About the course

Books

DIP by Gonzalez and Woods

Fundamentals of DIP by Jain

+ other sources

Assessment

2 mid semester exams* (30%) + 1 Final exam* (25%) = 55% (theory)

Weekly assignments* (25%) + 1 final project* (20%) = 45% (practice)

*If you fail to submit more than 1 assignment you will get 0/25 for the assignment component; If copying is detected, you get 0 marks for the assignment.

Portal for the course website http://courses.iiit.ac.in

Portal for Image processing virtual lab

http://deploy.virtual-labs.ac.in/labs/cse19/index.php

* Weights may change depending on the final numbers in the class

Visual information (in a digital image) processing: challenges

Why Image processing ?

- Proliferation of cameras
- Variety of uses for images
  - Personal, journalism/news, medical diagnostics, satellite, deep space probes, under water exploration…

Routine tasks of interest

Input

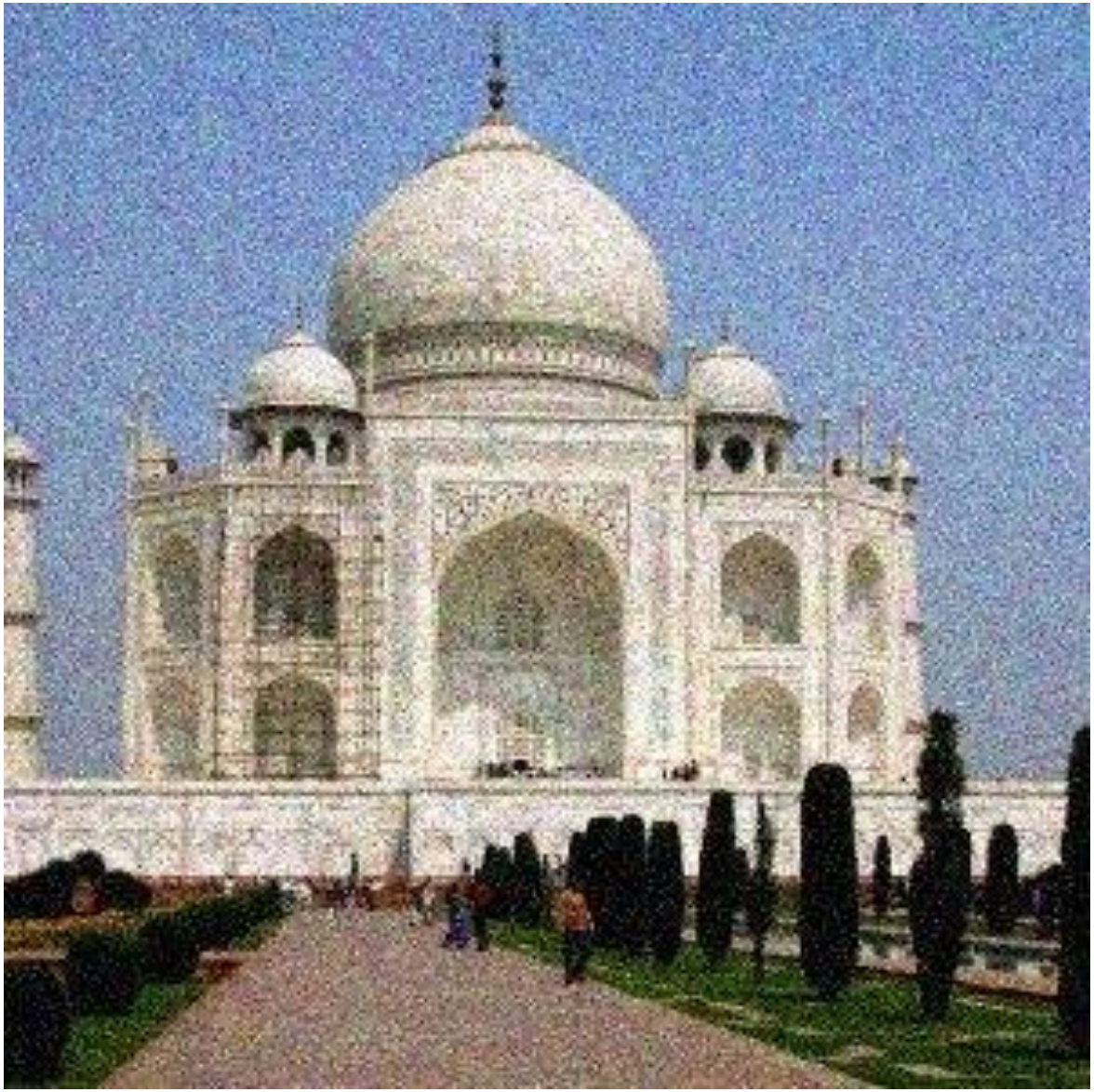
Processed output

Enhance the image

Input

output

Correct the view point



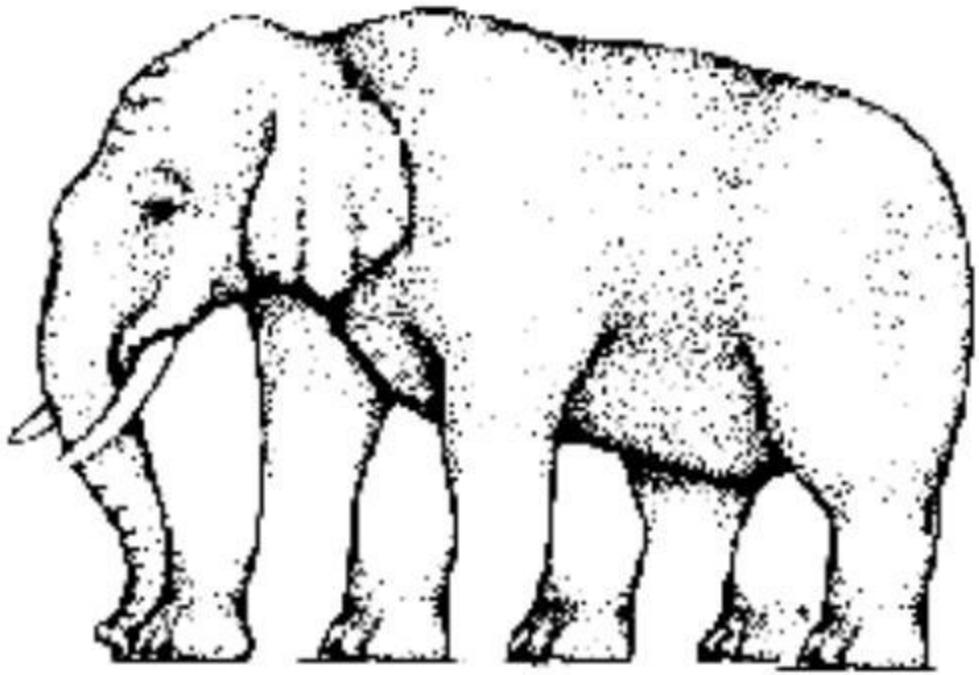
De-noise

De-blur

Higher order tasks of interest

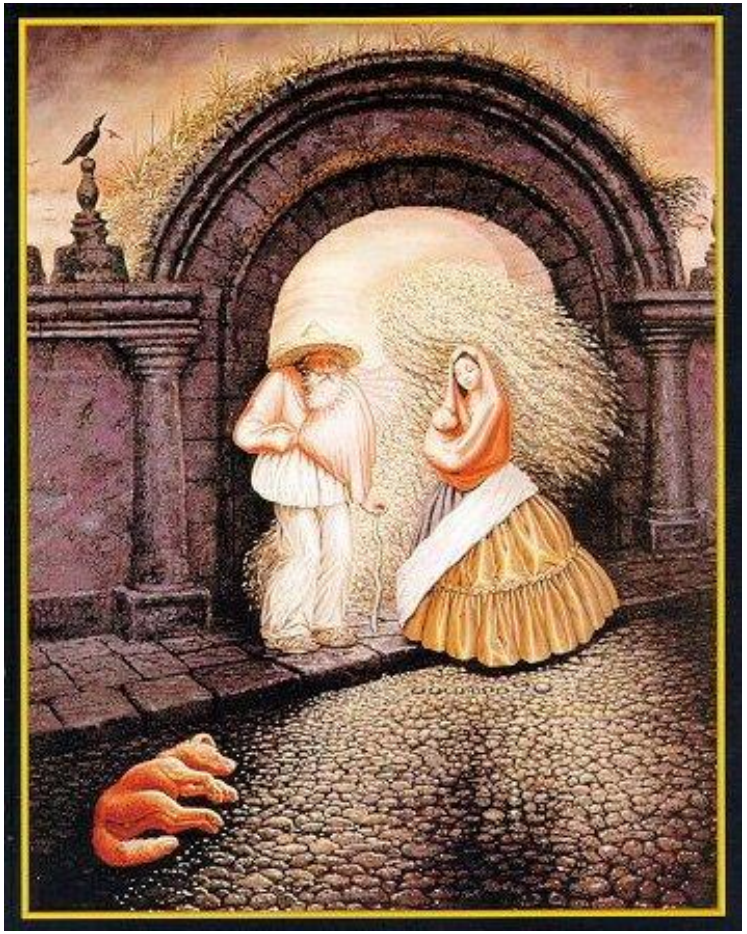
“Find and Replace” in images

Replace *Madras* with *Chennai*



How many legs does this elephant have?

