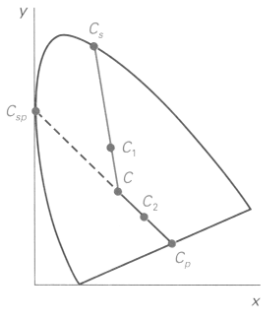
CIE Chromaticity Diagram



Compare Color Gamuts



Identify Complementary Colors



Determine Dominant Wavelength and Purity

Figures 15.8-10 from H&B

RGB Color Gamut

Color gamut for a typical RGB computer monitor

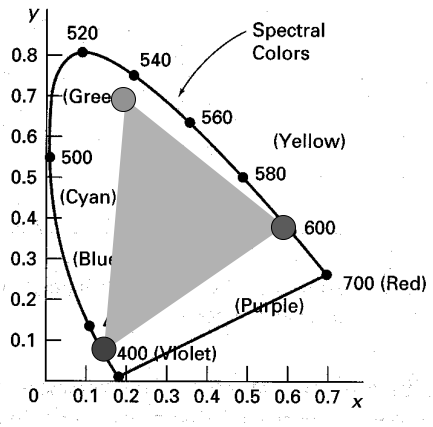
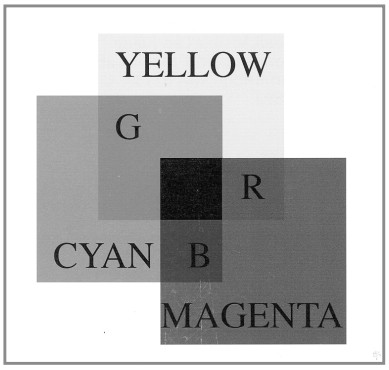


Figure 15.13 from H&B

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	

Plate II.7 from FvDFH

CMY Color Cube

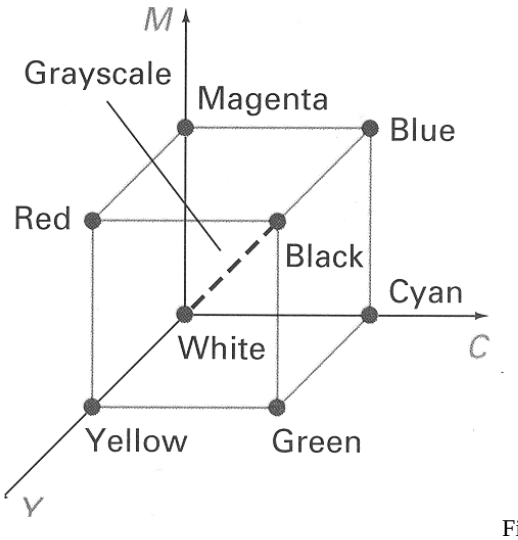
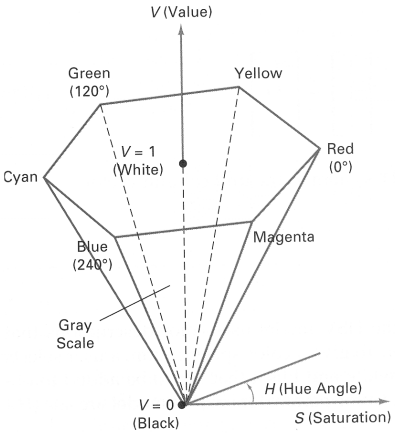


Figure 15.14 from H&B

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	

Figure 15.16&15.17 from H&B

Summary

- Display hardware
  - Monitors: CRTs, LCDs, etc.
  - Hard-copy: printers, plotters, etc.
- Raster graphics systems
  - Display processors
  - Frame buffers
  - Video controllers
  - Devices cannot display all visible colors
- Color models
  - Tristimulus theory of color
  - Different color models for different devices, uses, etc.