

CAPITULO I

REPRESENTACIÓN VISUAL COMPUTARIZADA

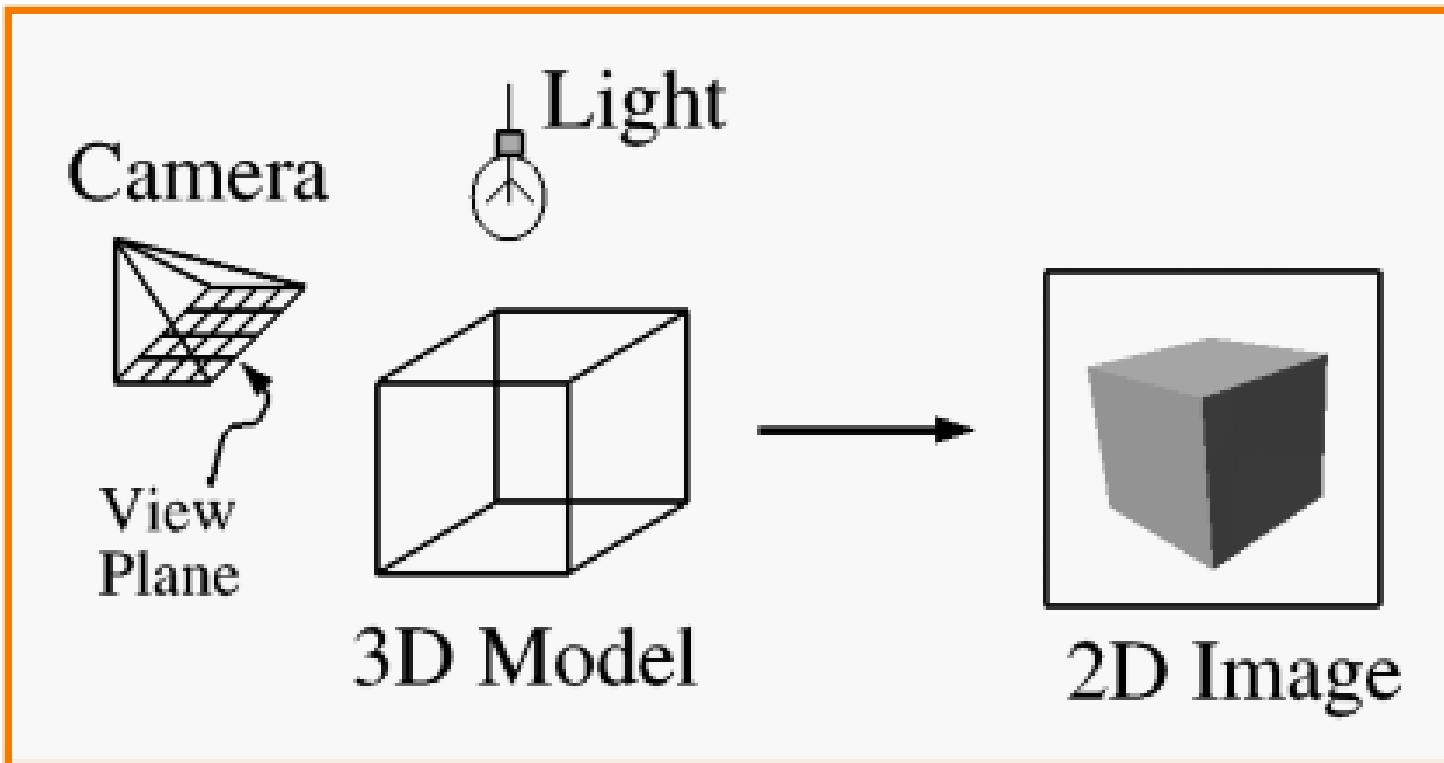
1.3

CONCEPTOS BÁSICOS DE REPRESENTACION GRÁFICA

GRAPHIC DISPLAY INTRODUCTION

What is computer graphics?

- Imaging = *representing 2D images*
- Modeling = *representing 3D objects*
- Rendering = *constructing 2D images from 3D models*
- Animation = *simulating changes over time*



I. Imaging

II. Modeling

III. Rendering

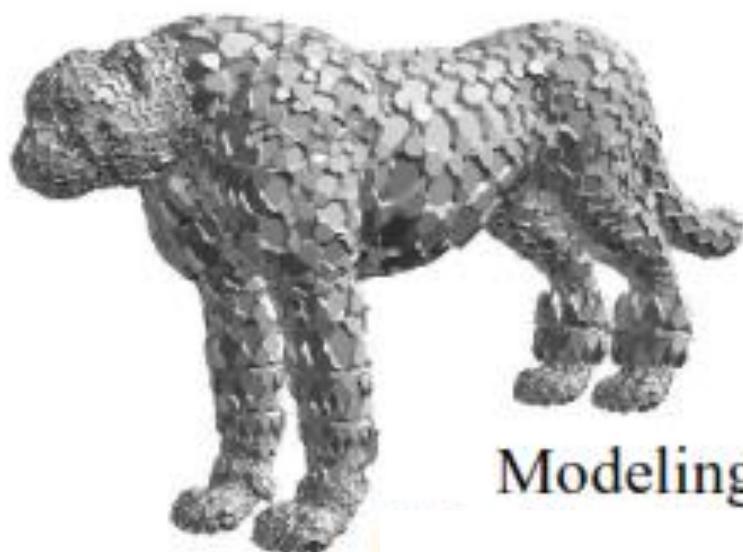
IV. Animation



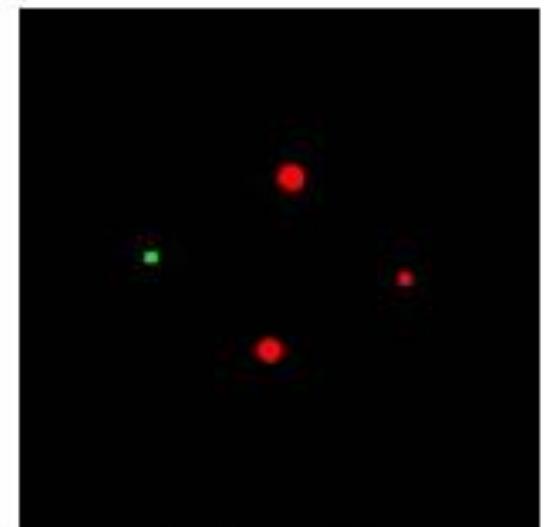
Image Processing



Rendering



Modeling



Animation

1. Imaging

- Image Basics
 - Definition
 - Color models
- Image Representation
 - Sampling
 - Reconstruction
 - Quantization & Aliasing
- Image Processing
 - Filtering
 - Warping
 - Composition
 - Morphing



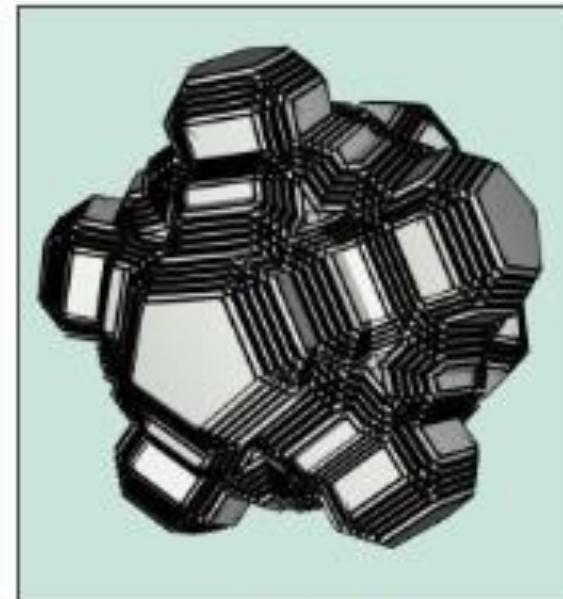
Image Composition



Image Morphing

2. Modeling

- Representations of geometry
 - Curves: splines
 - Surfaces: meshes, splines, subdivision
 - Solids: voxels, CSG, BSP
- Procedural modeling
 - Sweeps
 - Fractals
 - Grammars



3. Rendering

- 3D Rendering Pipeline
 - Modeling transformations
 - Viewing transformations
 - Hidden surface removal
 - Illumination, shading, and textures
 - Scan conversion, clipping
 - Hierarchical scene graphics
 - OpenGL
- Global illumination
 - Ray tracing
 - Radiosity



Pixel Shading



Global Illumination

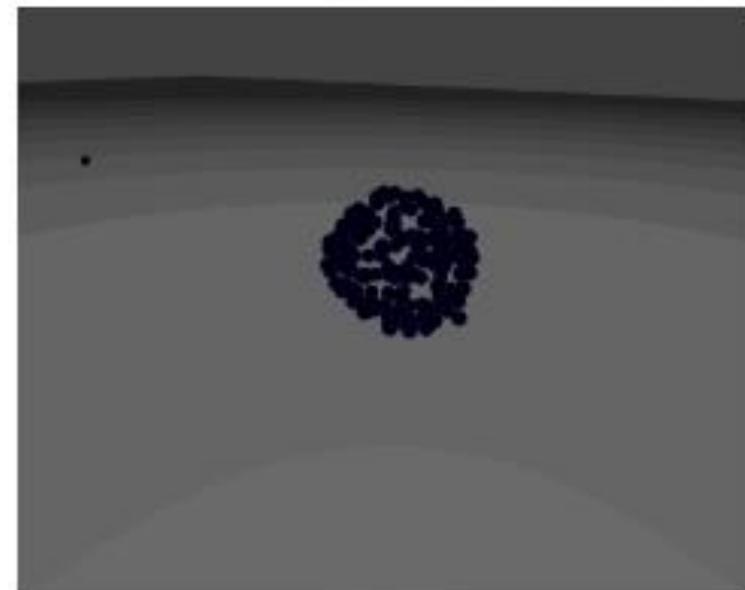
4. Animation

- Keyframing
 - Kinematics
 - Articulated figures
- Motion capture
 - Capture
 - Warping
- Dynamics
 - Physically-based simulations
 - Particle systems
- Behaviors
 - Planning, learning, etc.



