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Course Requirements and Grading
6 Homeworks/Lab Exercises 30%
2 Subjective experiments 5%
Midterm 20%
Final Exam 45%
The midterm and final will be in class, open book and open notes


Prerequisites: Familiarity with Matlab (or willingness to learn!) Basic knowledge of linear algebra, linear systems, Fourier Transforms. Read Chapter 1 in the textbook for a general overview of image processing.

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Radiometric and Photometric Quantities and Units
from Digital Pictures by Netravali and Haskell, and Digital Image Processing by Pratt

*Radiometry* is concerned with physical intensity measurements of electromagnetic energy.

*Photometry* seeks to quantitatively describe the perceptual brightness of visible electromagnetic energy.

**Radiant energy,** $Q$, is the energy propagating in the form of electromagnetic radiation and is measured in **Joules**.

**Radiant flux,** $\Phi$ is the radiant power or time rate of flow of radiant energy, and is measured in $\text{Watts} = \text{Joules} / \text{sec}$.

**Radiant exitance,** $M$, is the density of radiant flux, measured in $\text{Watts} / \text{meter}^2$.

**Irradiance,** $E$ is a restricted case of exitance and denotes density of radiant flux incident on a surface.

**Radiant intensity,** $I$ is the radiant flux per unit solid angle in a given direction. It is measured in $\text{Watts} / \text{steradian}$.

**Radiance,** $L$ is the radiant flux per unit of projected area and per unit solid angle either leaving a point in a given direction, or arriving at a given point in a given direction. Its unit is $\text{Watts} / \text{steradian-m}^2$.

**Relative luminous efficiency** $y(\lambda)$ specifies the spectral sensitivity of the human visual system to optical radiation as a function of wavelength for a typical person ("standard observer"). $y(\lambda)$ is dimensionless.

![Photopic Luminosity Function](image1.png)

![Scotopic Luminosity Function](image2.png)
**Luminous flux** is a measure of the capacity of radiant flux to create a sensation of light. This is evaluated by multiplying by \( y(\lambda) \) and integrating over the visible spectrum:

\[
\Phi_v = \int_{380}^{780} \Phi(\lambda) y(\lambda) d\lambda
\]

\( \Phi_v \) can be measured in **watts**, or in **lumens** by using the scaling constant \( k_m = 680 \) lumens / Watt.

**Luminous intensity,** \( I_v \) is visible radiant intensity, and is given by

\[
I_v = k_m \int_{380}^{780} I(\lambda) y(\lambda) d\lambda \quad \text{in candelas}
\]

**Luminance,** \( L_v \) (visible radiance) is the luminous intensity per unit projected area, and is given by

\[
L_v = k_m \int_{380}^{780} L(\lambda) y(\lambda) d\lambda \quad \text{in candelas / m}^2
\]

Luminance is directional and determines the ability of a luminous object to produce an effect at a given point in space.

**Luminous energy,** \( Q_v \) or the quantity of light, is measured in **lumen-seconds**, also called **talbots**.

**Illumination,** \( E(\lambda) \) is the density of luminous flux incident upon a surface. It is measured in **lux** = lumens / m\(^2\) or in foot candles = lumens / ft\(^2\).

**Luminous exitance** is the density of luminous flux emitted from a surface with no regard to direction. A common unit for it is the **lambert** = lumens / cm\(^2\).

**Brightness** is a psychological term, referring to perceived luminance. It is a subjective descriptor.

Many of the terms above can be used for self-luminous sources, or for light reflected from an object, or for light transmitted through some translucent object. \( r(\lambda) \) and \( t(\lambda) \) are used to denote the wavelength dependent **reflectivity** and **transmissivity**.
Simultaneous contrast

The Benussi ring

Mach bands