CMSC 426: Image Processing (Computer Vision)

What is Vision?

- What does it mean to see?
- To know what is where by looking (Marr 1982)
- To understand from images the objects and actions in the world.

The goal of Computer Vision

- We would like machines that are able to autonomously interpret the images taken by their sensors and are able to interact with the world.
- We would like human-like or even super-human like capabilities.
- But what does it mean to understand?

Vision depends on:

- Geometry
- Physics
- The nature of objects in the world
  (This is the hardest part).

Human Vision appears easy

- We use more than 60% of our brain for visual perception
- Vision is immediate
- What we perceive is a reconstruction within our brain
- We regard it as reflecting the world

Human Vision is

- Subject to illusions
- Quantitatively imprecise
- Limited to a narrow range of frequencies
- A passive sense -- but we are not passively seeing

Interesting Approaches

- Many animals have vision (frogs, insects,birds)
- Active, Purposive Vision: Our Vision is related to our capabilities and we are embodied.
  "We move therefore we see"

The Computer Vision we study

A set of computational techniques that allow us to estimate geometric and dynamic properties of the 3D world from digital images

What we will cover

- **Image Formation and Image Models** :
  Geometric aspects, Radiometric Aspects, Digital Images,Camera Calibration, Lightness and Color
- **Image Processing:**
  Filtering, Edge Detection, Feature detection
- **Reconstruction of Geometric and Dynamic Properties of 3D Surface:**
  Multiple View Geometry, Motion, Shape from Single Image Cues (Texture, Shading, Contours)

Books

- E. Trucco and A. Verri, “Introductory Techniques for 3D Computer Vision”,

  Prentice Hall (strongly recommended)
- BKP Horn, “Robot Vision”,MIT Press
- M. Sonka and V. Hlavac, “Image Processing, Analysis, and Machine Vision”, PWS Publishing
- D. Forsyth and J. Ponce, “Computer Vision
- A Modern Approach”,Prentice Hall

Related Disciplines

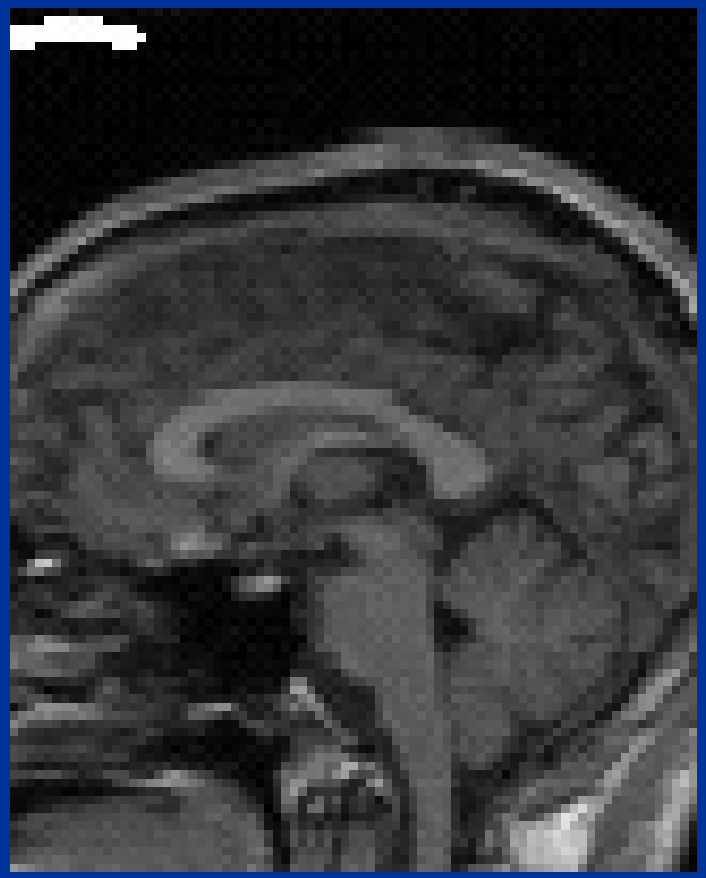
- **Image Processing**: image-to-image transformations, image enhancement (e.g to interpret radiography of lungs), compression, feature extraction (image operations which extract differential invariants of the image)
- **Pattern Recognition**: recognizing and classifying objects
- **Photogrammetry:** obtaining accurate measurements from noncontact imaging, higher accuracy

