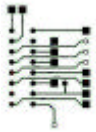
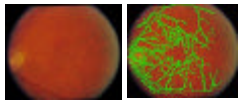
Overview of Computer Vision

Uses of Computer Vision



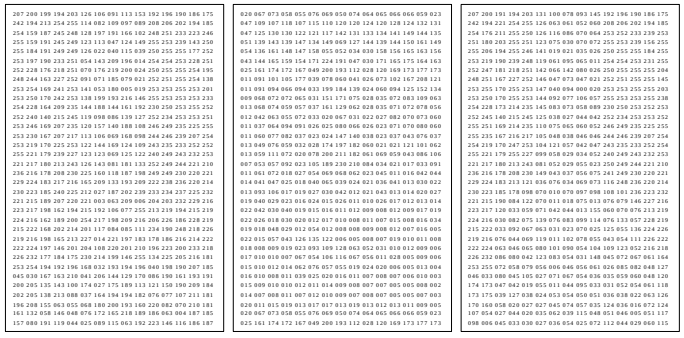
Industrial


Surveillance


Medical


The "Vision Problem"

Input → Vision Algorithm → Output



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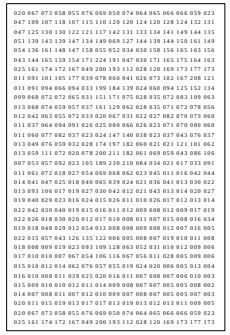
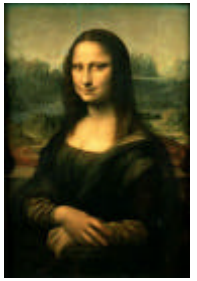
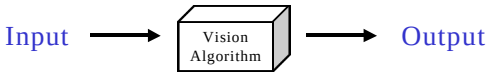



Allies and Inspiration

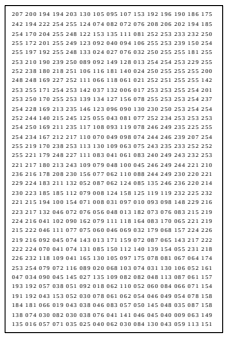


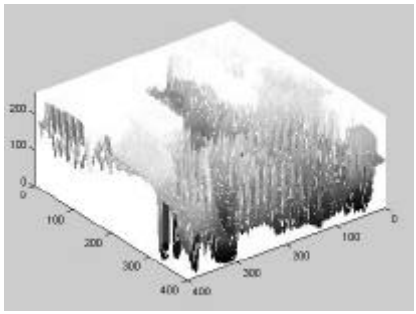
- Image Processing
- Cognitive Science
- Physics, Optics
- Engineering
- Biology, Psychology
- Computer Science

Graphics, AI, NNets, ...

Recognizing objects

What is an image? What is an object?





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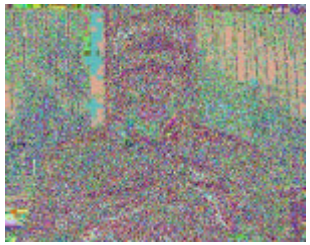
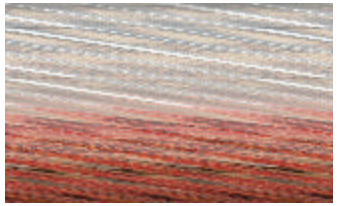




Computer Vision vs Image processing

- Image Processing
  - Mostly concerned with *image-to-image* transformations
    - Filtering
    - Enhancement
    - Compression
- Computer Vision
  - Concerned with how images *reflect the 3D world*
    - Filtering *for feature extraction*
    - Enhancement *for recognition/detection*
    - Compression *that preserves geometric information in images*

Tasks in Vision

Perception:

- What: Label what is in a scene: What people, animals, objects...