Dancing Guy

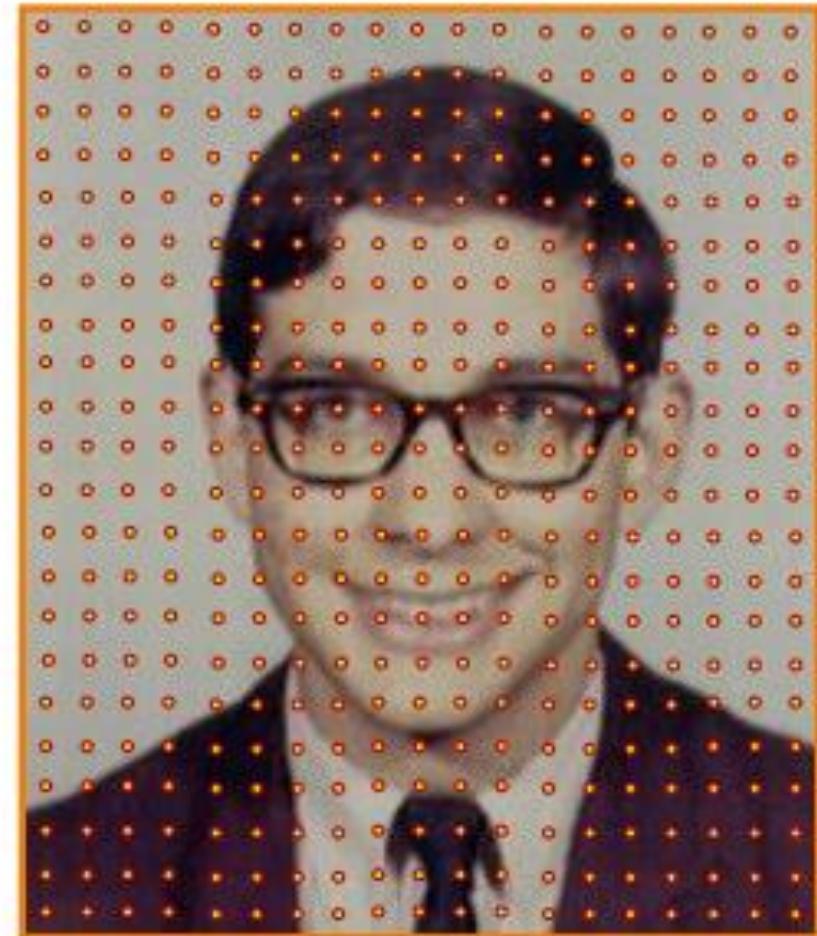
Particle system



What is an Image?

What is an Image?

An image is a 2D rectilinear array of pixels

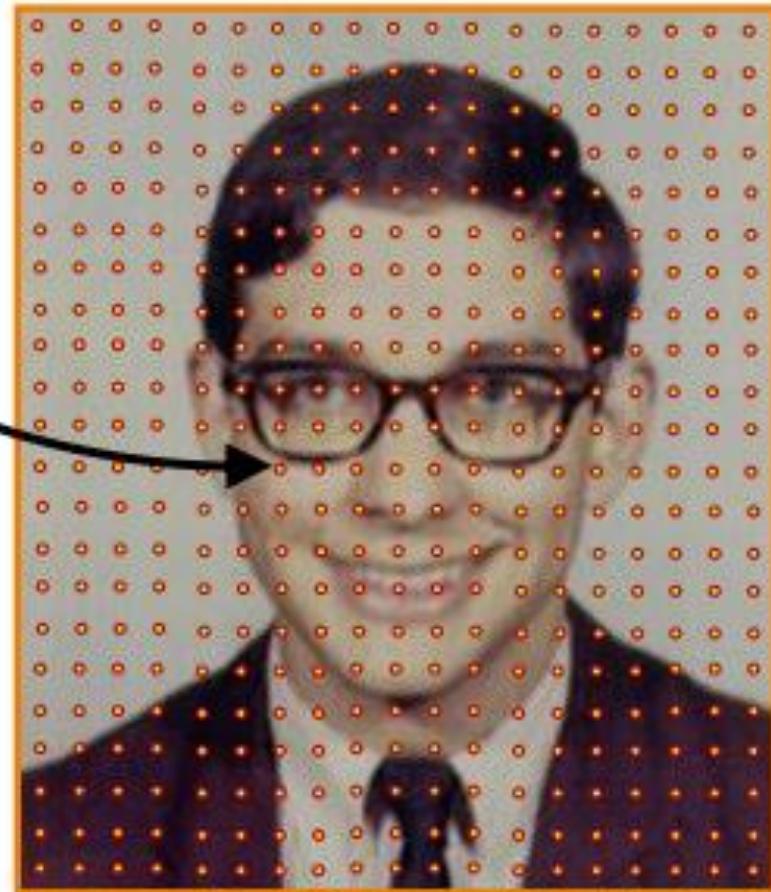


Digital image

What is a Pixel?

What is a Pixel?

Pixel

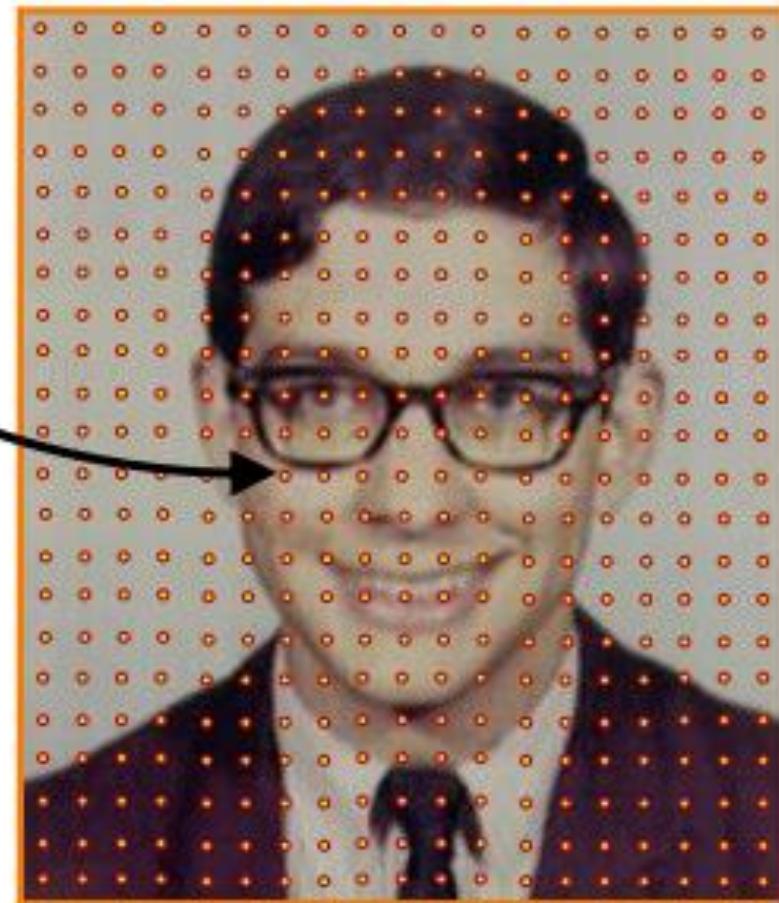


Digital image

What is a Pixel?