Locate the faces and text in these images



Seeing is effortless for us….

The challenge is to endow computers with the same ability !

Image processing is the first step in that direction

Which of the tasks is DIP concerned with?

Mostly

- Routine tasks: $I_{in} \rightarrow I_{out}$

Partly

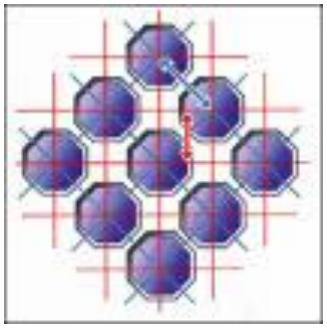
- Higher order tasks: $I_{in} \rightarrow$ detection/recognition

Constraints

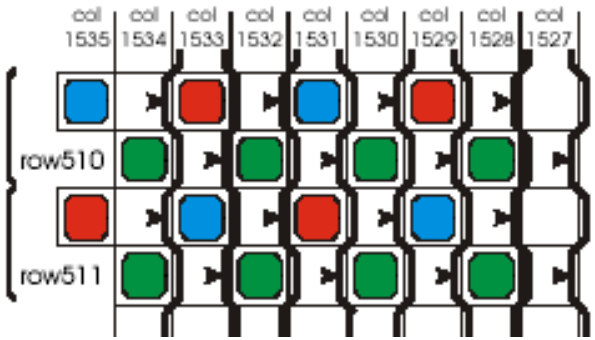
- An image is a set of integers
  - *intensity/colour* values, an objective quantity
- Each number depends on *several* factors
  - Surface property, illumination strength and wavelength
- The image is a 2D projection of a 3D scene
- What we perceive is *brightness*
  - A subjective sensation

