Overview

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

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

Raster Graphics

Adam Finkelstein
Princeton University
COS 426, Fall 2001
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Color CRT

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Electromagnetic Spectrum

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

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)

Color Perception

- Color models
  - RGB
  - XYZ
  - CMY
  - HSV
  - Others
RGB Color Model

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<th>Color</th>
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Colors are additive.

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

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
**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.