Sample of a function at a position

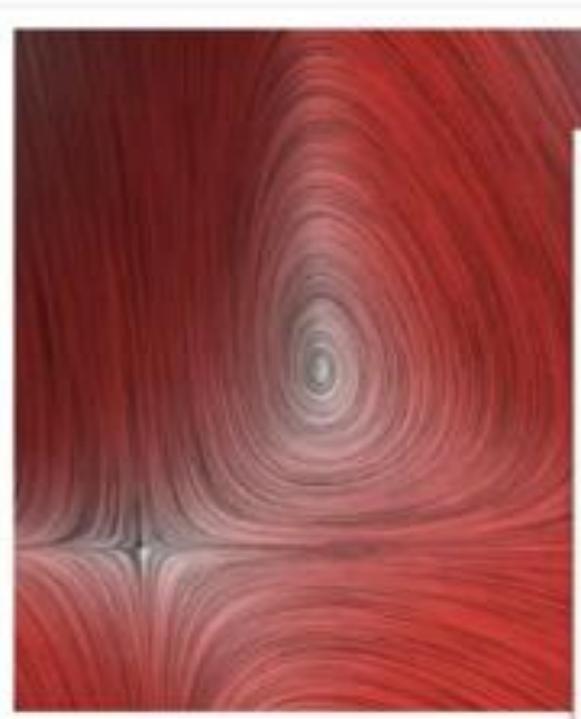
$I(x,y)$



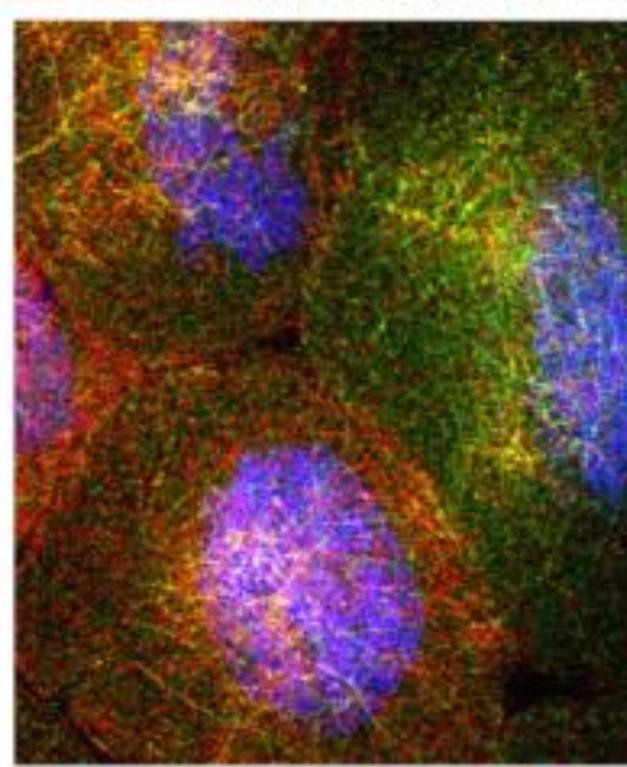
Digital image

What is a Pixel? What Function?

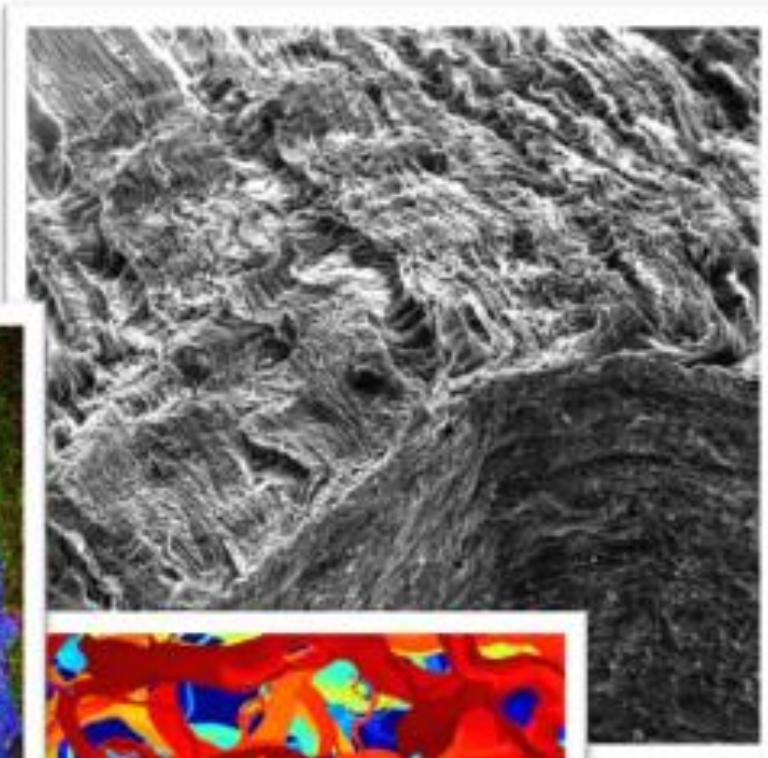
Could be any function ...



Mitchell A. Nahmias
Paul R. Prucnal



Shawn C. Little
Kristina S. Sinsimer
Elizabeth R. Gavis



Michael Kosk



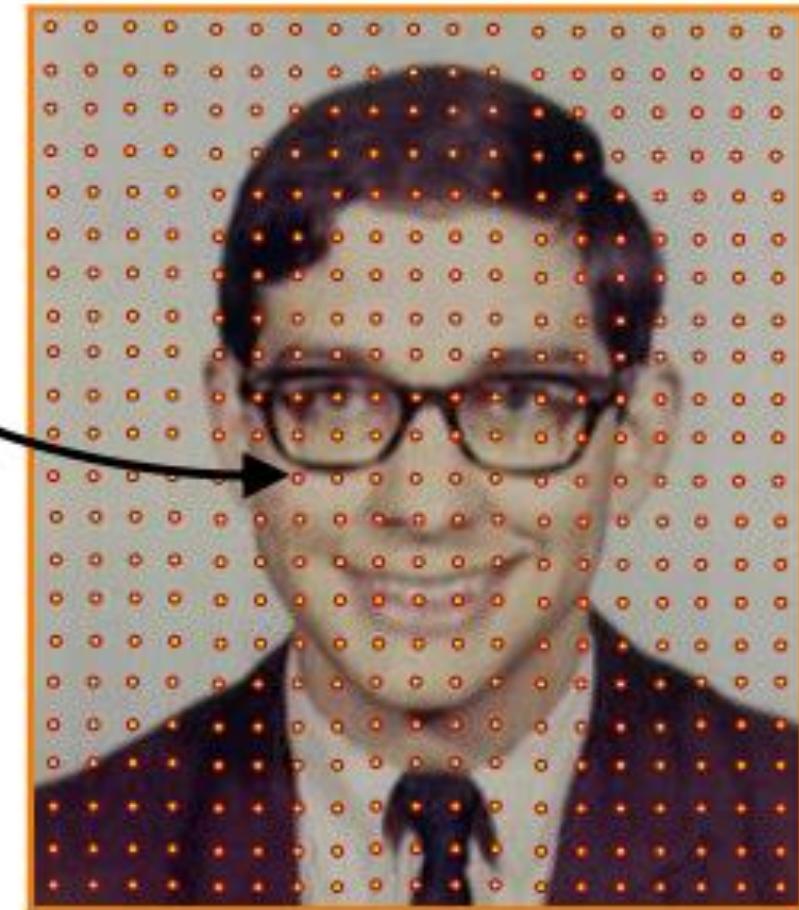
Mingzhai Sun
Joshua Shaevitz

Art of Science
(Friend Center hallway)

Pixel - What Function?

What about photographic images?

