CS 556: Computer Vision

Lecture 1

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CS 556: Computer Vision

- Instructor:

  Sinisa Todorovic

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- Office:

  2107 Kelley Engineering Center

- Office Hours:

  Wed 3-3:30pm, or by appointment

- Classes:

  Tue 2-4pm, Thu 2-3pm BEXL 207

- Class website:

  http://web.engr.oregonstate.edu/~sinisa/courses/OSU/CS556/CS556.html

Recommended Textbooks

- "Computer Vision: Models, Learning, and Inference," by Simon J. D. Prince, Cambridge University Press, 2012
- "Computer Vision: Algorithms and Applications," by Richard Szeliski, Springer, 2010
- "Computer Vision: A Modern Approach," by D.A. Forsyth and J. Ponce, Prentice Hall, 2nd ed, 2011
- "Multiple View Geometry in Computer Vision," by R. Hartley and A. Zisserman, Academic Press, 2nd ed, 2004
- "Learning OpenCV: Computer Vision with the OpenCV Library," by Gary Bradski, Adrian Kaehler
- Additional readings on the class website

Prerequisites

- Undergraduate-level knowledge of:
  - Linear algebra
    - Matrices, Matrix Operations
    - Determinants, Systems of Linear Equations
    - Eigenvalues, Eigenvectors
  - Statistics and probability
    - Probability density function, Probability distribution
    - Priors, Posteriors, Likelihoods
    - Gaussian distribution
- Some programming skills
  - MATLAB, C, C++

Requirements and Grading Policy

- Homework assignments (30%)
  - HW1 — Feb 02
  - HW2 — Feb 21
  - HW3 — March 07
  - HW4 — Mar 21
- Exam 1 (30%) — Feb 9
- Exam 2 (40%) — Mar 16

Grading Policy

Late policy:

Zero tolerance without prior approval

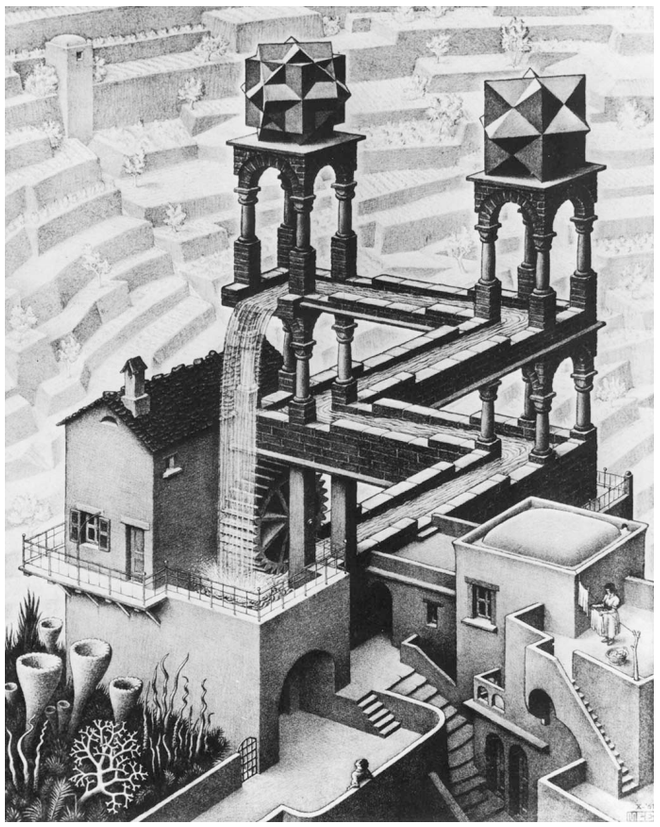
Homework

- Mini projects using MATLAB
- http://is.oregonstate.edu/accounts-support/software/software-list/matlab
- Must have:
  - Computer Vision Toolbox
  - Neural Network Toolbox
- Individual work, but collaboration is allowed
- Use any helpful source code that is available online
- **Turn in homework online via TEACH**

“...Understanding vision is a key to understanding intelligence...”

T. Poggio

What is Computer Vision?



