CSI 4133 Computer Methods in Picture Processing and Analysis

Fall 2024

Pengcheng Xi, Ph.D.

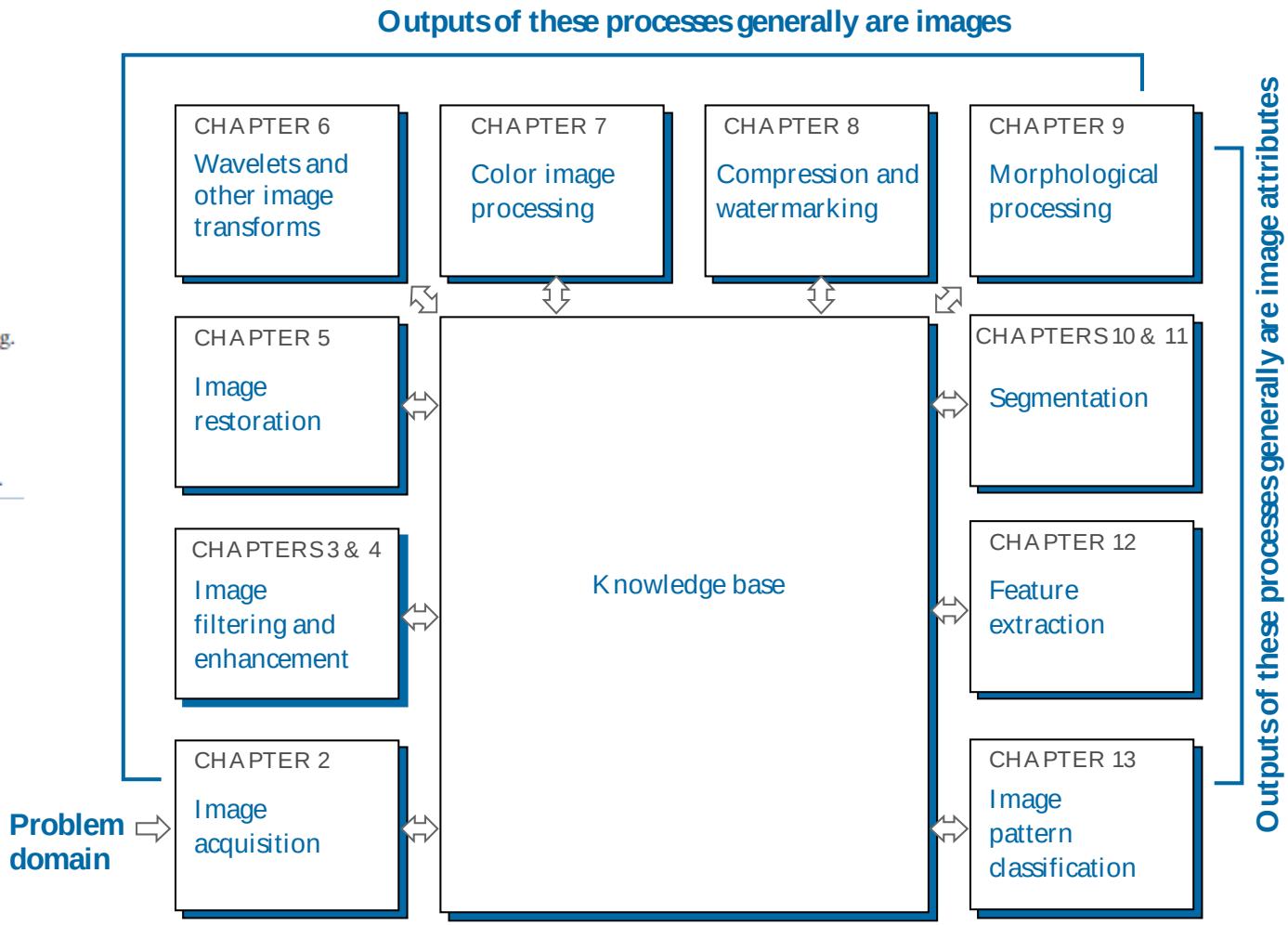
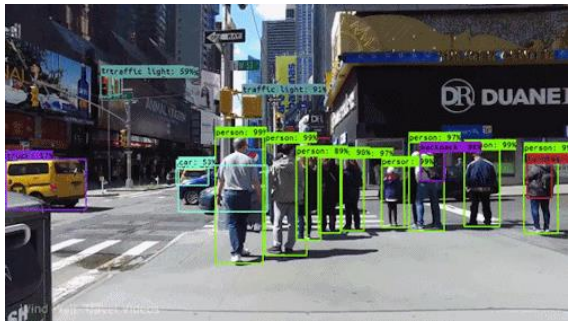