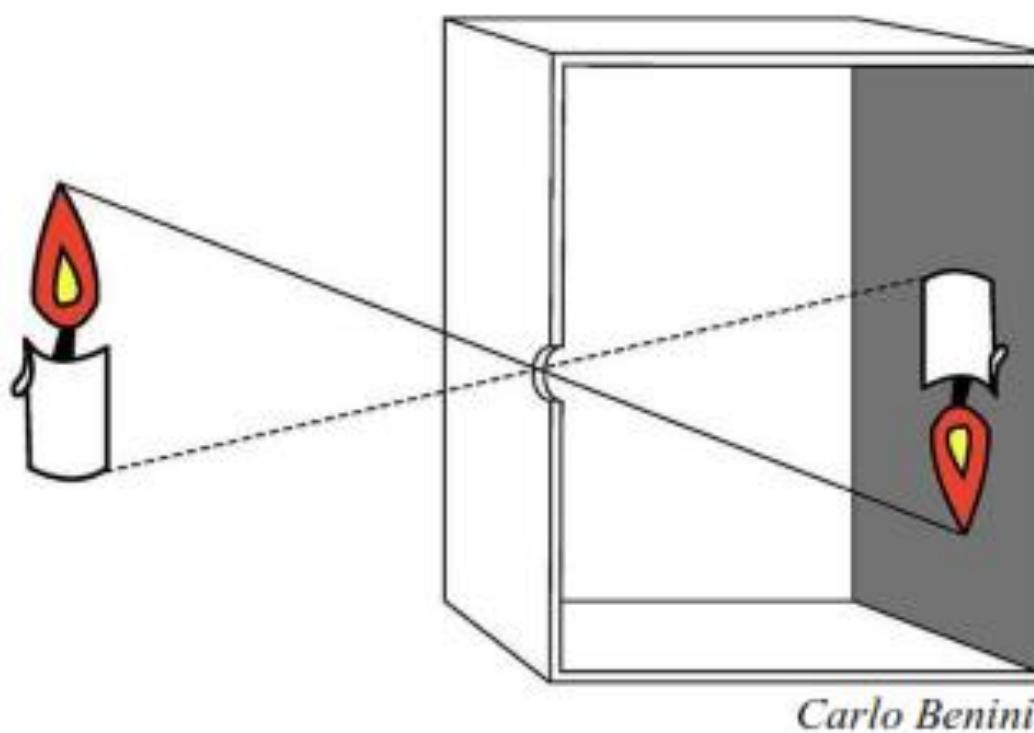
$I(x,y)?$



Digital photograph

Pixel - Plenoptic Function

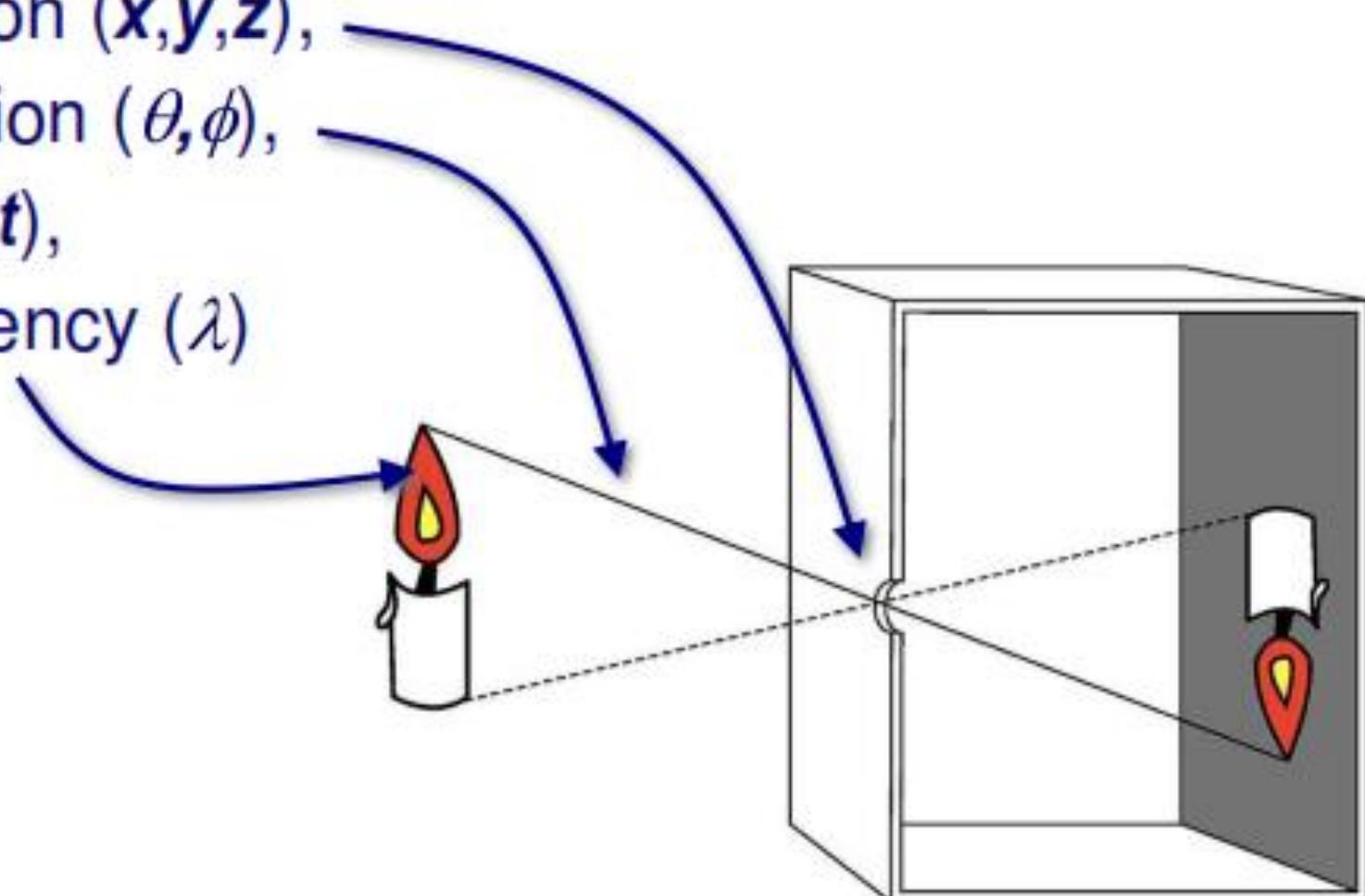
Each pixel of a photographic image is a function of radiance arriving at a sensor.



Pixel - Plenoptic Function

The 7D plenoptic function $L(x,y,z,\theta,\phi,t,\lambda)$ describes the radiance arriving ...

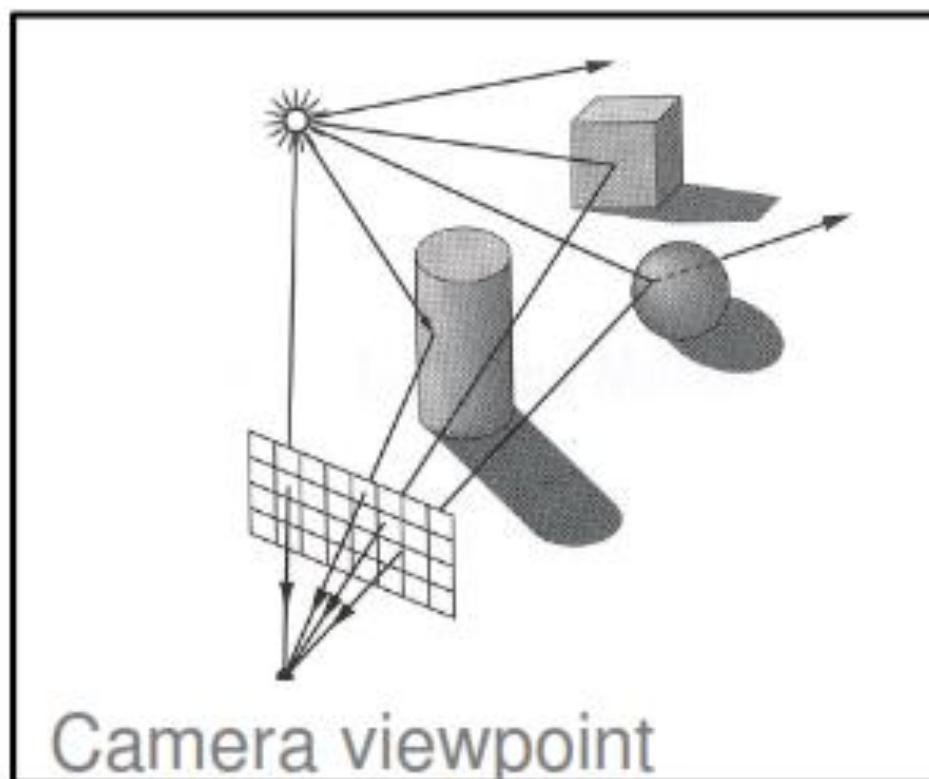
- at any position (x,y,z),
- in any direction (θ,ϕ),
- at any time (t),
- at any frequency (λ)



Pixel - Photographic Images

An idealized photographic image contains a 2D array of samples of the 7D plenoptic function

