

CSE 564: Visualization

Image Basics

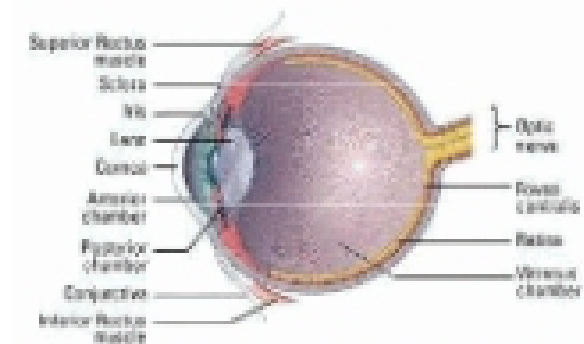
Klaus Mueller

Computer Science Department

Stony Brook University

Human Eye

Two types of receptors on retina: rods and cones



Rods:

- spread all over the retinal surface (75 - 150 million)
- low resolution, no color vision, but very sensitive to low light

Cones:

- a dense array around the central portion of the retina, the fovea centralis (8 - 7 million)
- high-resolution, color vision, but require brighter light

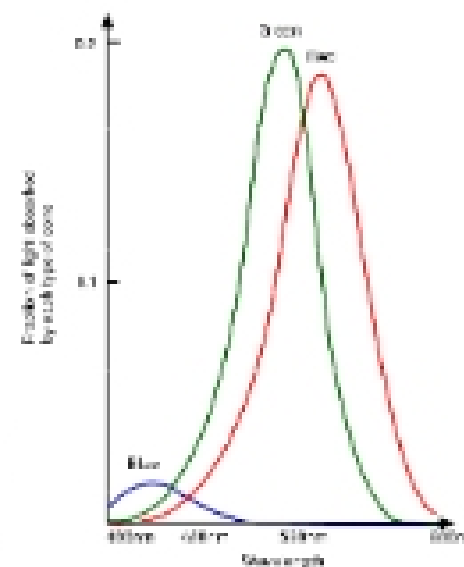
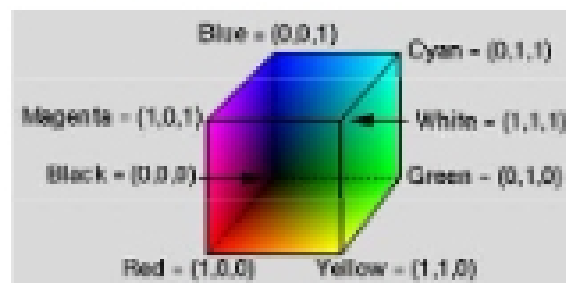
Color Perception

Tristimulus Theory:

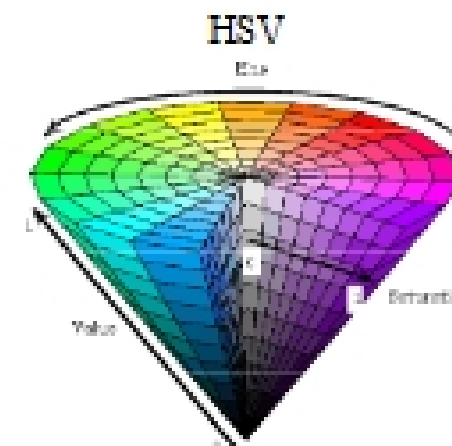
- the eye has three types of color receptors: Red, Green, Blue.

Color reproduction:

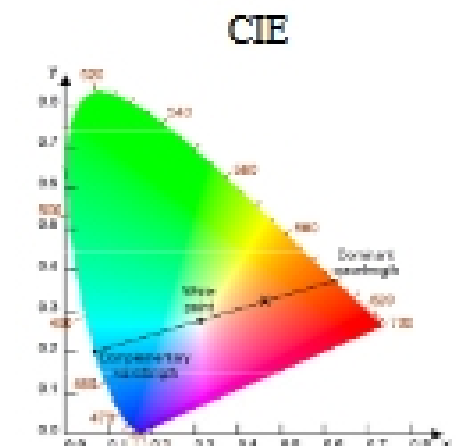
- one can generate (almost) any color on a monitor by mixing three primaries, RGB
- CRT monitor have 3 color guns: RGB



Color Spaces

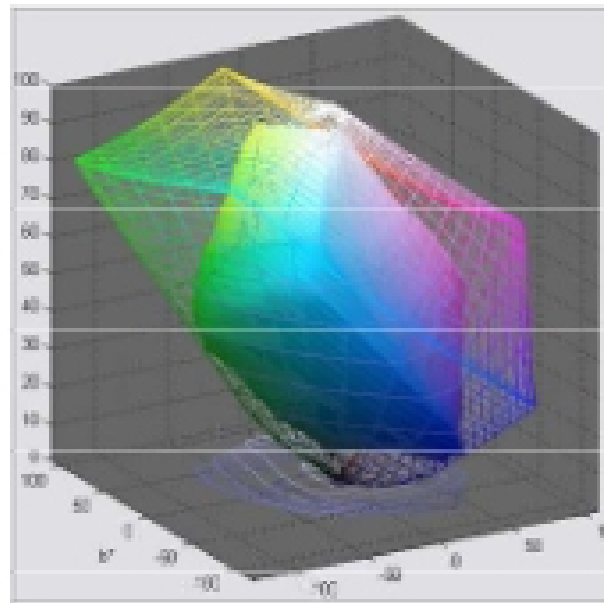


Hue: color
Saturation: peak from white light
Value: overall integral across all λ