FIGURE 1.23
Fundamental steps in digital image processing. The chapter(s) indicated in the boxes is where the material described in the box is discussed.

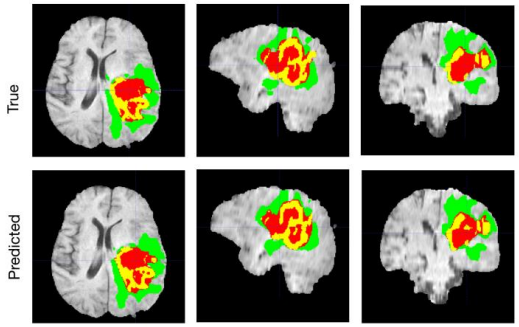
Computer vision tasks

Classification/detection



[How do self-driving cars see?]

Reconstruction/segmentation



[Automatically segmenting brain tumors]

Generation

[Generating with style]

And more …

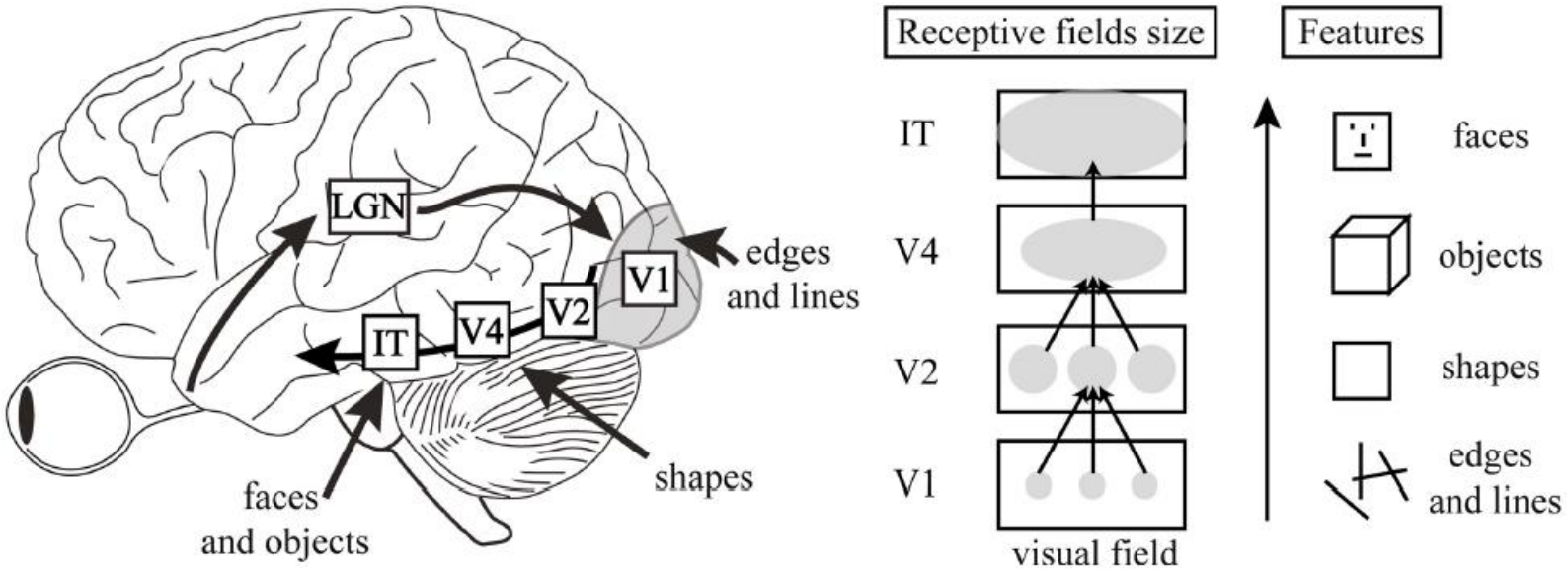
Vision vs. Perception vs. Computer Vision