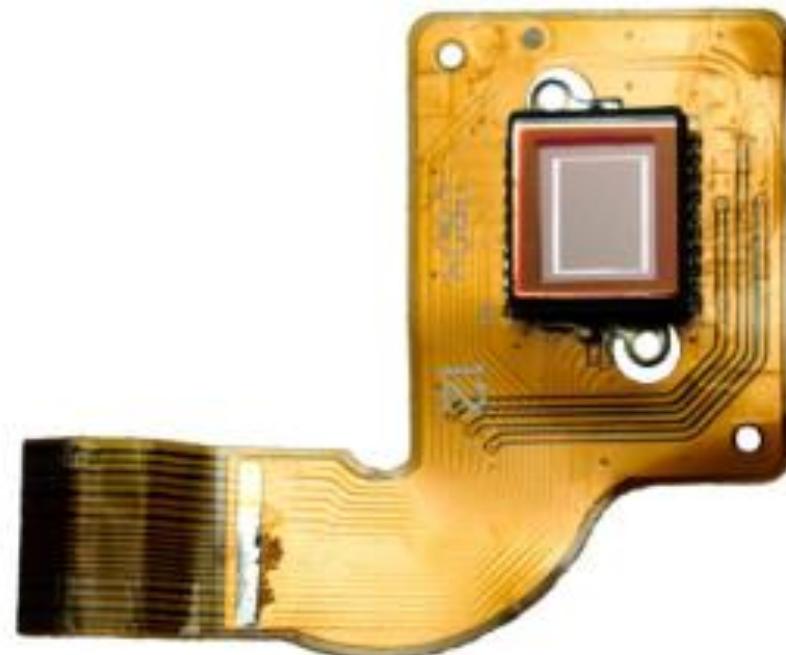
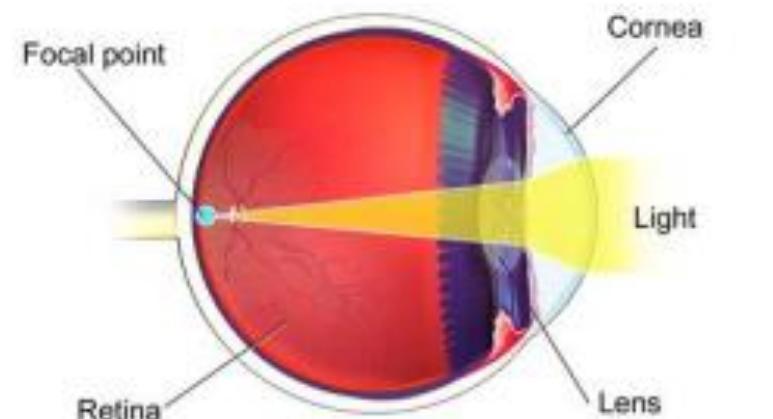
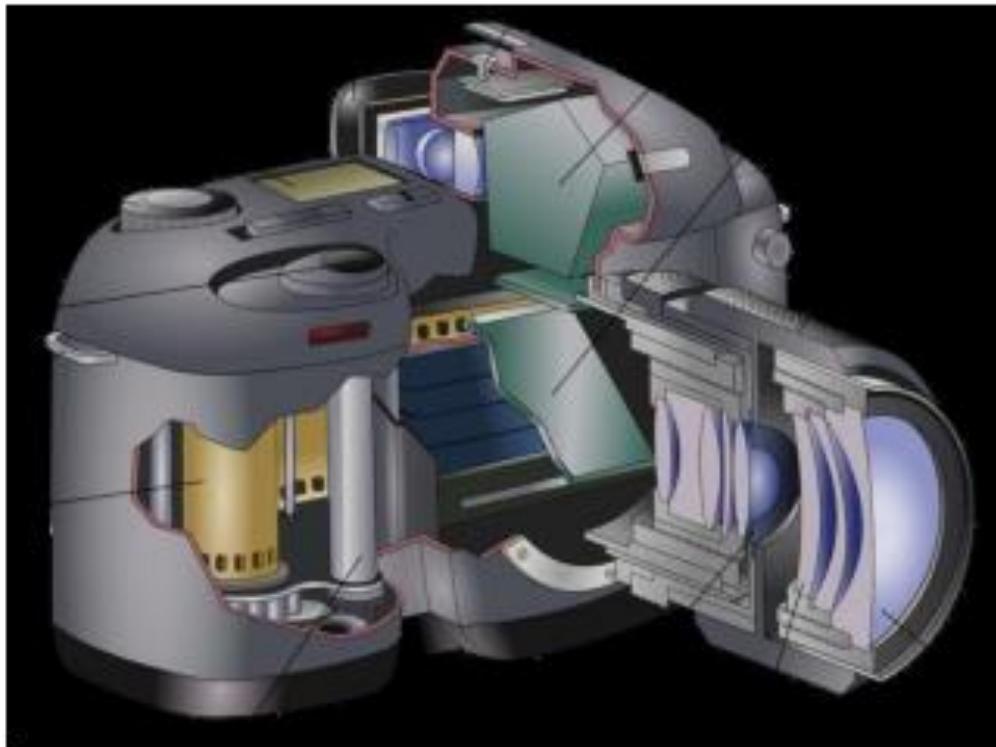
- at a particular camera viewpoint,
- for 2D array of directions,
- at a certain time,
- at certain frequencies



Pixel - Photographic Images

In practice, can't measure plenoptic function directly

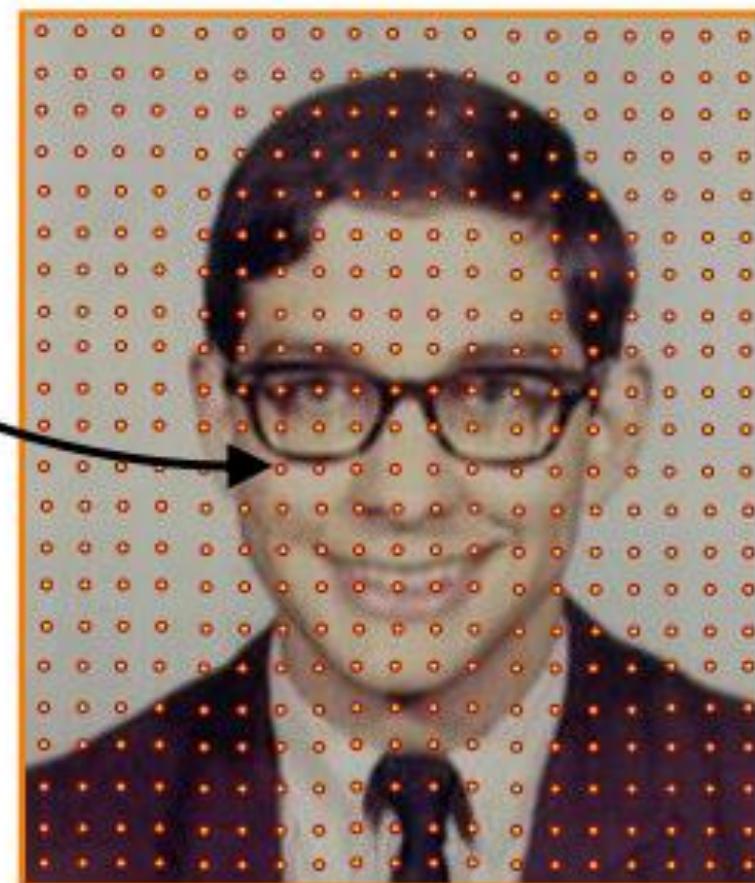
- Photoreceptors in eye
- Film in a traditional camera
- CCD cells in digital camera



Pixel - Photographic Images

Photographic pixels as finite samples of the plenoptic function

$$f(x,y,z, \theta, \phi, t, \lambda)$$



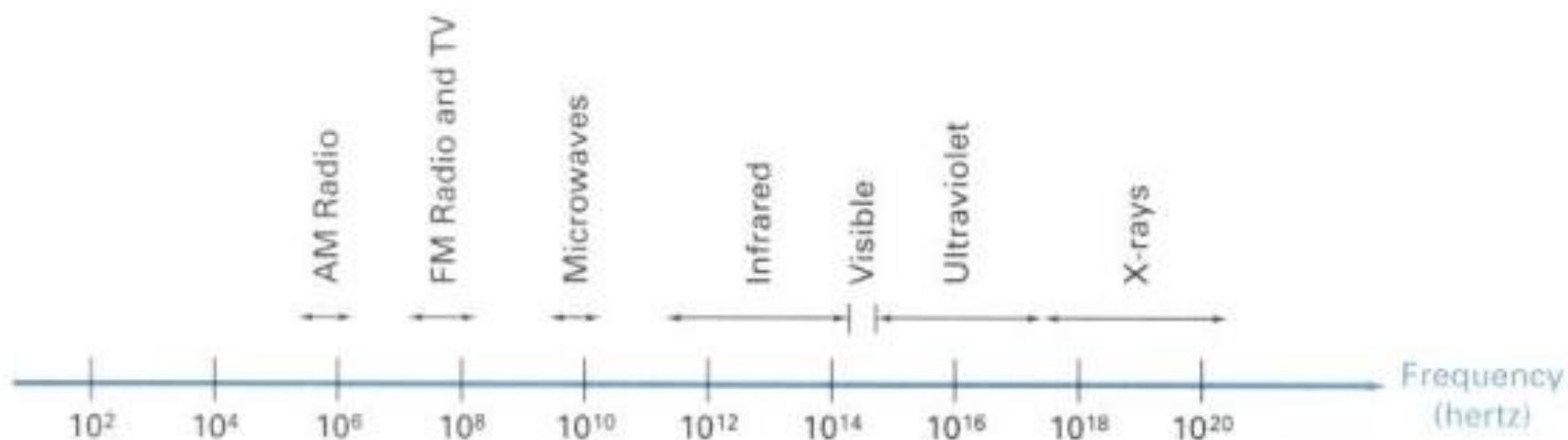
Digital photograph

Pixel - Photographic Images - What Frequencies?