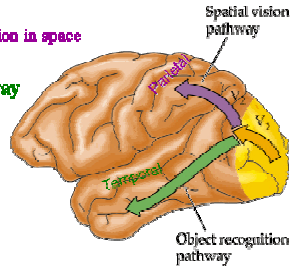
Action:

- Where: Determine the coordinates of where something is. (Mishkin, Ungleider)
- How: Use vision to perform some physical manipulation task. (Goodale etc.)

Compare in Human vision: Dorsal and Ventral Pathways

Dorsal (magno) Pathway
- to parietal lobe
- spatial vision – localization in space
- "WHERE"

Ventral (parvo) Pathway
- to temporal lobe
- object recognition
- "WHAT"



What: Recognizing people and objects

How do we determine that these are the same objects?

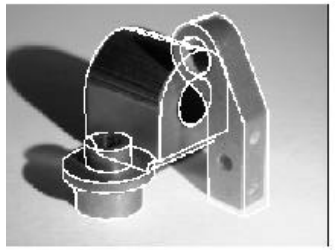
Two approaches:

1. Shape
2. Texture

Model based recognition: Find and match the shape

Example:

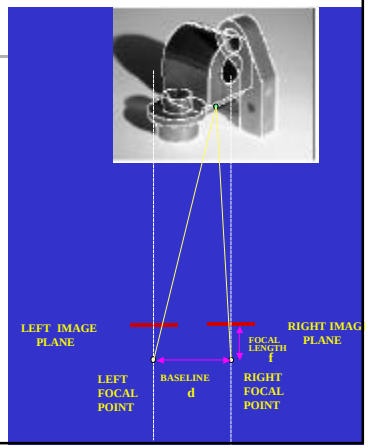
- Find the outlines of objects.
- Try to generate 3D or some pseudo 3D geometric description
- Check database for a similar geometric object



Model based recognition: Techniques.

Stereo:

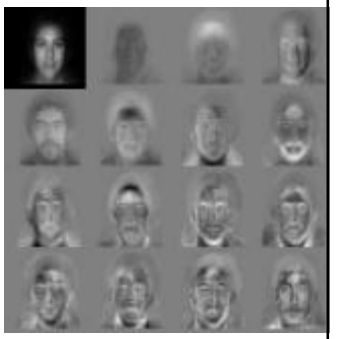
- From two (or more) images, determine the geometry of the scene by *matching* corresponding areas of the images



Apperance based recognition Match the 2D visual "texture"

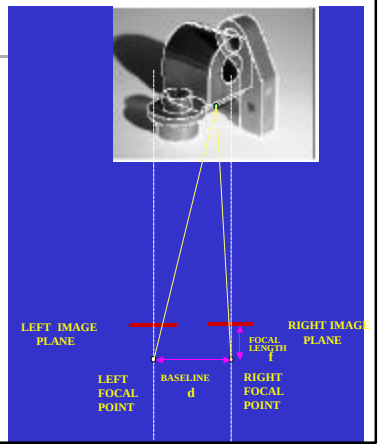
Methods:

1. Spatial: Determine "likeness" by correlation.
2. "Frequency": Transform and measure in fourier or KL space.



Where

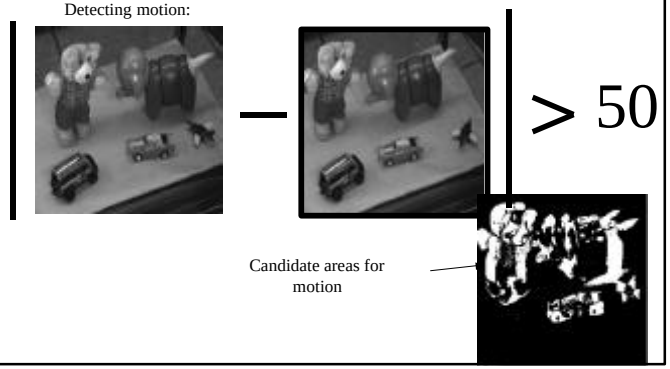
- Use stereo to determine 3D location with respect to camera.
- If we know where the camera is we can determine 3D world position



How (to act in the world)?