- **Vision**: visual perception via the visual system, also one of the senses
- **Perception**: In psychology and cognitive sciences, perception is the process of acquiring, interpreting, selecting, and organizing sensory information
  - The extraction of information from sensory signals
- **Computer vision** is the science and technology of machines that **see**
  - Artificial systems for perception from images or multi-dimensional data

Two types of eyes

- Natural selection and evolution has led to:
  - The **compound** (lenticular) eye
    - Insects
    - Poor image resolution
    - Very large view angle
    - Ability to detect fast movement
  - The **projective** (camera) eye
    - Human eyes
    - Depth perception
    - Panoramic view

Human vision system



- Visual cortex processes visual information in a hierarchical feed-forward fashion. [1]

[1] M. Manassi, B. Sayim, and M. H. Herzog, “When crowding of crowding leads to uncrowding" Journal of Vision, vol. 13, pp. 10-10, 11 2013.

Human vision process

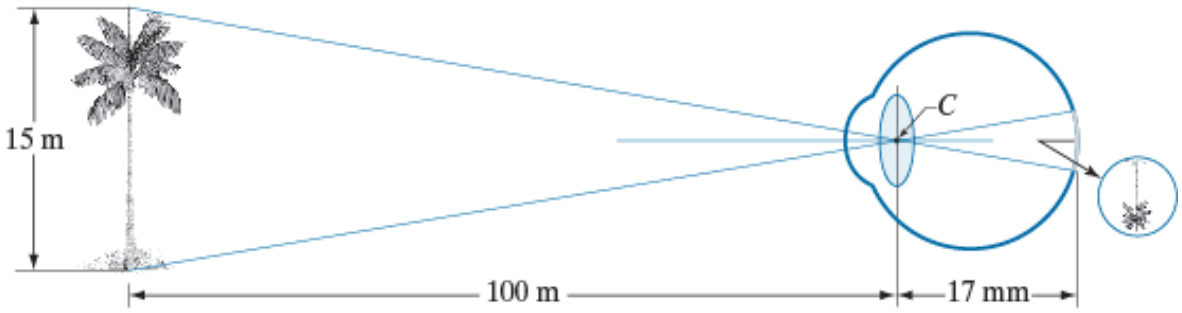


FIGURE 2.3
Graphical representation of the eye looking at a palm tree. Point *C* is the focal center of the lens.

