Computer Vision

CS 482

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Thursday 7:20-10:00pm

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S&T II, Rm 427

Office hours: Wed. 4-6pm

http://www.cs.gmu.edu/~zduric/cs482.html

Texts and sources

- Introductory Techniques for 3-D Computer Vision, Trucco and Verri, 1998
- Machine Vision, E.R. Davies, 2nd ed., 1998
- Foundations of Vision, Wandell, Sinauer Associates, 1995
- Course requirements:
  - Midterm: 20%
  - Final (take home): 20%
  - Homeworks 30%
  - Project: 20%
  - Class participation and presentations: 10%

What is vision?

- Recognize objects
  - people we know
  - things we own
- Locate objects in space
  - to pick them up
- Track objects in motion
  - catching a baseball
  - avoiding collisions with cars on the road
- Recognize actions
  - walking, running, pushing

Vision is

- Deceivingly easy
- Deceptive
- Computationally demanding
- Critical to many applications

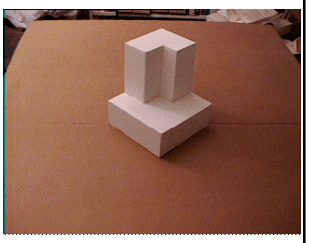
Vision is deceivingly easy

- We see effortlessly
  - seeing seems simpler than “thinking”
  - we can all “see” but only select gifted people can solve “hard” problems like chess
  - we use nearly 70% of our brains for visual perception!
- All “creatures” see
  - frogs “see”
  - birds “see”
  - snakes “see”

but they do not see alike

Vision is deceivingly easy

- The M.I.T. summer vision program
  - summer of 1965
  - point TV camera at stack of blocks
  - locate individual blocks
    - » recognize them from small database of blocks
  - describe physical structure of the scene
    - » support relationships
- Formally ended in 1985



Vision is deceptive

- Vision is an exceptionally strong sensation
  - vision is immediate
  - we perceive the visual world as external to ourselves, but it is a reconstruction within our brains
  - we regard how we see as reflecting the world “as it is;” but human vision is
    - » subject to illusions
    - » quantitatively imprecise
    - » limited to a narrow range of frequencies of radiation
    - » passive

Vision is deceptive

- Human vision is
  - subject to illusions
  - quantitatively imprecise
  - limited to a narrow range of frequencies of radiation
  - passive

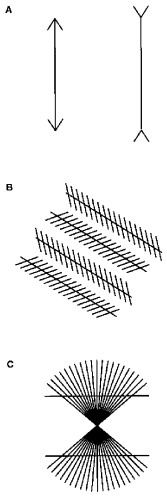


FIGURE 9–8. A. Müller-Lyer illusion. I
sion. C. Hering illusion.

Spectral limitations of human vision

- We “see” only a small part of the energy spectrum of sunlight
  - we don’t see ultraviolet or lower frequencies of light
  - we don’t see infrared or higher frequencies of light
  - we see less than .1% of the energy that reaches our eyes
- But objects in the world reflect and emit energy in these and other parts of the spectrum

Non-human vision

- Infrared vision
- Polarization vision
  - navigation for birds
- Ultrasound vision
- X-ray vision!
- RADAR vision

Infrared vision

- Vision systems exist that can see reflected and emitted infrared light
  - visual system of the pit viper
  - infrared cameras used for night vision
- Why haven't our eyes evolved to see into the infrared?
  - we would see the blood flow through the capillaries in the eye

Human vision is passive

- It relies on external energy sources (sunlight, light bulbs, fires) providing light that reflects off of objects to our eyes
- Vision systems can be "active" - carry their own energy sources
  - Radars
  - Bat acoustic imaging systems

Critical to many applications in

- Manufacturing
- Communications
- Medicine
- Transportation
- Entertainment
- Agriculture
- Defense

Manufacturing

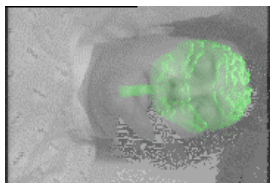
- Visual inspection for quality control
  - during the manufacture of parts in the automotive industry
  - inspection of semiconductors
- Visual control of robots
  - during assembly of parts from pieces
  - during calibration of robot control systems

Communications

- Smart document readers
  - character recognition
  - discrimination of text from graphics and images
  - reading cursive script
  - “language” recognition
- Virtual teleconferencing
- Virtual reality

Medicine

- Diagnosis
  - radiology - read X rays, CAT scans
  - pathology - read biopsies
- Remote and tele-medicine
- Virtual reality surgical assistance
  - project images onto head during brain surgery



Transportation

- Traffic safety and control
  - detection and ticketing of speeding vehicles
  - vehicle counting for flow control'
- Robot drivers
  - convoys
- Advanced automobiles
  - autonomous parallel parking
  - road sign detectors and driver alerts
  - collision avoidance
  - smart cruise control

Pittsburgh to San Diego!

Entertainment

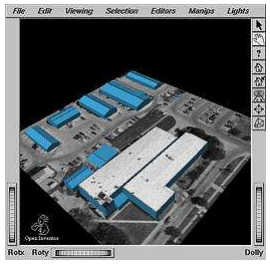
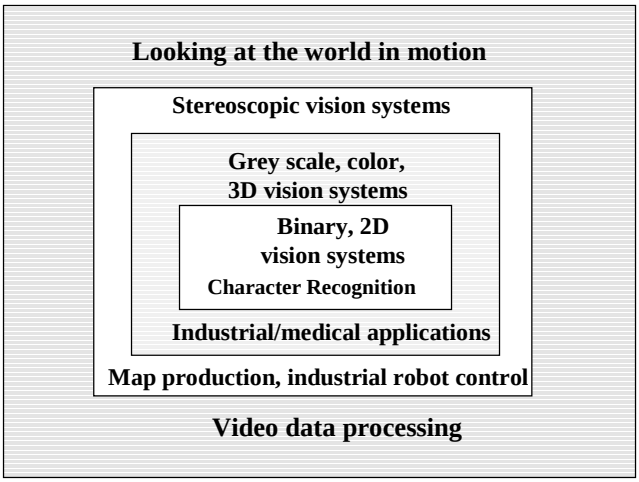
- Acquisition of 3D computer models for graphical manipulation
- Control of animation through vision
- Indexing tools for video databases

Agriculture

- Safety and quality inspection
  - sorting by size - peaches
  - sorting by shape - potatoes
  - identifying defects - blemishes on fruit, rot in potatoes
  - disease monitoring - chickens
- Robotic farming equipment
  - robotic harvesters - apple pickers, orange pickers

Defense

- Automatic target recognition systems
  - cruise missiles
  - air to surface “smart” missiles
- Reconnaissance
  - monitoring strategic sites
- Simulation
  - acquisition of terrain models from imagery
  - model acquisition of buildings, roads, etc.



Course organization