CIE $L\alpha\beta$: equal distances mean equal perceptual differences

CIE LAB Space



L
(Perceived brightness)

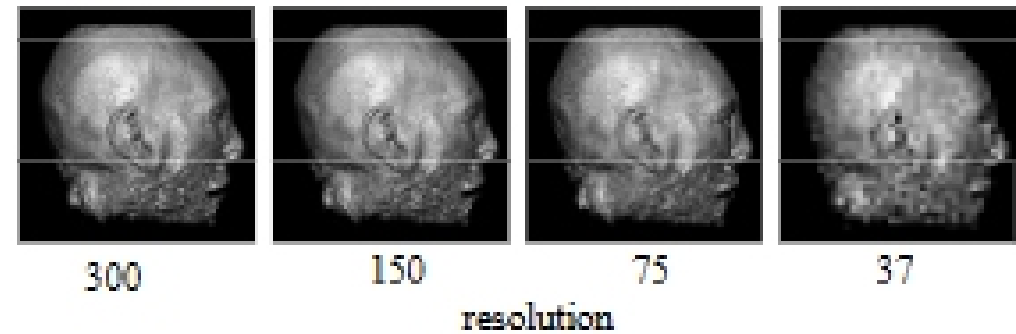
Digital Image

Image:

- 2D matrix of pixels

Image resolution:

- number of pixels along each matrix dimension



Each pixel has a value:

- a single value if greylevel image
- a triple RGB if color image

Dynamic Range

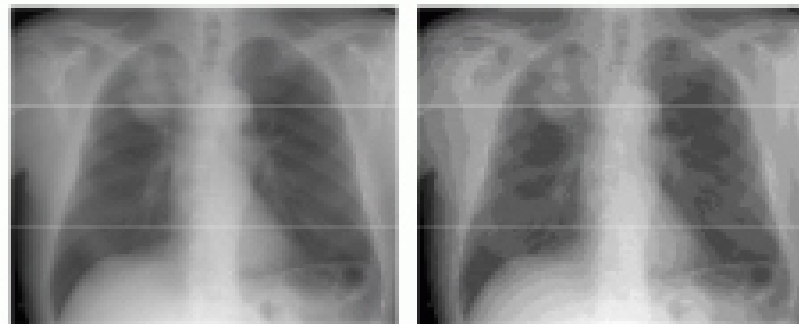
Each pixel is represented by a number of bits

Quantization:

- process of discretizing a continuous value into bits

Minimal number of bits = 6 (64 greylevels or 4 levels for R,G,B)

- most medical digital images have 12 bits (4096 grey levels)



8 bits

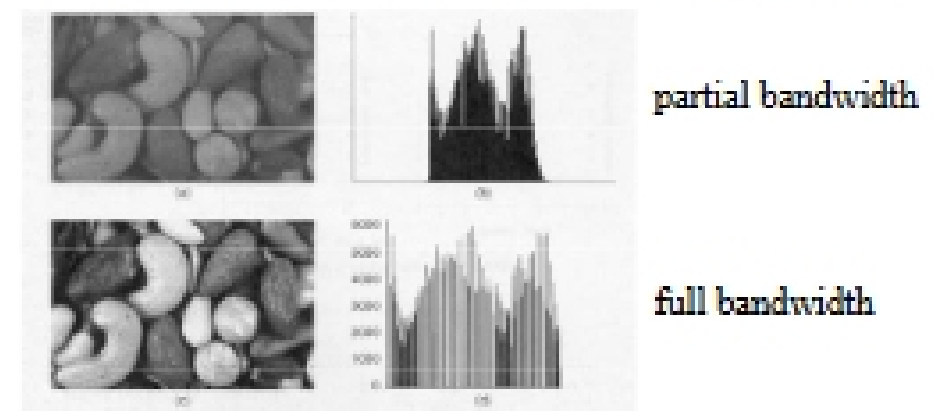
4 bits

- not enough bits leads to quantization artifacts and loss of resolution

Histogram

A histogram counts the number of pixels at each greylevel

- $h(v)$ = number of pixels having grey value v / total number of pixels

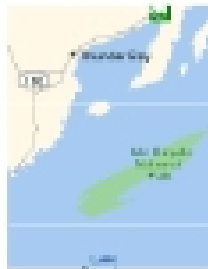


Good contrast requires a histogram with full bandwidth

Contrast

Difference of brightness in adjacent regions of the image

- grey-level (luminance) contrast
- color contrast



Point Spread Function

Each pixel is not a sharp spike, but represented by a point spread function (PSF)

The PSFs overlap and form a continuous function (for the eye)

Smaller PSFs give sharper images