M. C. Escher, “Waterfall” 1961

Develop

- representations,
- learning and inference algorithms,

for interpretation of images and video in terms of

- recognition,
- detection,
- segmentation, etc.,

of

- objects (parts), surfaces,
- human activities, events, etc.,

and their 3D spatiotemporal relations, e.g.,

- depth, occlusion, 3D orientation, supported-by,
- followed-by, cause, effect

A Typical Computer Vision System

3D world:
objects
scenes
events

camera

algorithms
representations

image
interpretation

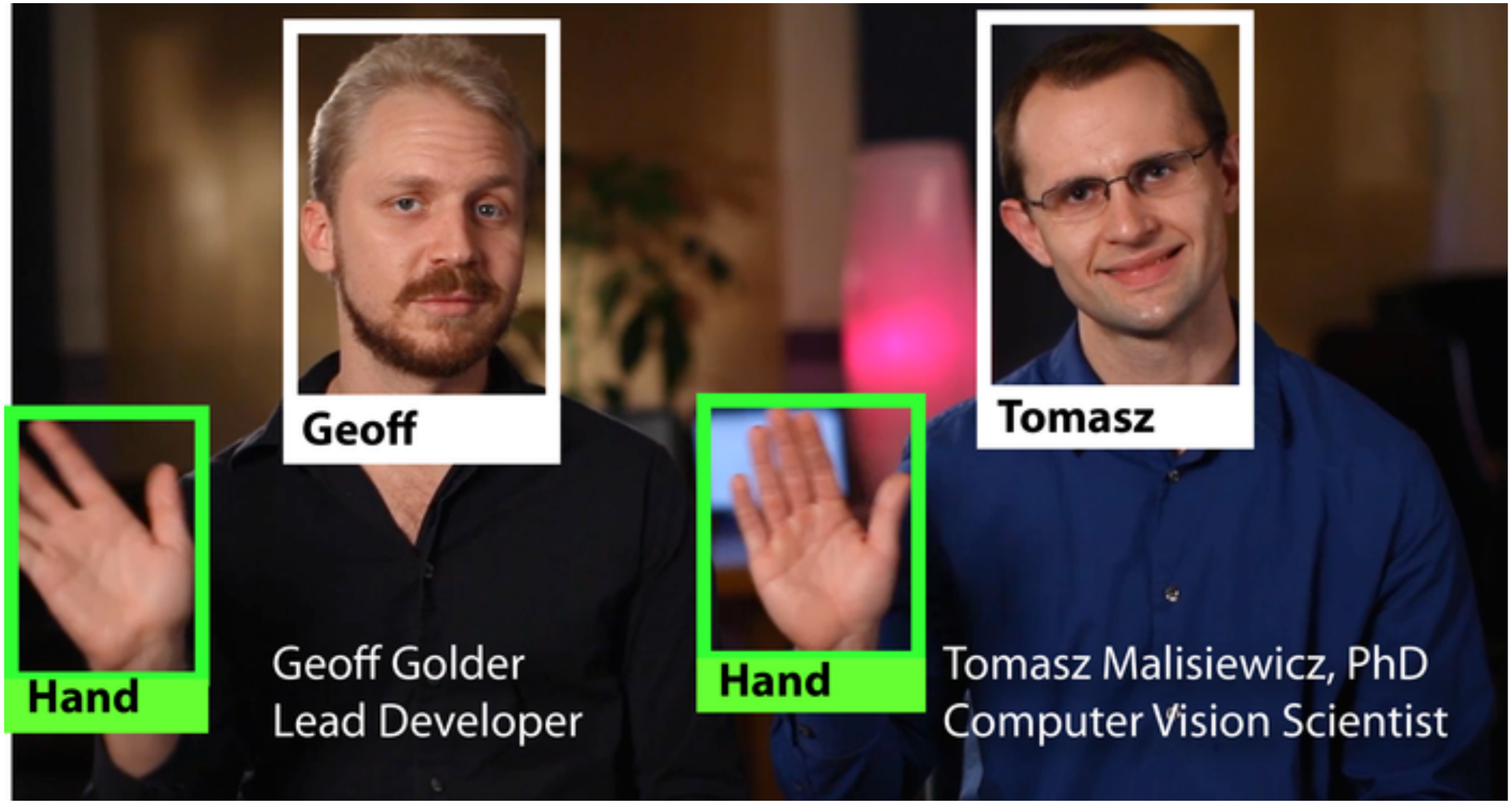
users

problem understanding
trade offs
training data

Applications: Face Detection

Automatic adjustment of camera focus, aperture, and shutter speed based on face detection

Applications: Object Recognition

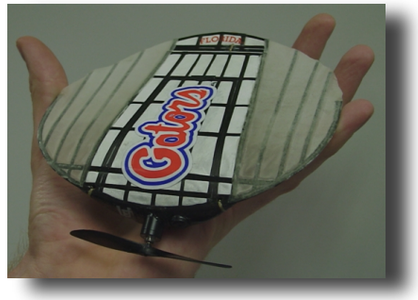


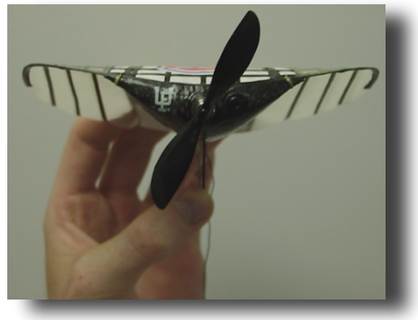
http://www.kickstarter.com/projects/visionai/vmx-project-computer-vision-for-everyone