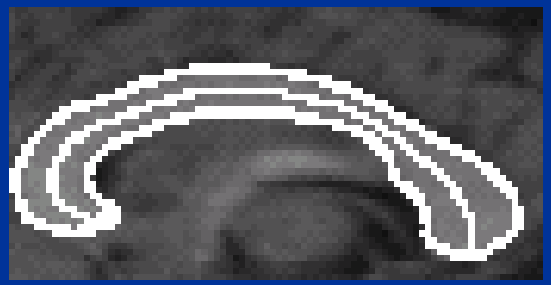
Related Fields

- Graphics. “Vision is inverse graphics”.
- Visual perception (Psychphysics)
- Neuroscience.
- AI
- Learning
- Robotics
- Math: eg., geometry, stochastic processes,optimaztion

A Quick Tour of Computer Vision

Boundary Detection



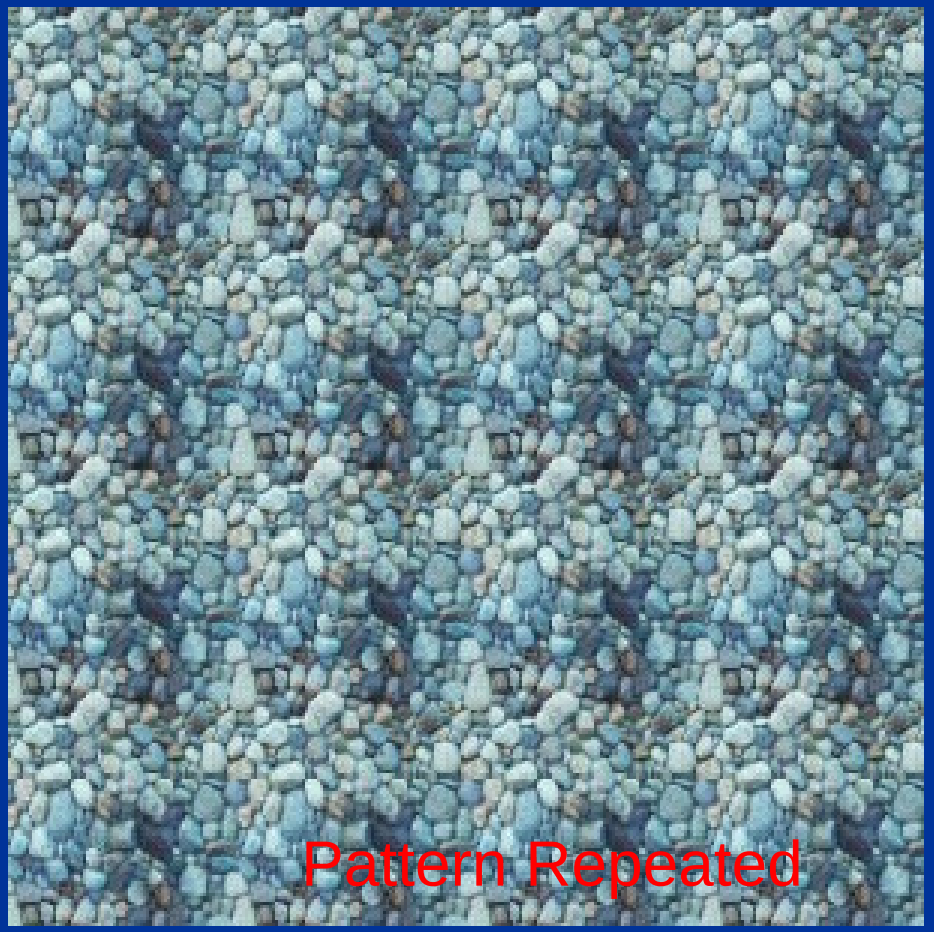


Finding the Corpus Callosum

(G. Hamarneh, T. McInerney, D. Terzopoulos)