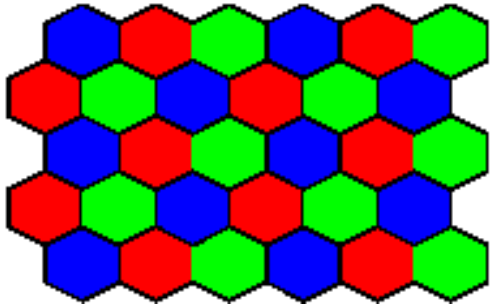
Imaging -Sensor layout in cameras

Traditional

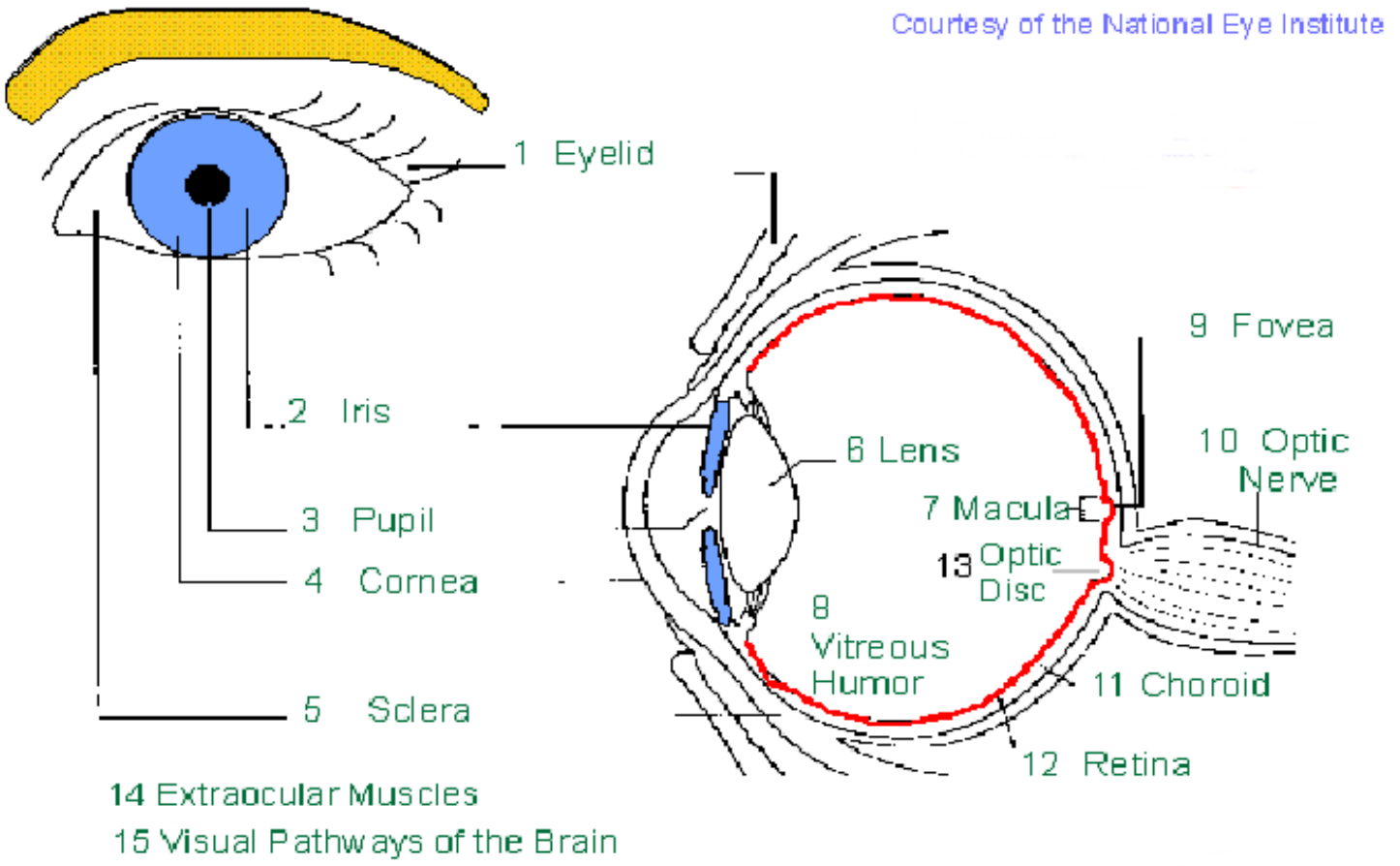


Novel

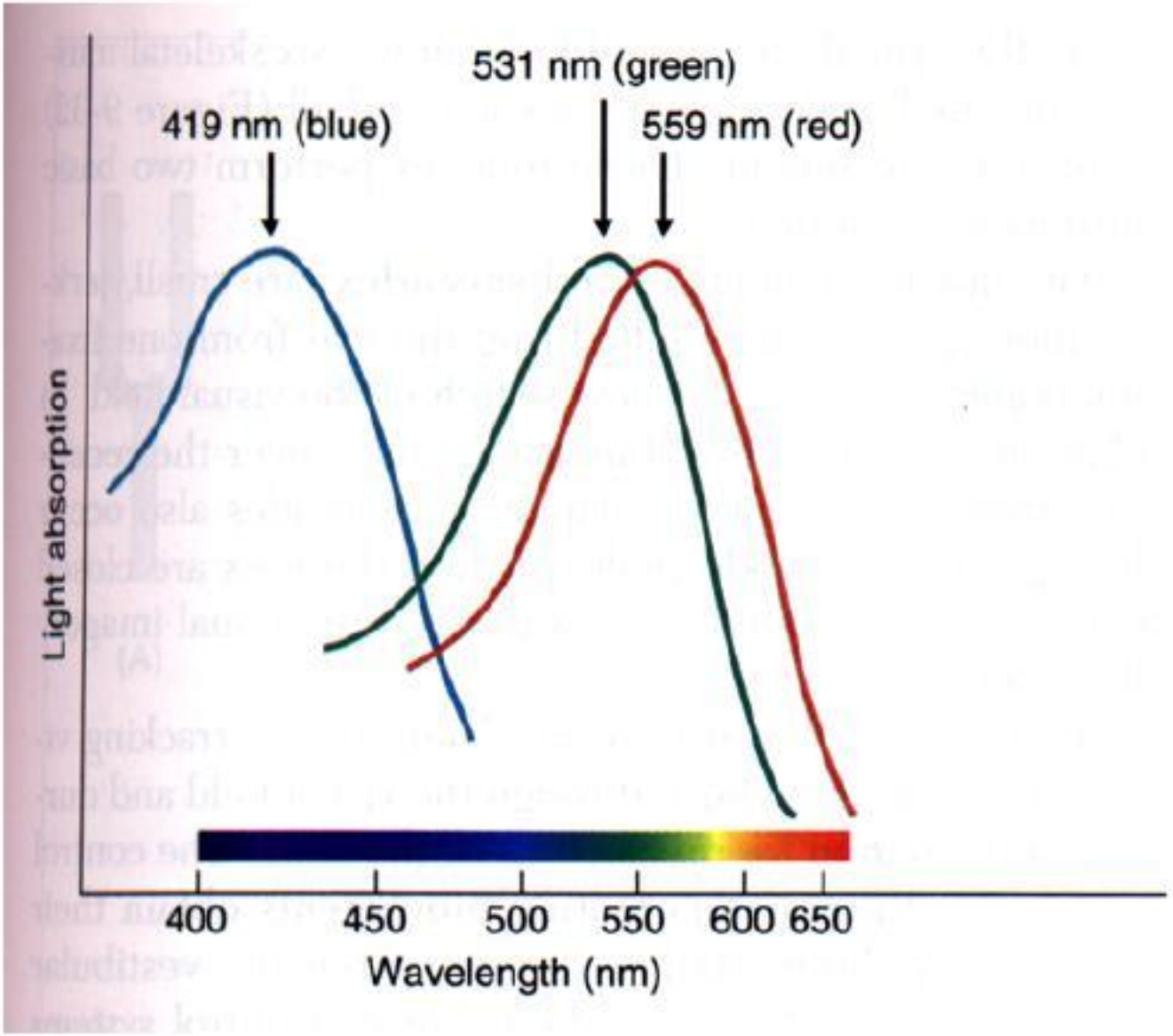




Imaging in Humans



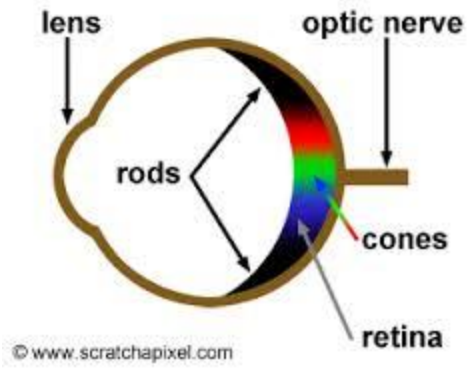