$$f(x,y,z, \theta, \phi, t, \lambda)$$

Photographic Images - What Frequencies? – Electromagnetic Spectrum

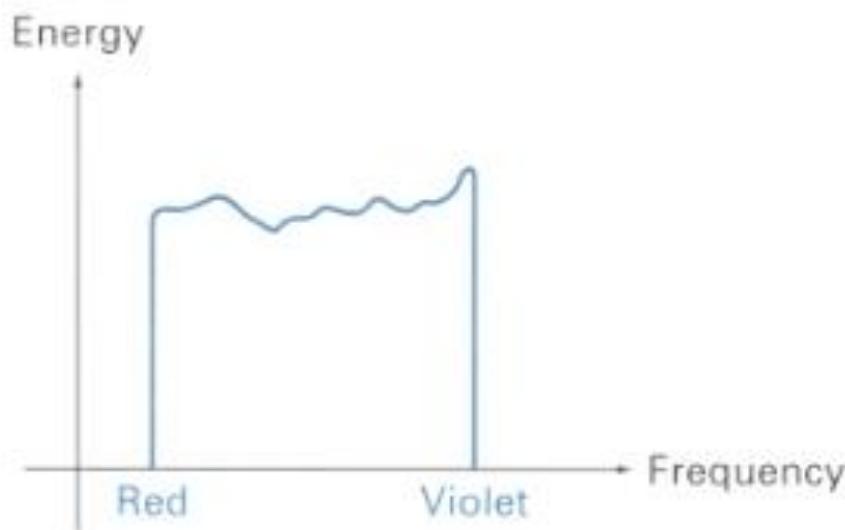
- Visible light frequencies range between ...
 - Red = 4.3×10^{14} hertz (700nm)
 - Violet = 7.5×10^{14} hertz (400nm)



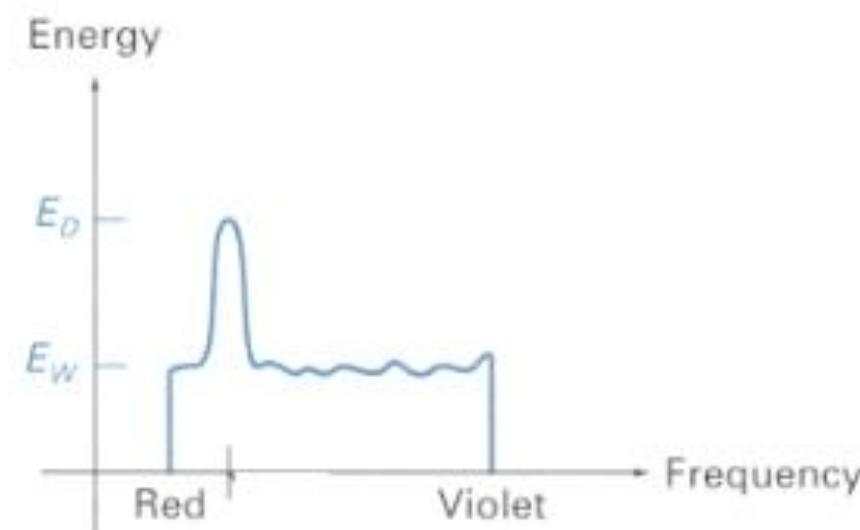
Photographic Images - What Frequencies? – Electromagnetic Spectrum - Color

The color of light is characterized by its spectrum

- Magnitude of energy at every visible frequency



White Light

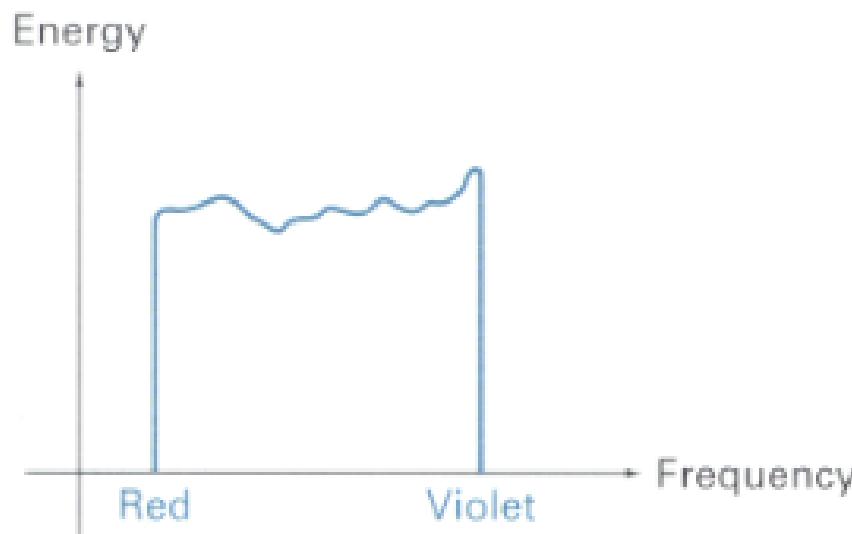


Orange Light

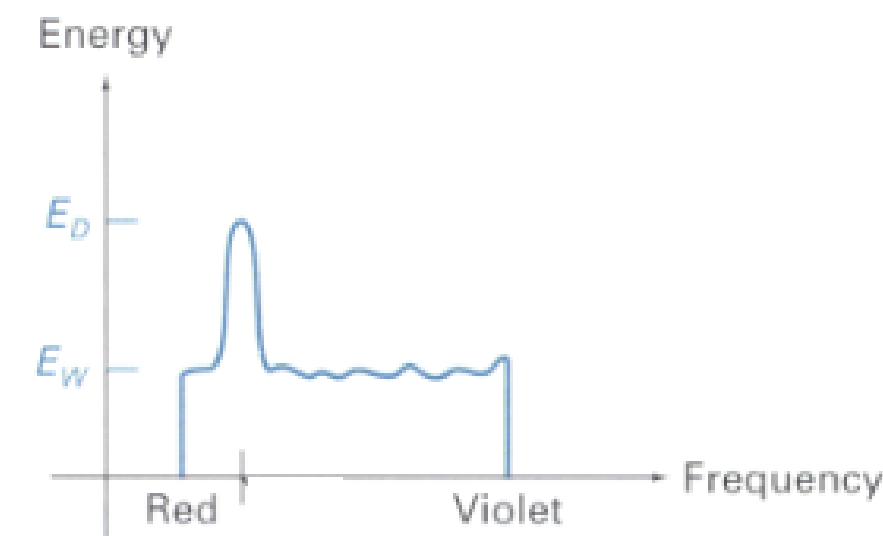
Photographic Images - What Frequencies? – Electromagnetic Spectrum - Color

How do we represent a color in a computer?

Must store a finite amount of data to represent magnitudes for infinite number of frequencies