Texture

Photo



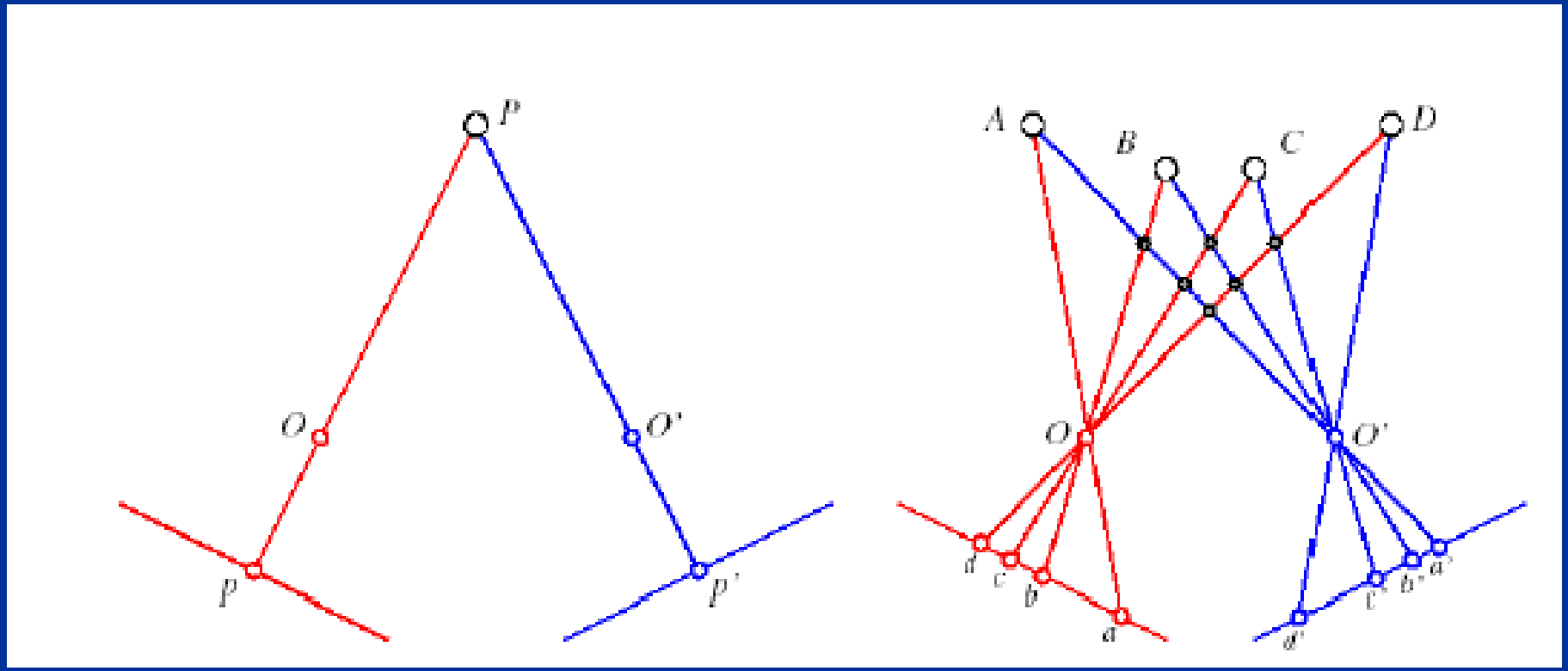
Texture

Photo

Pose Determination

Visually guided surgery

Stereo



http://www.ai.mit.edu/courses/6.801/lect/lect01_darrell.pdf

Stereo

http://www.magiceye.com/

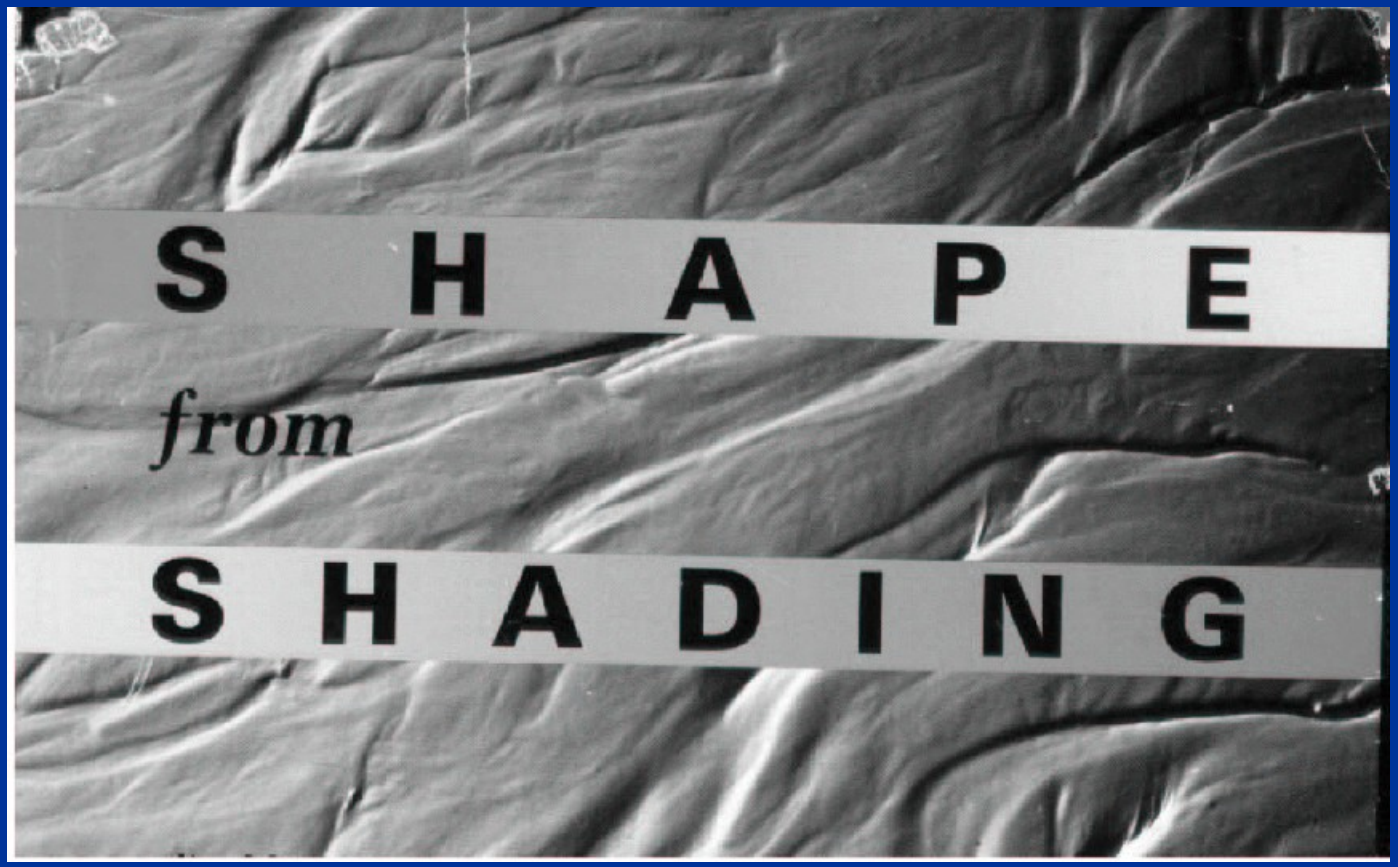
Stereo

http://www.magiceye.com/

3D model construction

Airborne Video Surveillance

Shape from Shading



Statistical classifiers

- MIT Media Lab face localization results.
- Applications: database search, human machine interaction, video conferencing.

New camera design