Human eye

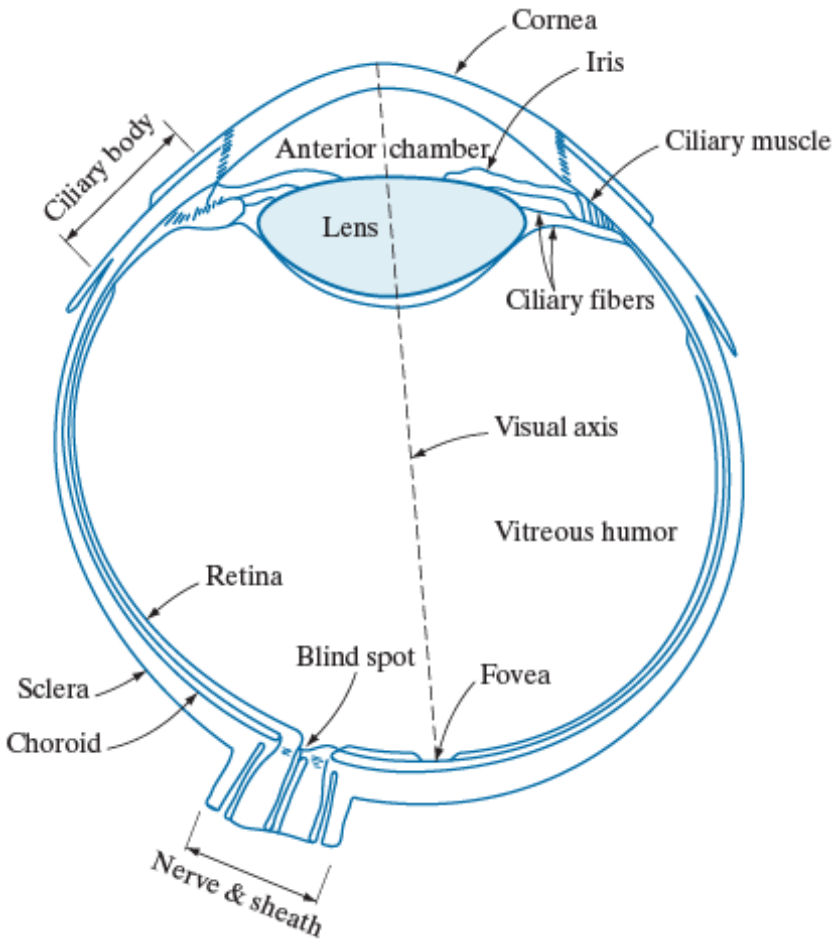


FIGURE 2.1
Simplified diagram of a cross section of the human eye.

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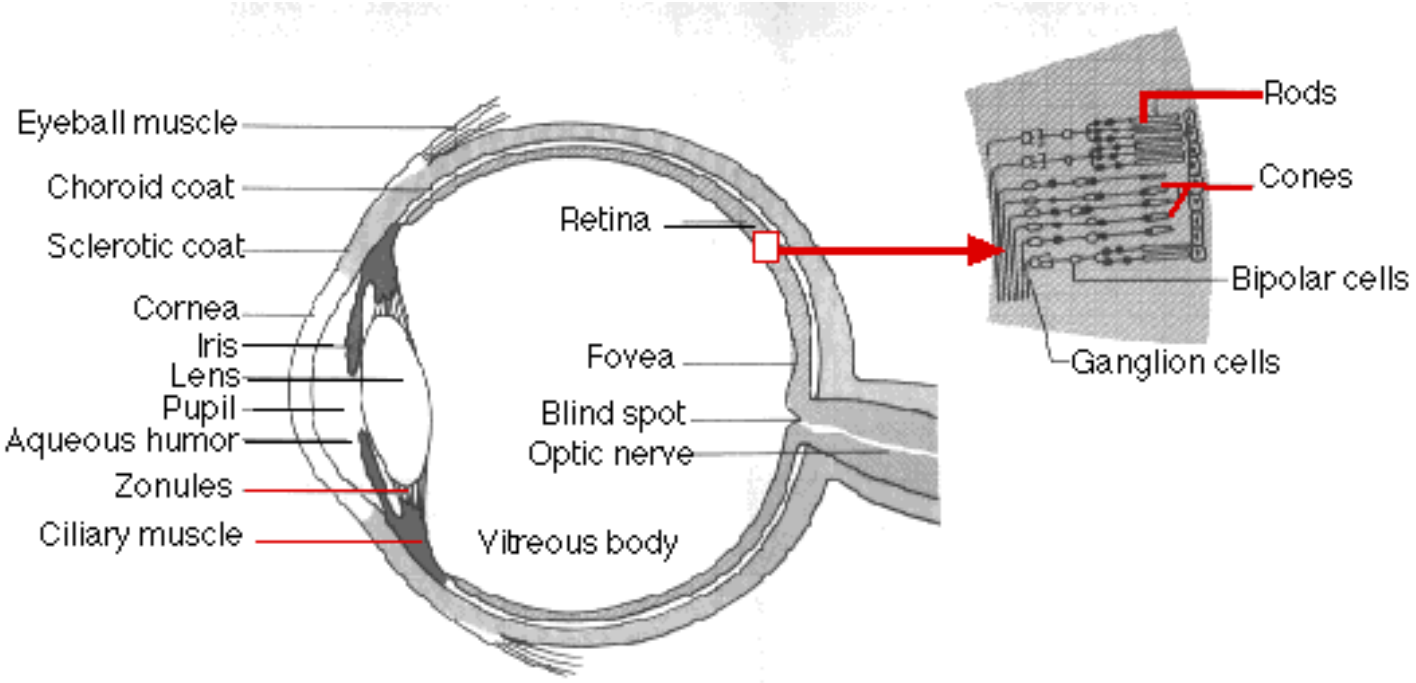
Human eye – rods and cones



