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DIP Class Notes

20/08/2021

Lecture-2: Digital Imaging Fundamentals

Elements of Visual Perception:

↳ Human visual system

Cornea: Analogous to aperture [controls exposure of light]

Lens: Absorbs 8% of visible light spectrum, IR, UV

Retina: Has sensors/receptors known as

1) Rods: Sensitive to low illumination levels
2) Cones: Long, Short, Medium } Based on wavelength they're sensitive to [colors]

Most cones in foveal region.

Fovea: Circular (assumed to be sensor array

Image formation:

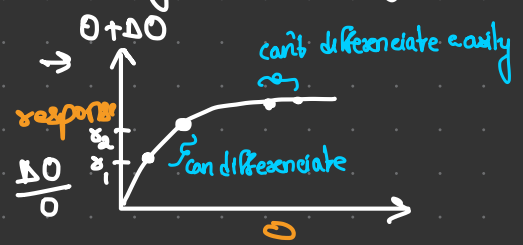
→ Eye lens is flexible by ciliary muscles

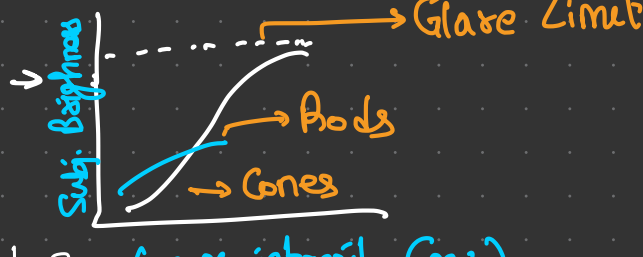
→ Flattens to focus on distant objects & tightens for close vision

→ Focal length: 14-17mm

Brightness Adaptation:

→ Dynamic range - 10^{-6} ↬ 10^{4}





Many behaviours are logarithmic [Webei's law]

Brightness Discrimination

↳ $\frac{\Delta I_c}{I}$ — ΔI_c: increment of illumination; I: Background Illumination

Larges weber ratio ⇒ bad discrimination

Smalles weber ratio ⇒ good discrimination

Psychovisual effects

simple

↳ Perceived brightness isn't a function of intensity

Examples: Optical illusions

Image sensing & acquisition:

→ Light energy is given as input to a sensor which converts it to voltages

→ Minimum threshold of light is needed for voltage

→ Voltage saturates after a certain level of light energy based on sensor material

→ Can use a linear/circular sensor strip

Lights can be expressed as particles (photons), can be seen in photo-electric effect.

$E = h\nu$

CMOS electric sensor is sensitive to 'light' & not 'color'

Bayer filters:

→ Put RGB filters to let respective colors pass

→ Helps in capturing colors

→ Why are there more green filters? [More Red ones in eyes]

↳ Humans are more sensitive to green so less cones

↳ Could be based on experiments

→ To get for each pixel, interpolation can be done

Demosaicing:

Combining outputs of R, G, B bayer filters to get colors of images.

Sampling & Quantisation:

→ Signal has infinite values, so to load them to computers we do sampling.

→ So, we do sampling at horizontal & quantise in vertical axis.

↓

Gives rise to digital signal.

→ 2-D Image signal can be taken as function of discretised space $f(x,y)$ [spatial sampling]

→ Videos are sampled by time also

→ Larger sensor size & high no. of pixels gives better image quality.

Aspect Ratio:

→ Length to Width

→ 720P ⇒ 16:9 AspectRatio ⇒ 1280×720 where lower aspect has 720P

Intensity Quantisation:

8 bits/pixel → 4 bits/pixel → 2 bits/pixel → 1 bit/pixel

Quantisation:

→ Hardware: # of voltage levels, # of bits

→ Software: Raw → JPEG