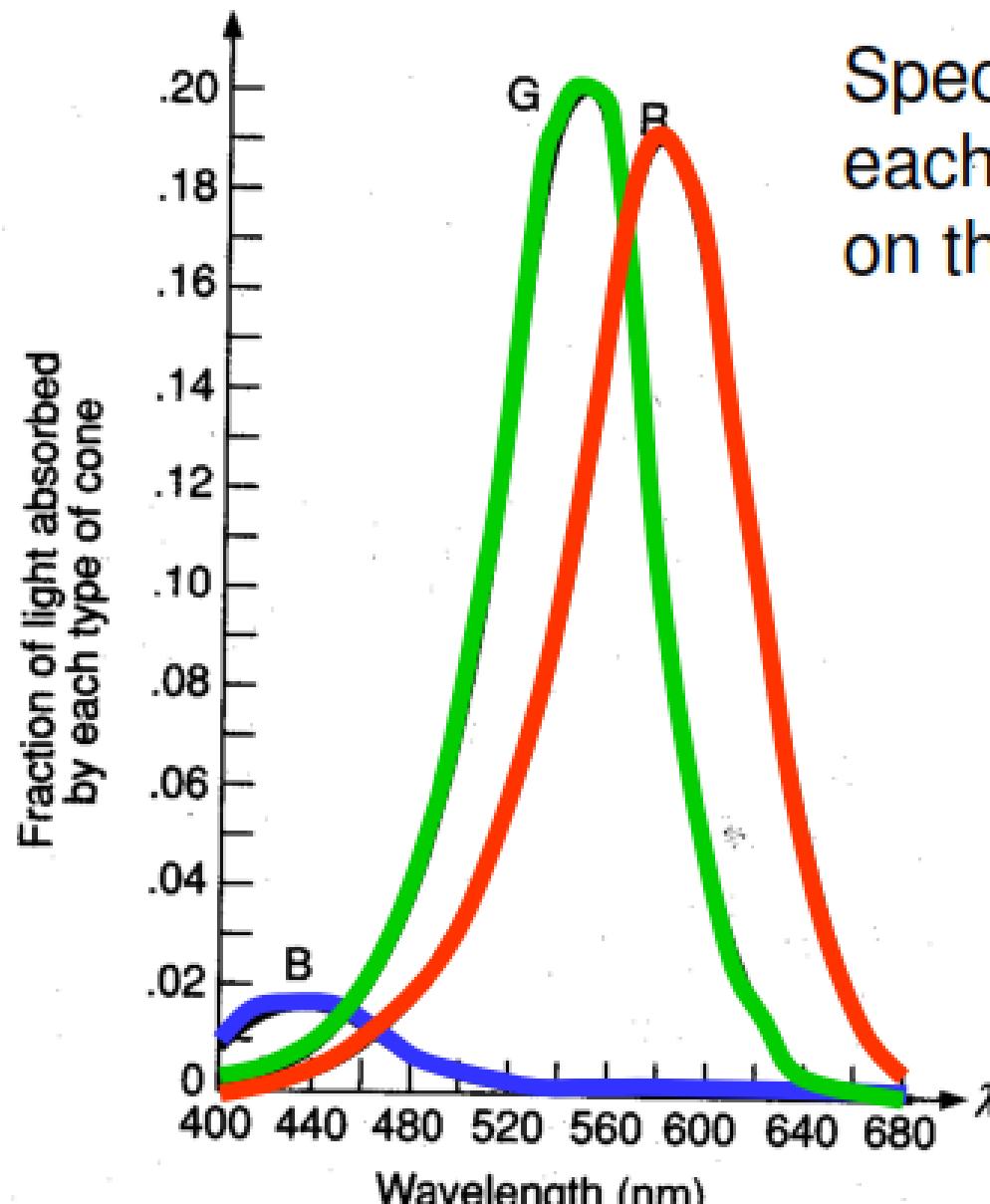
White Light



Orange Light

Electromagnetic Spectrum – Color – Why Red, Green and Blue (RGB)

Human Color Perception

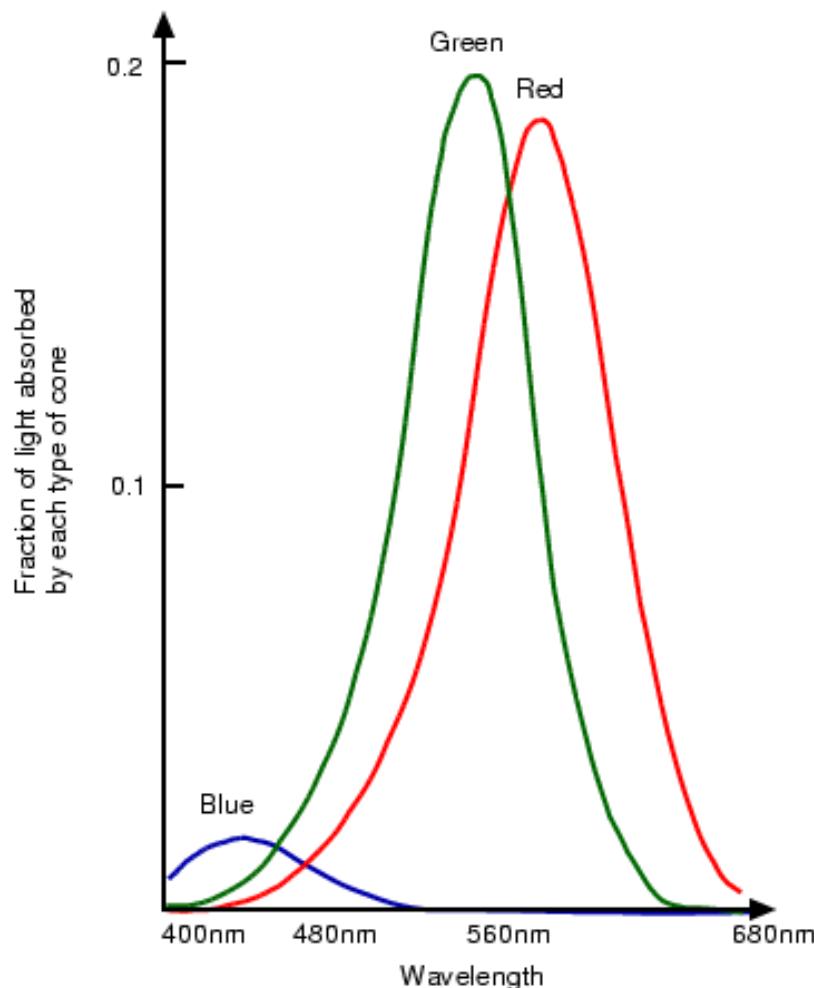


Spectral-response functions of each of the three types of cones on the human retina.

Tristimulus theory of color

Figure 13.18 from FyDFH

What Frequencies? – Electromagnetic Spectrum – Color – Color Frame Buffer



Spectral response curves for each cone type. The peaks for each curve are at 440nm (blue), 545nm (green) and 580nm (red).

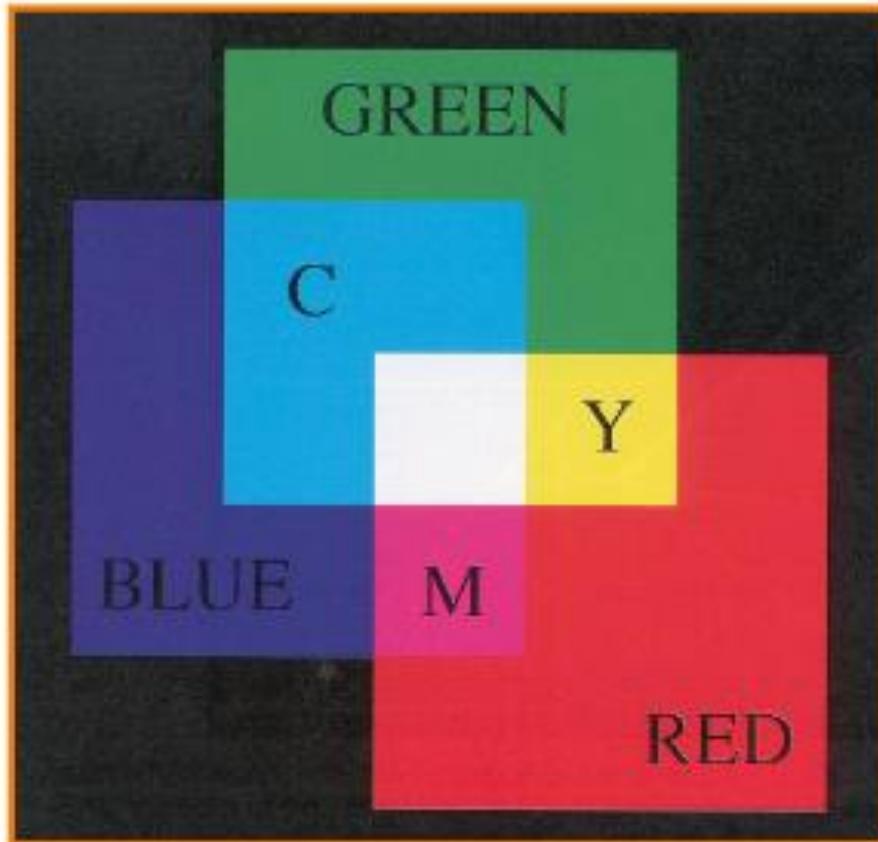
row		
		0
0	1	2
.392	.482	.576
.478	.63	.169
.580	.79	.263
.373	.60	.44
.443	.569	.376
		.306
		.478
		.561
		.674

