



جامعة الملك عبد الله
للعلوم والتقنية
King Abdullah University of
Science and Technology

VCC VISUAL
COMPUTING
CENTER

Computer Graphics CS248

Raster Images

Ivan Viola

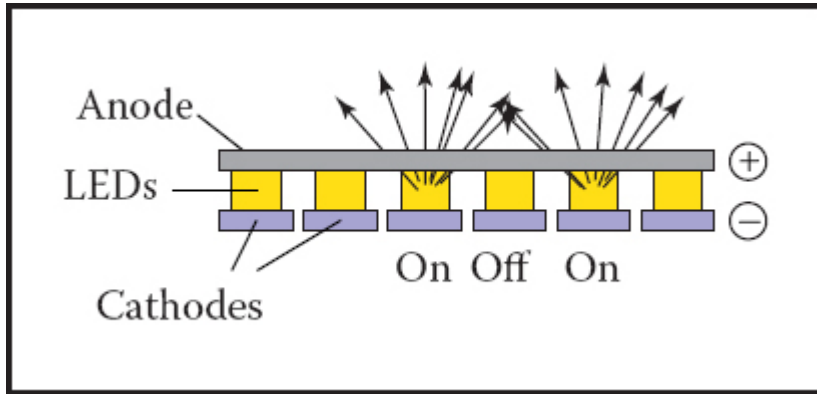
NANOVISUALIZATION GROUP

Discretized Representation: Image

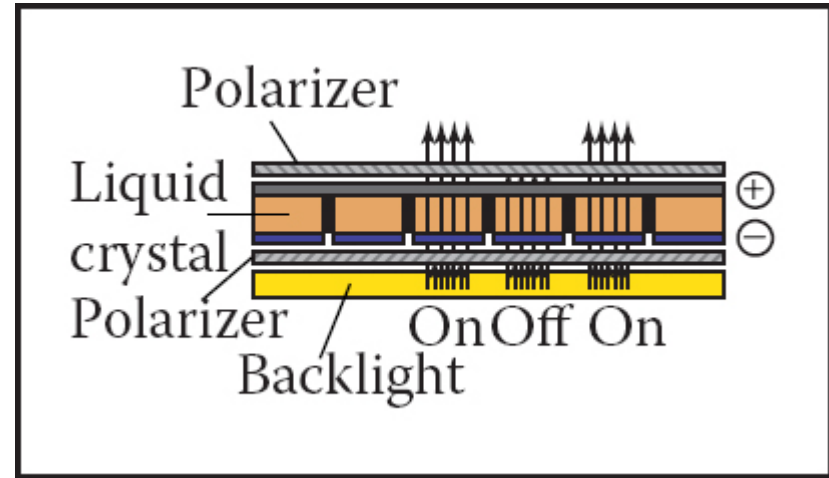
- Input devices: scanners, cameras
result in samples of the measured continuum
- Output devices: display, projector, printers
- Image is a grid of *pixels* (picture elements)
- Volume is a grid of *voxels* (volume elements)
- Resolution: (normalized) amount of samples