Cone Sensitivities

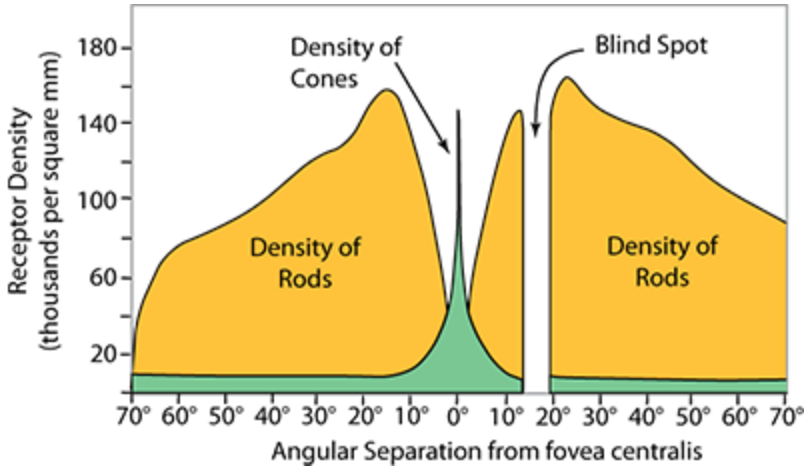


Retinal sensors

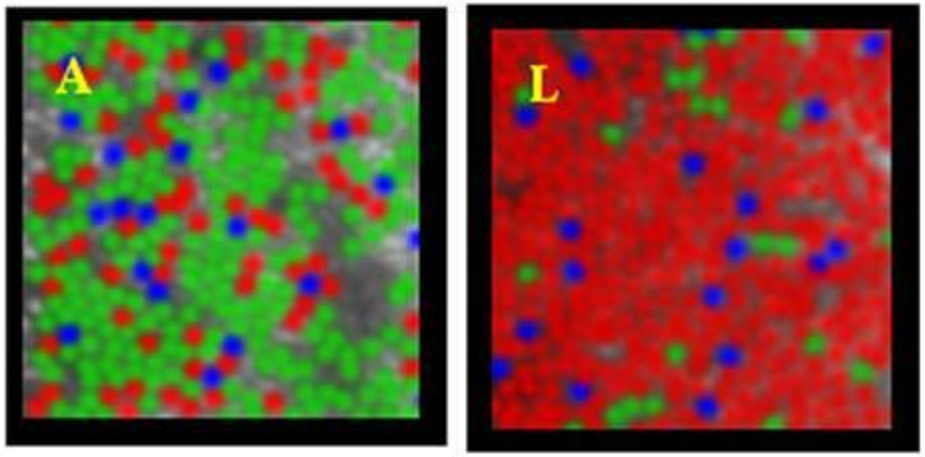
- Sensors: rods and cones
- Rods are achromatic
  - contribute mostly to low resolution peripheral vision
- Cones are chromatic
  - contribute to high resolution central colour vision

Retinal sensor layout





Unequal rod-cone distribution within retina



- Unequal distribution of colour sensor (cones) within the fovea
- The ratio of R,G cones varies across individuals (~1:1 to 16:1)