column

channel

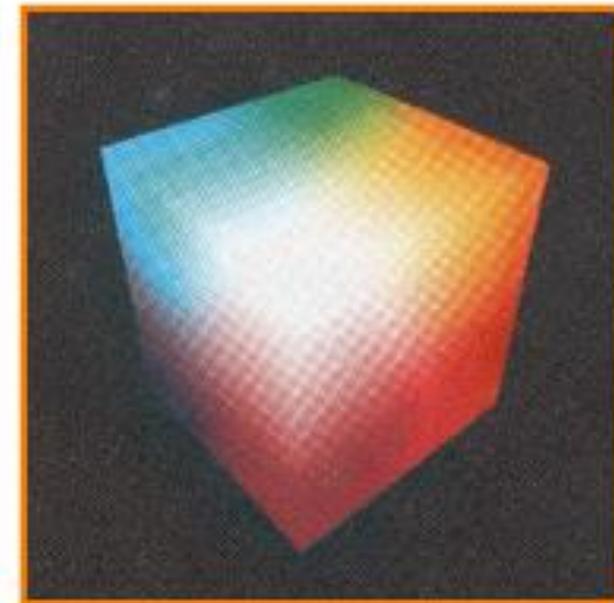
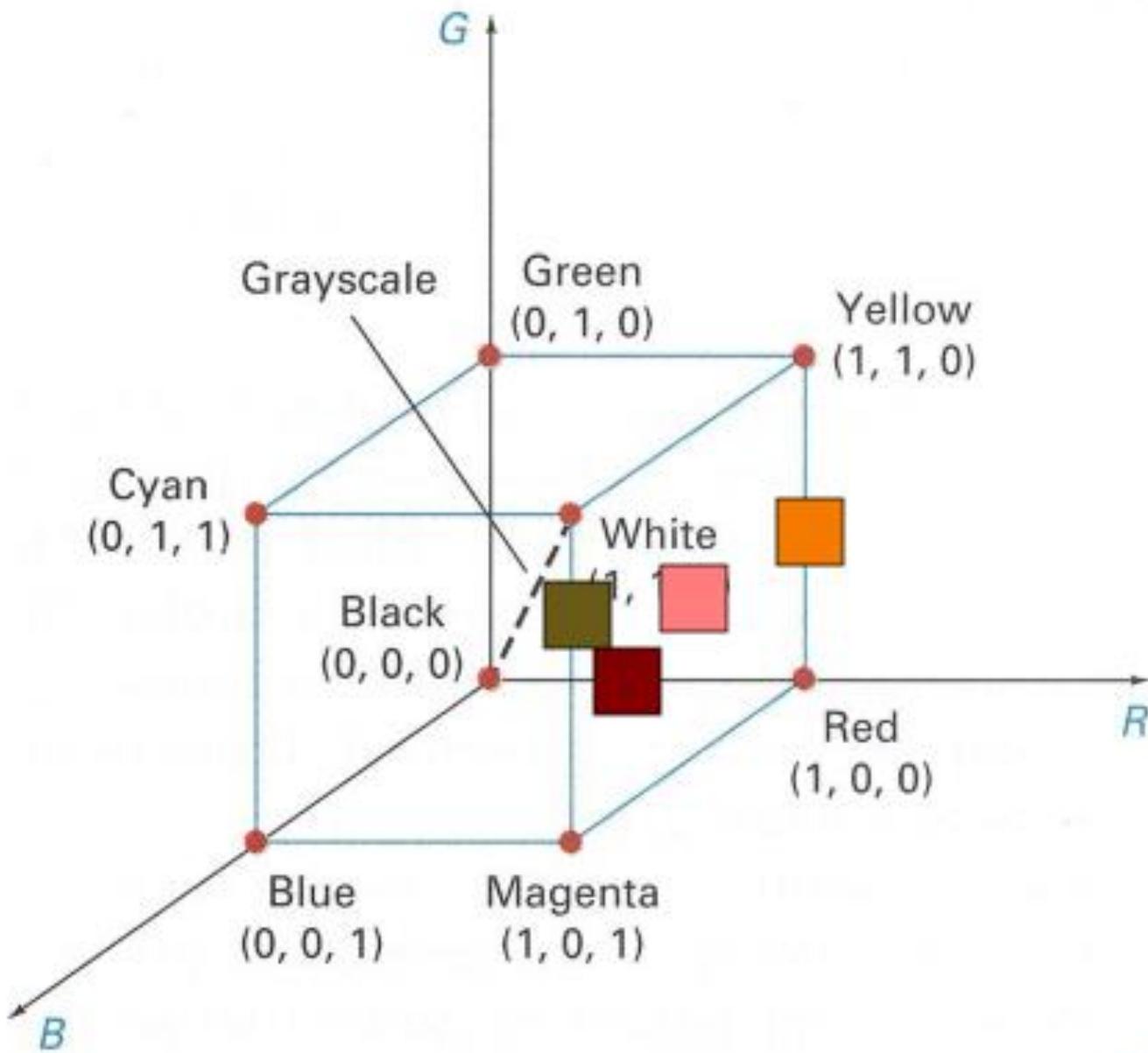
RGB color model

Electromagnetic Spectrum – Color – RGB Color Model



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	? 

Electromagnetic Spectrum – Color – RGB Color Cube



Figures 15.11&15.12 from H&B

Electromagnetic Spectrum – Color – Color Frame Buffer – Frame Buffer Display

- Video display devices
 - 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

Electromagnetic Spectrum – Color – Color Frame Buffer – Frame Buffer Display

Example: liquid crystal display (LCD)

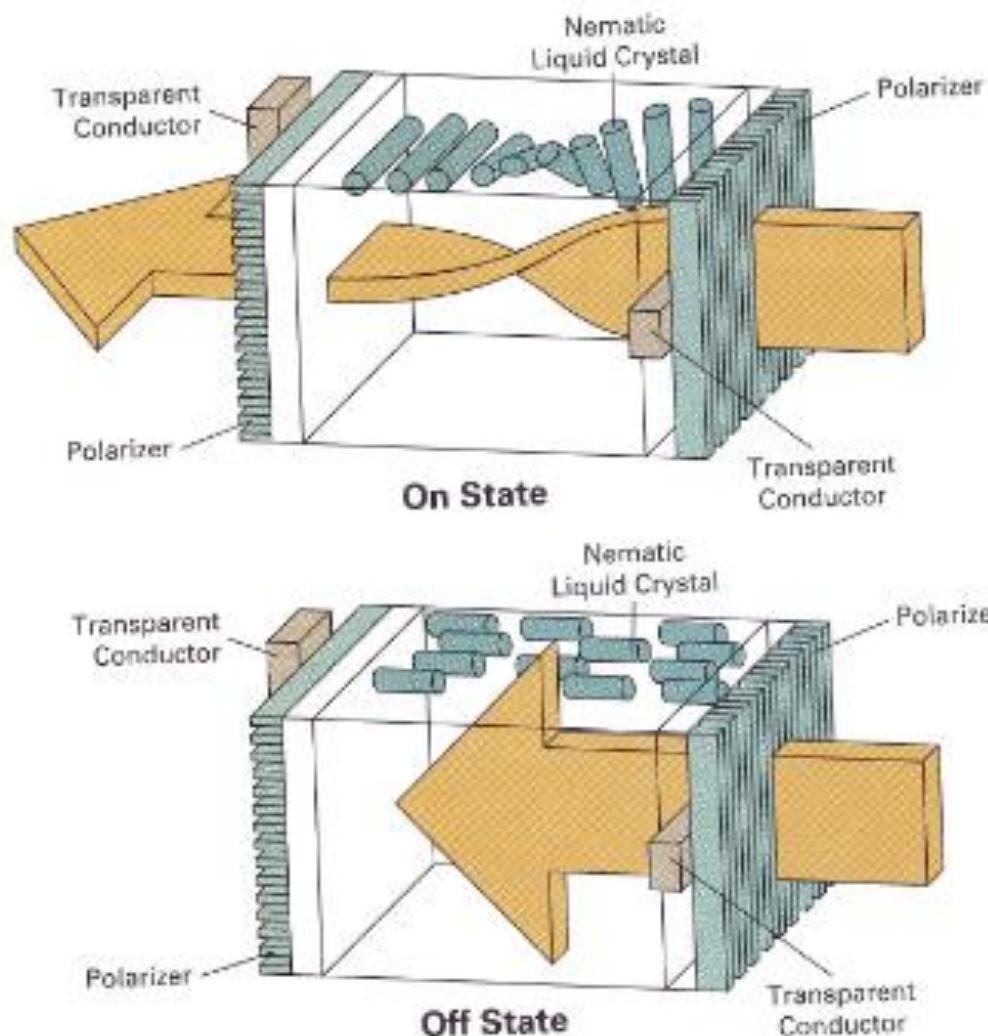


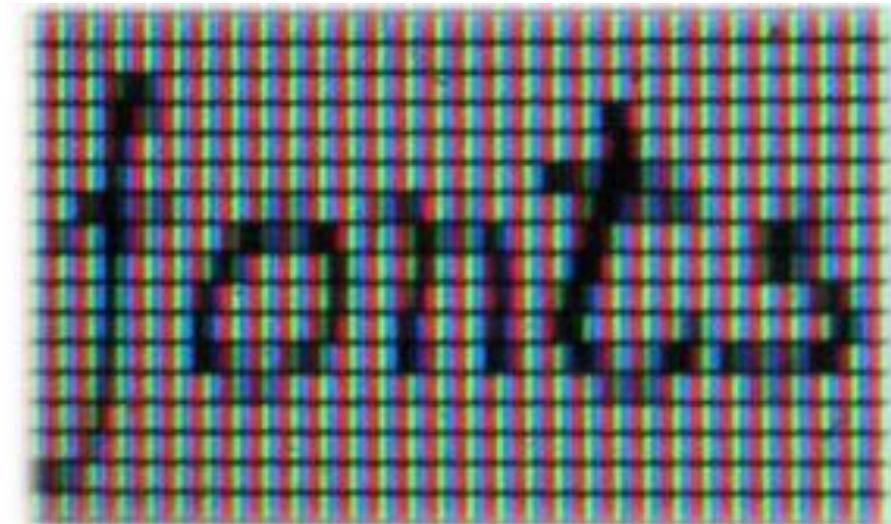
Figure 2.16 from H&B

Electromagnetic Spectrum – Color – Color Frame Buffer – Frame Buffer Display

LCD up close



Colors are interleaved



Electromagnetic Spectrum – Color – RGB Color Cube – Other Color Models

- CMY
- HSV
- XYZ
- La*b*
- Others

Different color models are useful for different purposes