Displays

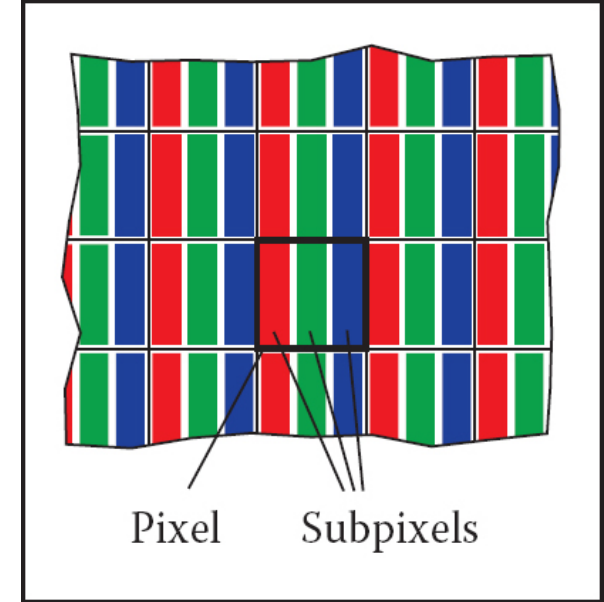
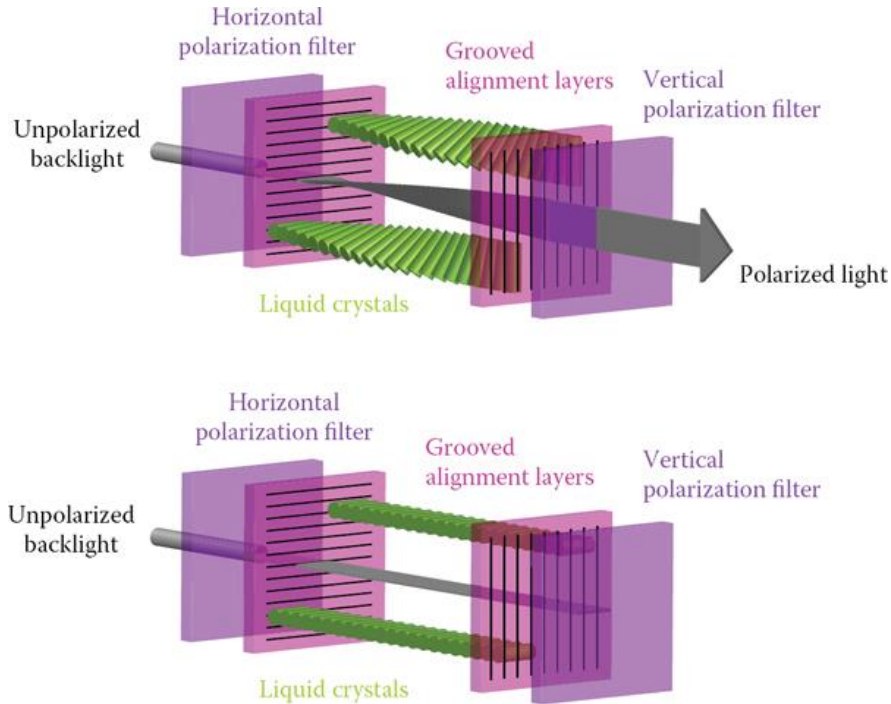
Emissive LED



Transmissive LCD



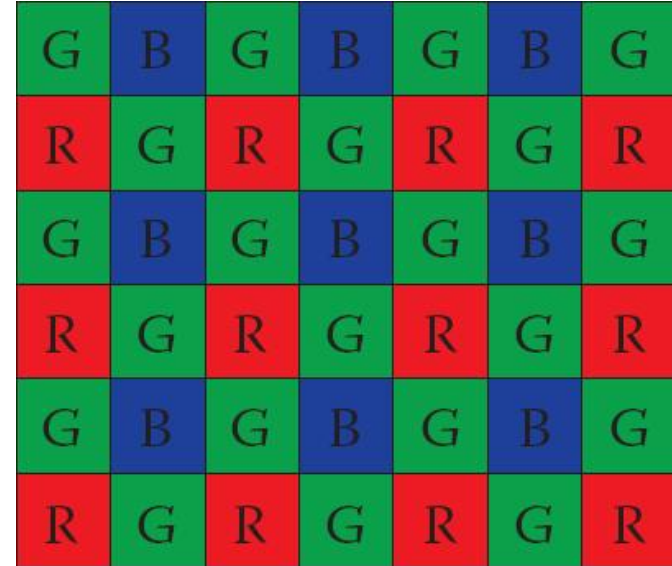
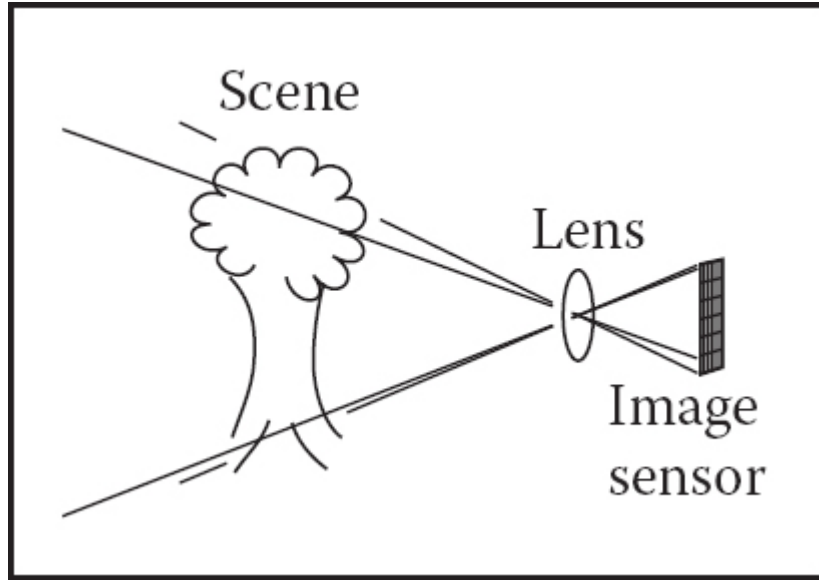
Displays (cont.)