http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/V/Vision.html

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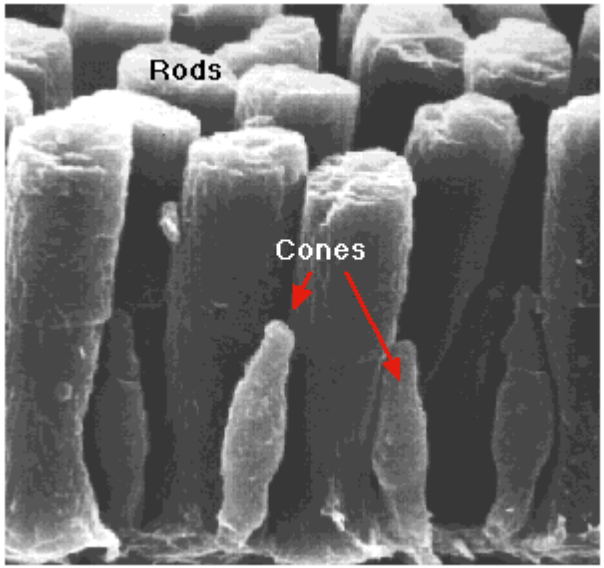
Rods and cones – photosensitive cells

- **Rod** cells
  - 75 to 150 million distributed over the retinal surface
  - Give a general, overall picture of the field of view
  - Not involved in color vision
  - Sensitive to low levels of illumination
  - Several rods connected to a single nerve
  - Responsible for **object detection**
- **Cone** cells
  - Between 6 and 7 million
  - Located in the central portion of the retina, called the fovea, and are highly sensitive to color
  - Each cone is connected to its own nerve end
  - Responsible for **object identification**



Sensitivity of eyes

Rod dominated

0.04 cd/m^2

Cone dominated

1000 cd/m^2

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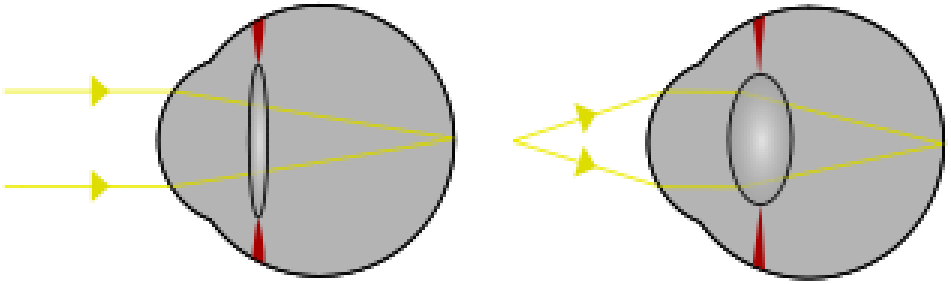
More about eyes

- If the eye is considered to be a type of camera
  - The retina is equivalent to the film inside the camera
    - Registering the tiny photons of light which interact with it
- In the retina
  - Light impulses are changed into electrical signals
  - Sent along the optic nerve and back to the occipital (posterior) lobe of the brain
  - Which interprets these electrical signals as visual images
- Our brain “sees” the world with the assistance of eyes

Human eye accommodation

- The eye is nearly a sphere, with an average diameter of about 20mm
- 1 million nerve cells exiting each eye
- When the ciliary muscle is relaxed, its diameter increases and lens is flattened



http://en.wikipedia.org/wiki/Accommodation_(eye)