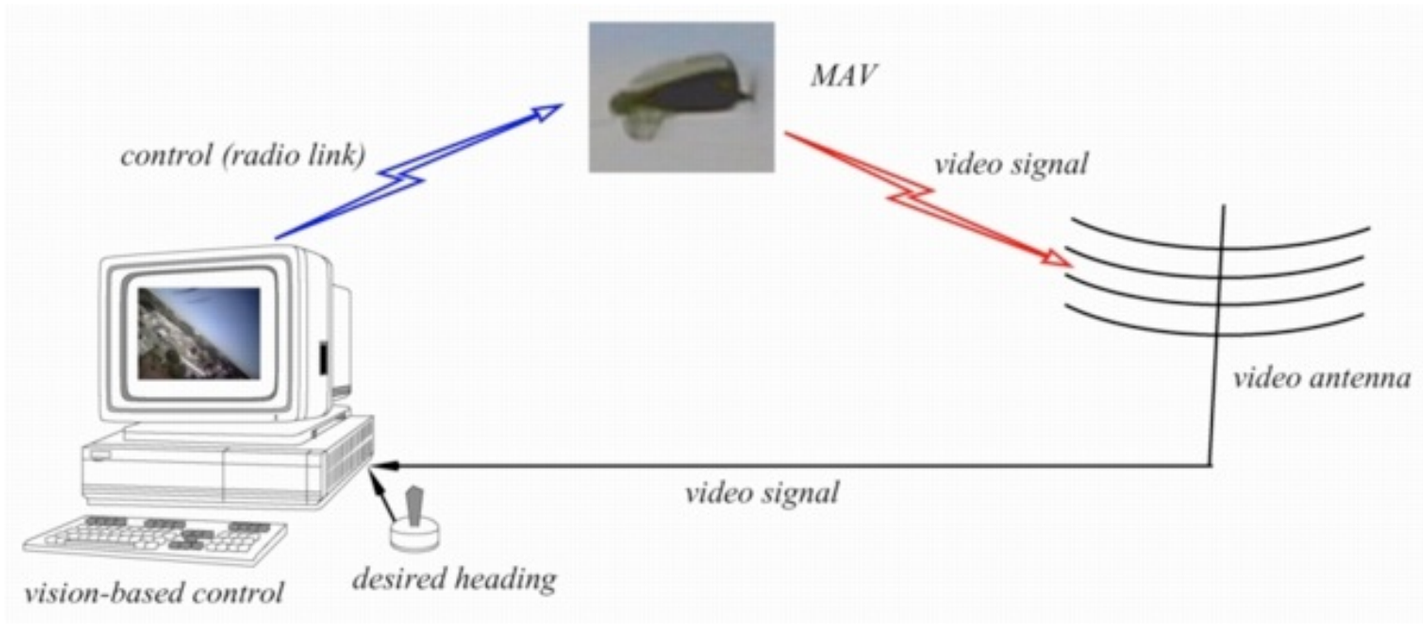
Applications: Monitoring Driver's Behavior

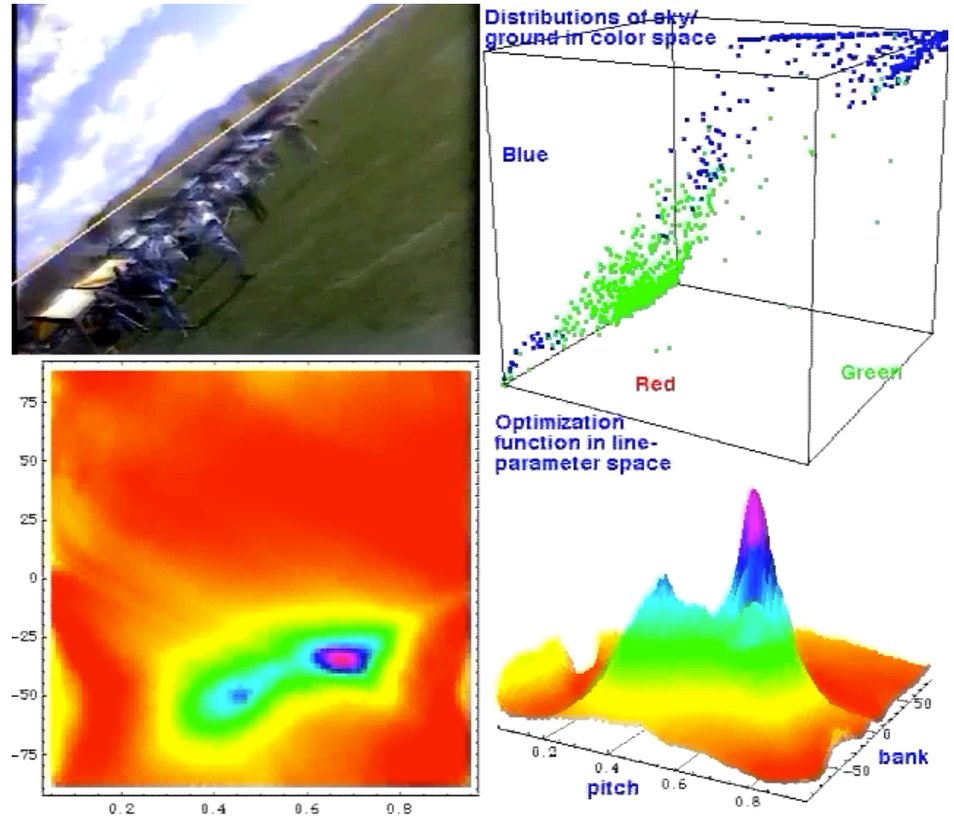
Source: P. Smith, M. Shah, and N.V. Lobo