Reinhard et al.: Color Imaging: Fundamentals and Applications, CRC Press, 2008

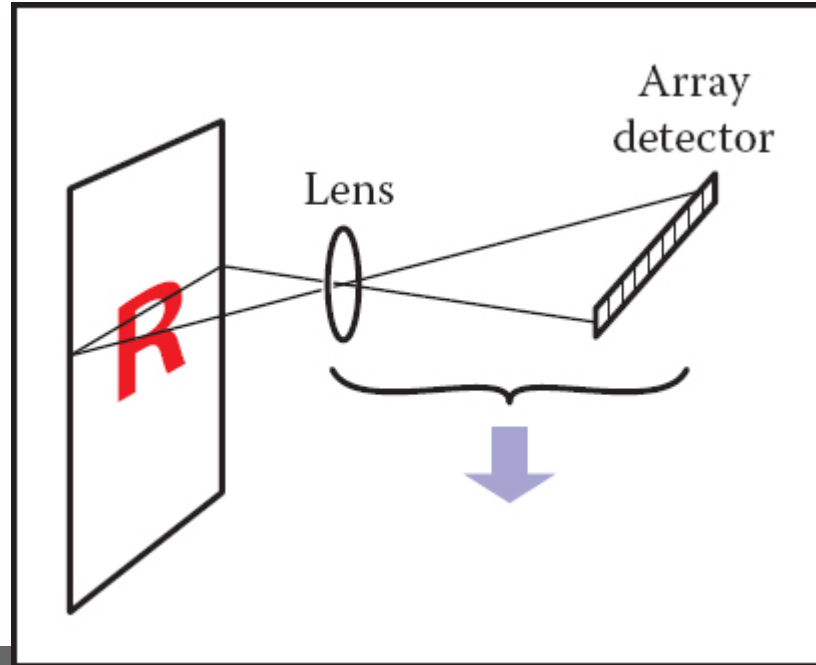
Input Devices

Digital camera: 2D raster input device



Input Devices (cont.)

Flatbed scanners: 1D raster input device



Formalizing Images

Definition:

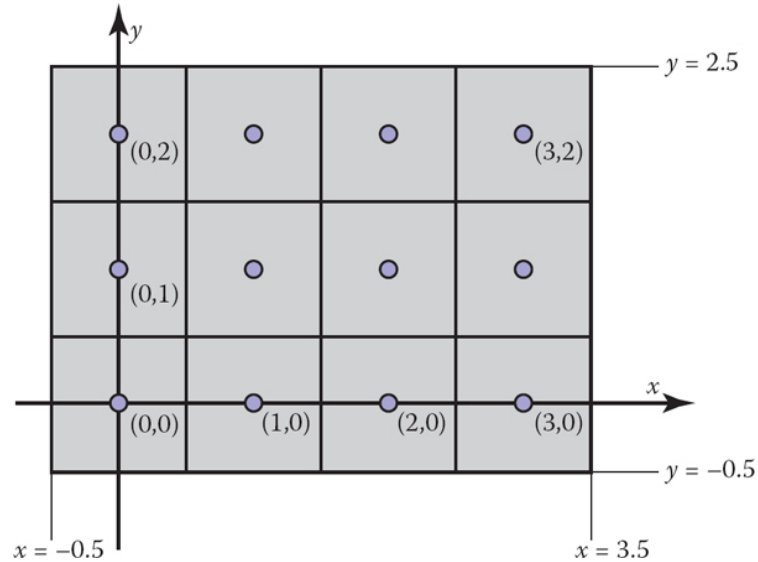
$$I(x, y): R \rightarrow V, \text{ where } R \subset \mathbb{R}^2, V \subset (\mathbb{R}^+)^3$$