Hofer *et al*. Jour. Neuroscience 2005

Processing in HVS

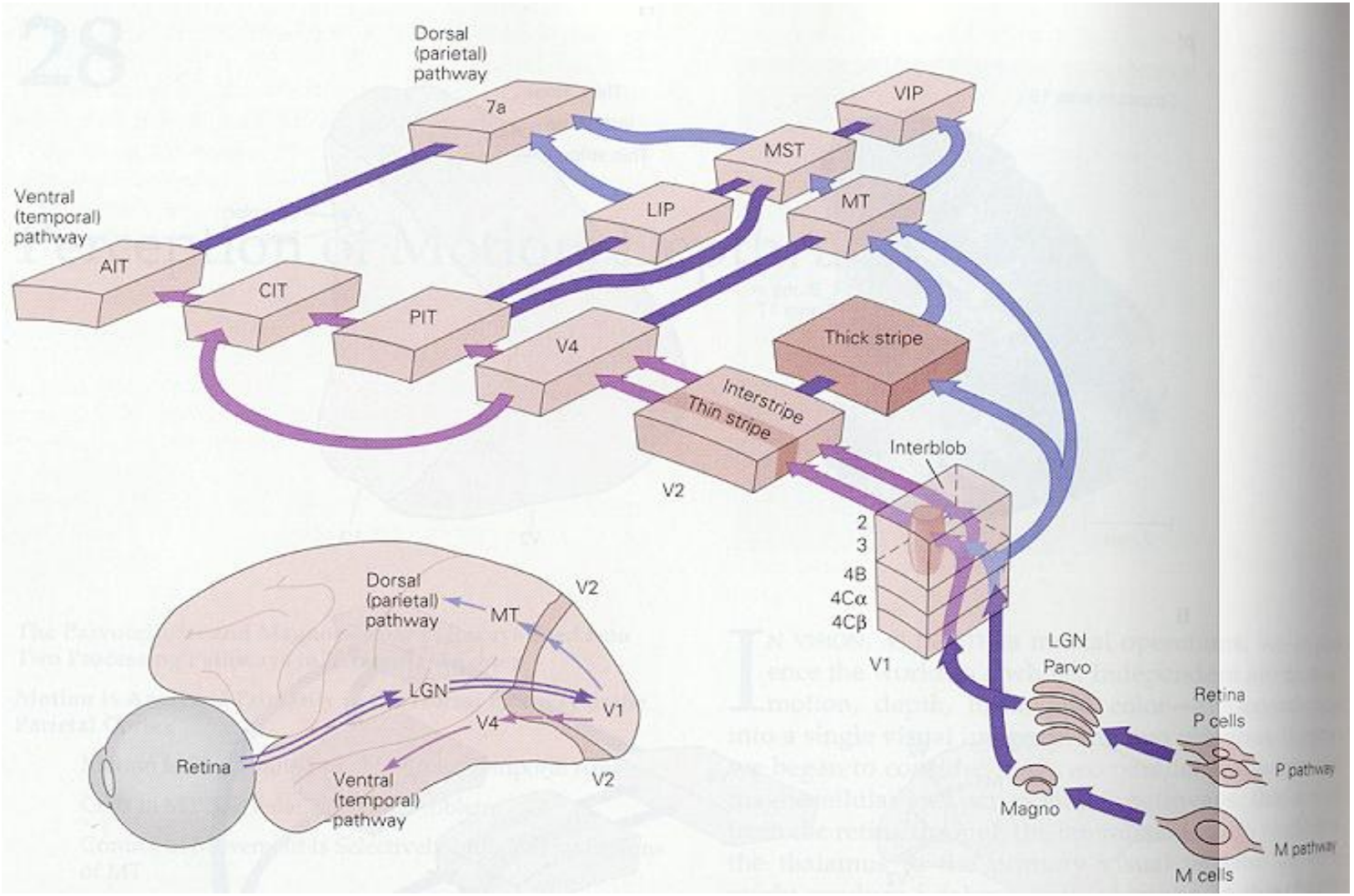


Image basics

An image…..

- Is a 2D signal, I.e. a function of **intensity** values **f(x,y): $\Re^2 \rightarrow \Re$ or $\Re^3 \rightarrow \Re$**
  - (x,y) or (x,y,z) spatial coordinates
  - domain and range of **f** is real

Intensity depends on many factors:

- Sensor
  - spectral characteristics
  - optics (lens)
- Environment and object
  - illumination
  - surface characteristics of the object

Digital image

- The intensity function is a digital signal
  - f(x,y) or f(x,y,z) is sampled and quantised
  - (x,y) or (x,y,z) → (m,n) or (m,n,k)
  - f → I

- the dimensionality of the spatial coordinates results in a 2-D pixel or 3-D voxel as the basic element

In this course, we deal with 2-D planar images

∴ digital image I(m,n): Z^2 → Z

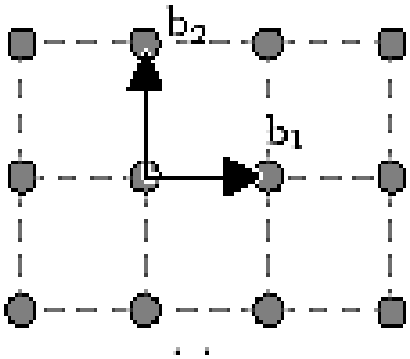
How do we sample a 2-D space?

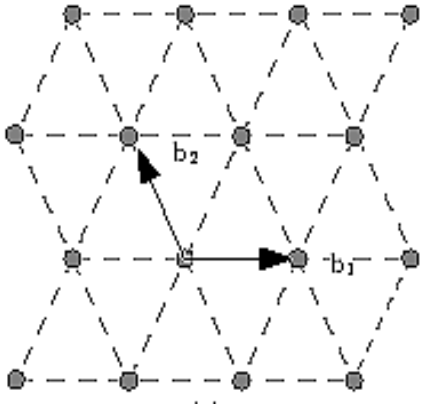
Options for sampling lattice

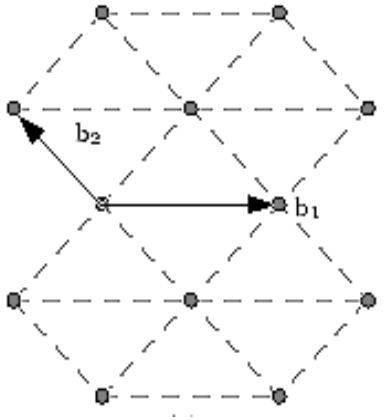
Sampling in

Orthogonal directions

Non-orthogonal directions







Square

Hexagonal

Quincunx

$L_s = [(1,0)\ (0,1)]$ (b1, b2)

