Introduction to Medical Imaging

Definitions

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 (6 - 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 perception diagram](image_url)
**Color Spaces**

**HSV**

- **Hue**: color
- **Saturation**: peak from white light
- **Value**: overall integral across all $\lambda$

**CIE L\alpha\beta**: equal distances mean equal perceptive differences
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
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)

- not enough bits leads to quantization artifacts and loss of resolution
A histogram counts the number of pixels at each greylevel

- \( h(v) = \frac{\text{number of pixels having grey value } v}{\text{total number of pixels}} \)

Good contrast requires a histogram with full bandwidth
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
Contrast

Difference of brightness in adjacent regions of the image
• grey-level (luminance) contrast
• color contrast
Signal-to-Noise Ratio

Signal-to-Noise ratio (SNR) = \( \frac{S_{\text{RMS}}}{N_{\text{RMS}}} \)

- RMS: root mean square

![Image showing high and low SNR](image.png)

high SNR

low SNR
Flat Field Correction

- Without correction
- Flat field: noise and scratches
- With correction