Indexing: (i, j) column (i) , row (j)

bottom-left \rightarrow top-right: $(0,0) \rightarrow (n_x - 1, n_y - 1)$

Formalizing Images (cont.)

$$R = [-0.5, n_x - 0.5] \times [-0.5, n_y - 0.5]$$



Pixel Bit Depth

- Megapixel means 10^6 not 2^{20} !
- 32-bit floating point / channel in range $[0,1]$
- Low dynamic range displays 8-bit depth
→ byte resolution sufficient
- High dynamic range uses 32-bit floating point

Common Formats

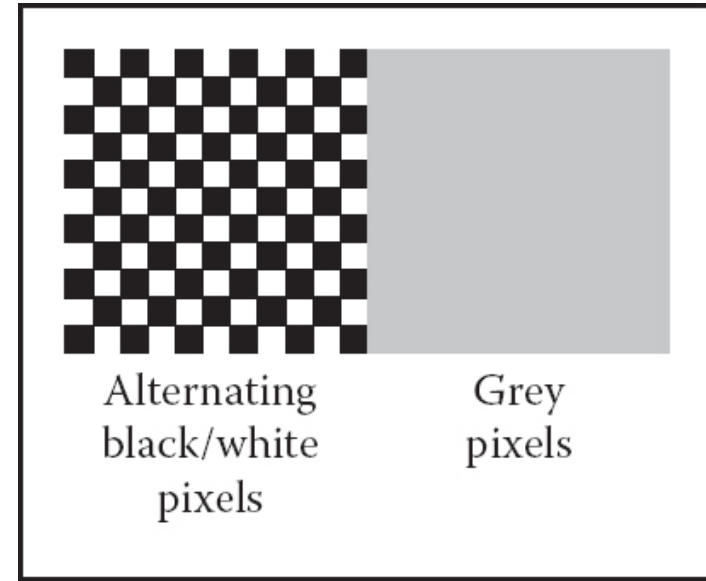
- 1-bit bitmap for black-and-white images
- 8-bit RGB fixed range color – LDR graphics
- 10-bit RGB fixed range color – displays
- 12-16 bit RGB fixed range – raw camera image
- 16-bit grayscale fixed range – medical imaging
- 32-bit RGB floating point – internal representation

Resolution Artifacts

- Clipping floating point value above 1 to a fixed-range maximal value
- Quantization artifacts if the bit depth is too low resulting into banding

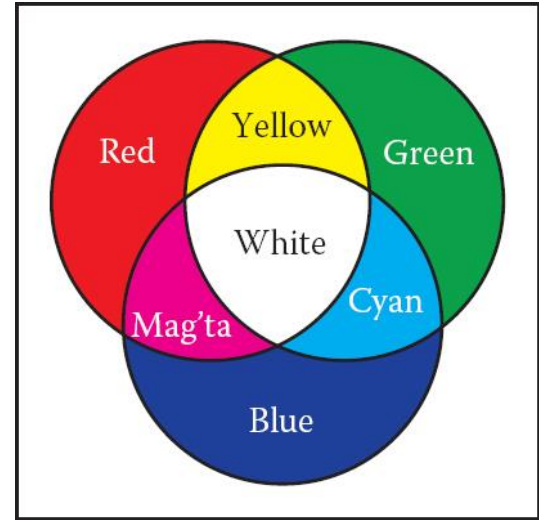
Monitor Intensities

- 0 value corresponds to black, 1 to white
- 0.5 halfway gray
- $I_d = I_{max}a^\gamma$
- Gamma estimation
$$0.5I_{max} = I_{max}a^\gamma$$
- Gamma correction $a' = a^{\frac{1}{\gamma}}$