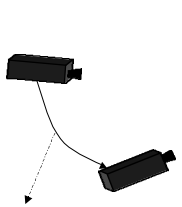
Motion estimation and tracking

Detecting motion:

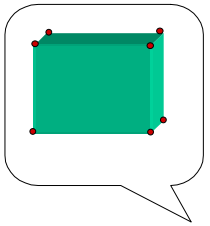


Moving the camera

- Like stereo!



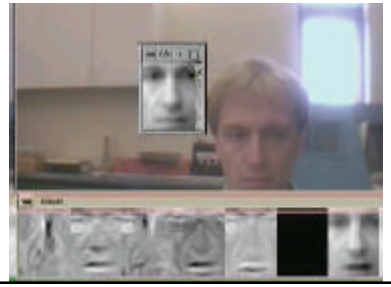
The change in spatial location between the two cameras (the “motion”)



Locations of points on the object (the “structure”)

Tracking

- Goal: Stabilizing motion.
- Method:Find same region in consecutive images



Vision and Sensory based motion control

Hand-Eye coordination in Man and Machine

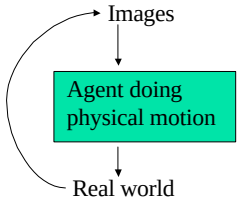
- New exciting course next semester (by yours truly) covering:

1. Visual motion: how to track and analyze it.
2. Motor movement: how to make robots do useful tasks.
3. How does the brain do it? Human visual-motor function, anatomy and physiology.
4. Putting things together: Man-Machine interfaces using vision and physical interaction.

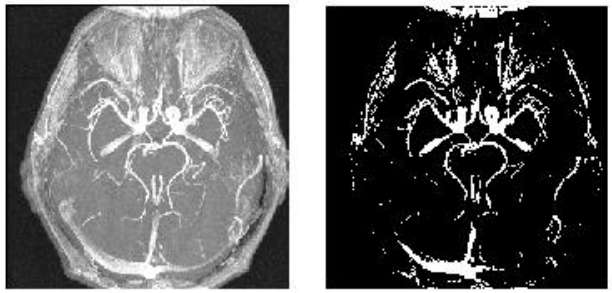
Main focus of c610:

- Most other courses are about static vision. What is in the image?

- This course: Vision for regestering, understanding and generating motion. How to act based on visual information.



Applications of Computer Vision: Medical Imaging



Applications of Computer Vision: Image Databases

(Courtesy D. Forsyth & J. Ponce)

From a search for horse pix in 100 horse images and 1086 non-horse images

Applications of Computer Vision: Data Acquisition

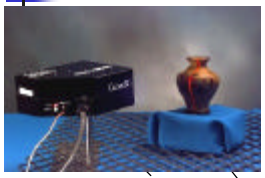
Welcome to Visual Computing

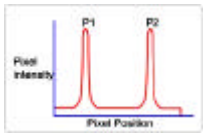
Seminars:
Wed Lunch

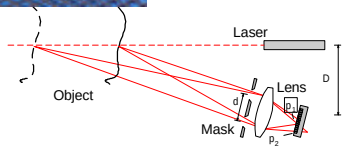
Rendering

- Basic techniques from the forward modeling perspective (traditional rendering)
  1. Input: 3D description of 3D scene & camera
  2. Solve light transport through environment
  3. Project to camera's viewpoint
  4. Perform ray-tracing
- Basic technique from the inverse modeling perspective (image-based rendering)
  1. Collect one or more images of a real scene
  2. Warp, morph, or interpolate between these images to obtain new views

3D sensors: Laser scanner







3D: Direct Replica of Large Museum Objects

3-D scan of the sculpture

STL model

Replicas produced by a 3-D Laser Sintering Machine (Kaiplast Inc.)

Computer Vision Summary:

The engineering solution: (Does not work well)

- 3D model based recognition and location determination solves what & where.

The biological solution? (Not proven yet)

- What: 2D recognition by pattern matching
- How: 2x 2D image based techniques

Your solution?