$L_h = [(1,0)\ (-½,\sqrt{3}/2)]$

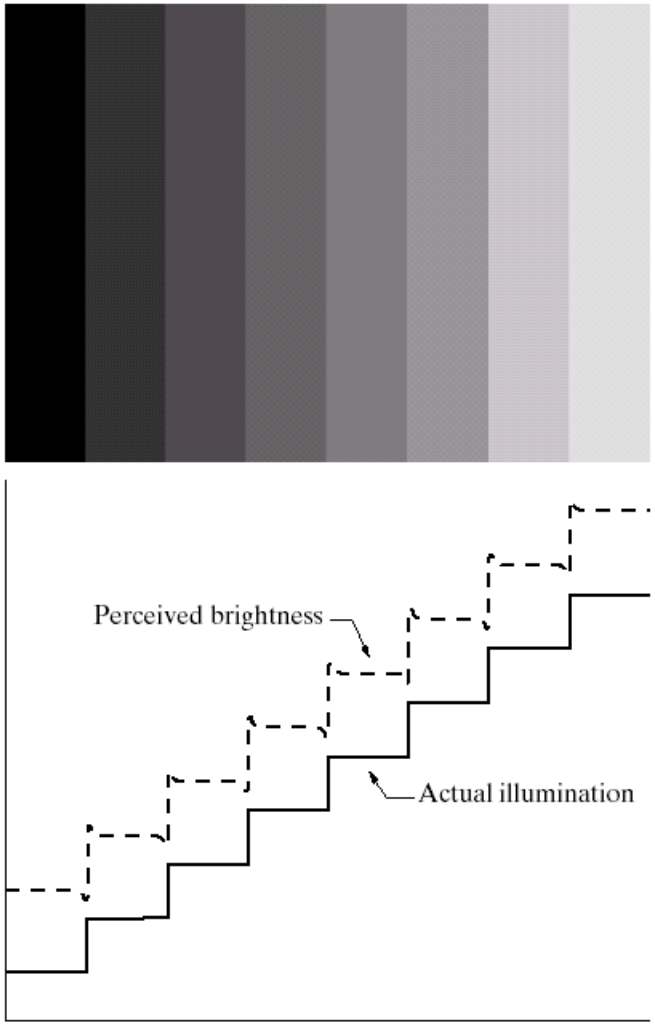
$L_q = [(2,0)\ (-1,1)]$

A point in the image is now expressed as $[m\ \ n]\ L$

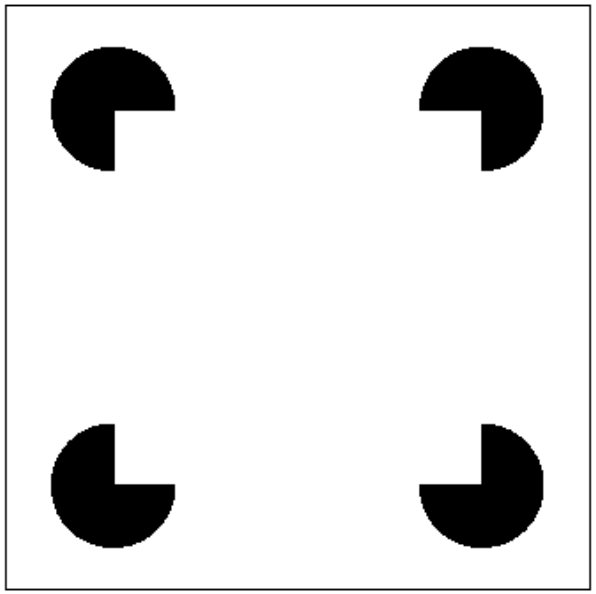
m,n are integer coordinates, L is the lattice

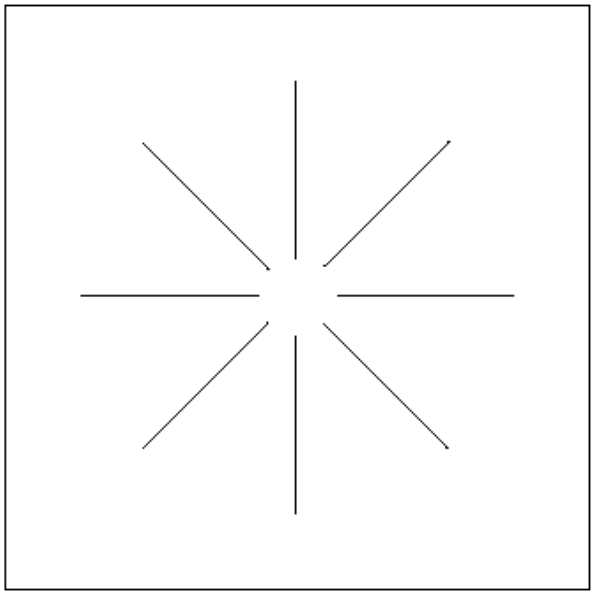
Luminosity and Brightness

- *Luminosity* i
  from a certa
  – reflected fr
- *Brightness* i
  or received



Brightness is not a simple function of intensity





A ely

Human perception is not fully understood !!

Pe

- c
- g , etc.

Pixel depth

- Current standard is 8 bits/colour plane

- Dolby is proposing 12-16 bits/colour plane
- Display brightness in candellas/m^2 (nits)
- Current std: 48 (legacy from film projectors) Dolby proposes 4000