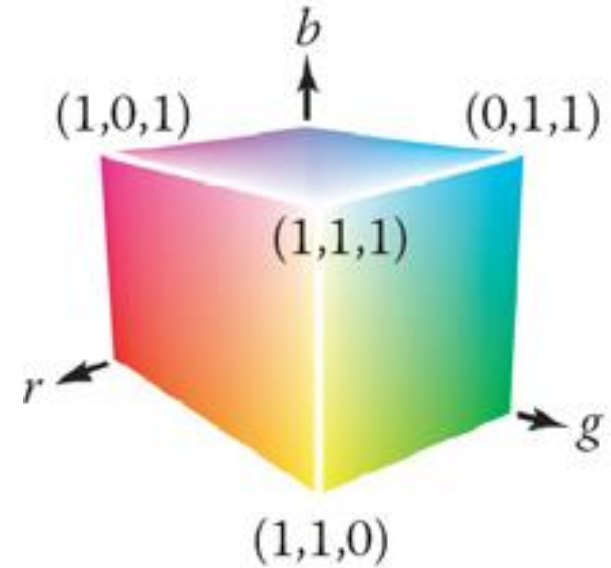
RGB Color Space

- Additive Color Mixing: $W = R + G + B$
 $Y = R + G, C = B + G, M = B + R$
- Three different colors mixed with all available intensities form a 3D color space



RGB Color Space (cont.)

- RGB Space coordinates
 $K = (0,0,0)$, $R = (1,0,0)$,
 $G = (0,1,0)$, $B = (0,0,1)$,
 $C = (?, ?, ?)$, $M = (?, ?, ?)$,
 $Y = (?, ?, ?)$, $W = (?, ?, ?)$
- $? = (0.3, 0.3, 0.3)$



Alpha Compositing

- $C_c = \alpha C_f + (1 - \alpha)C_b$
- Compositing a semitransparent foreground object on background
- Antialiasing for partially covered pixel area
- Alpha mask / alpha channel

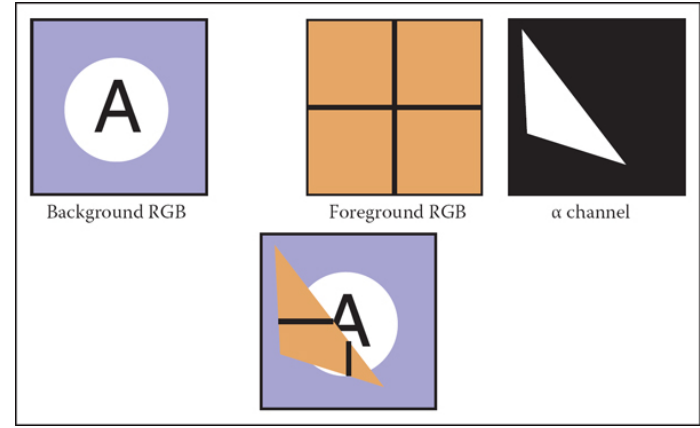
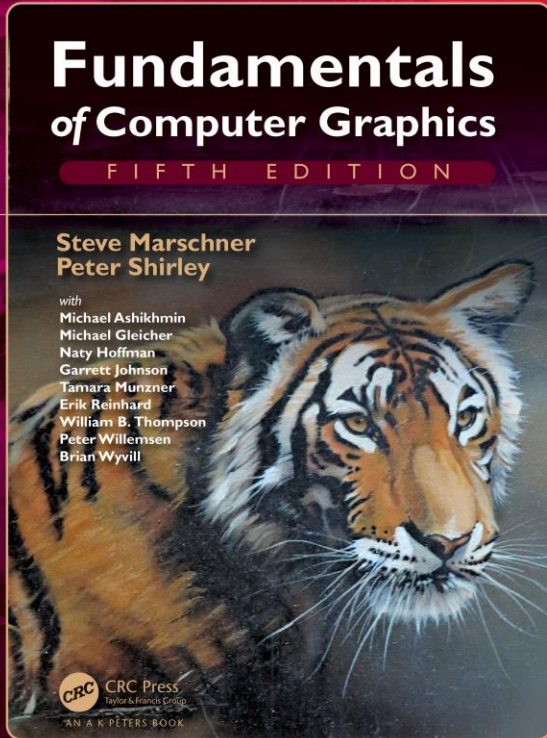


Image Formats

- Joint Photographers Expert Group (JPEG):
perception-inspired lossy compression
- Tagged Image File Format (TIFF):
lossless compression various formats
- Portable Pixmap (PPM):
simple uncompressed format
- Portable Network Graphics (PNG):
lossless compression with alpha channel



Credits



Fundamentals of Computer Graphics, 5th Edition

by Peter Shirley, Steve Marschner

Publisher: A K Peters/CRC Press

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ISBN: 9781000426359

<https://learning.oreilly.com/library/view/fundamentals-of-computer/9781000426359/>