Applications: Navigating UAVs





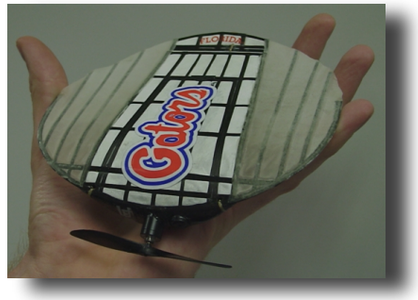


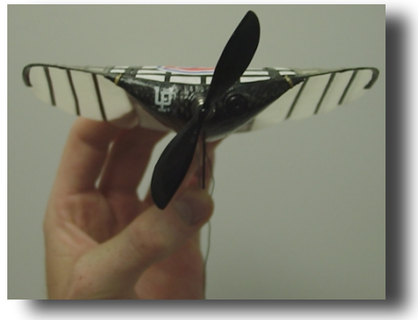


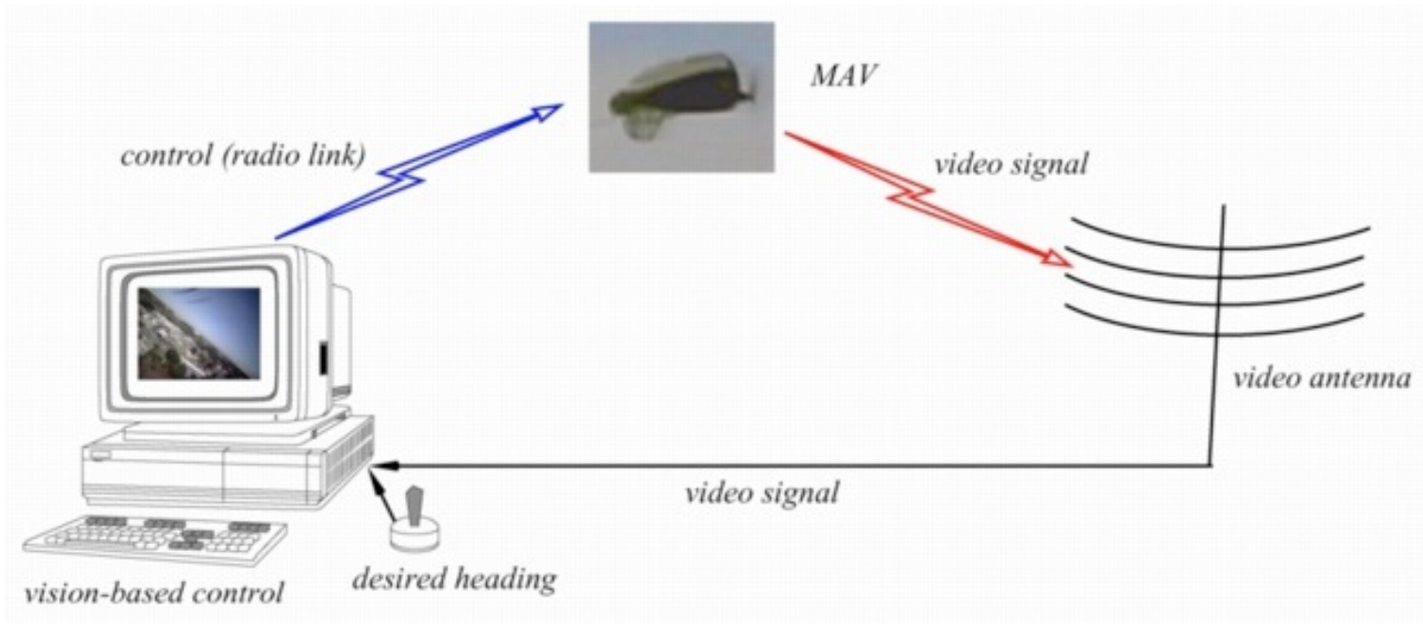
Flight stability and control of Micro Air Vehicles

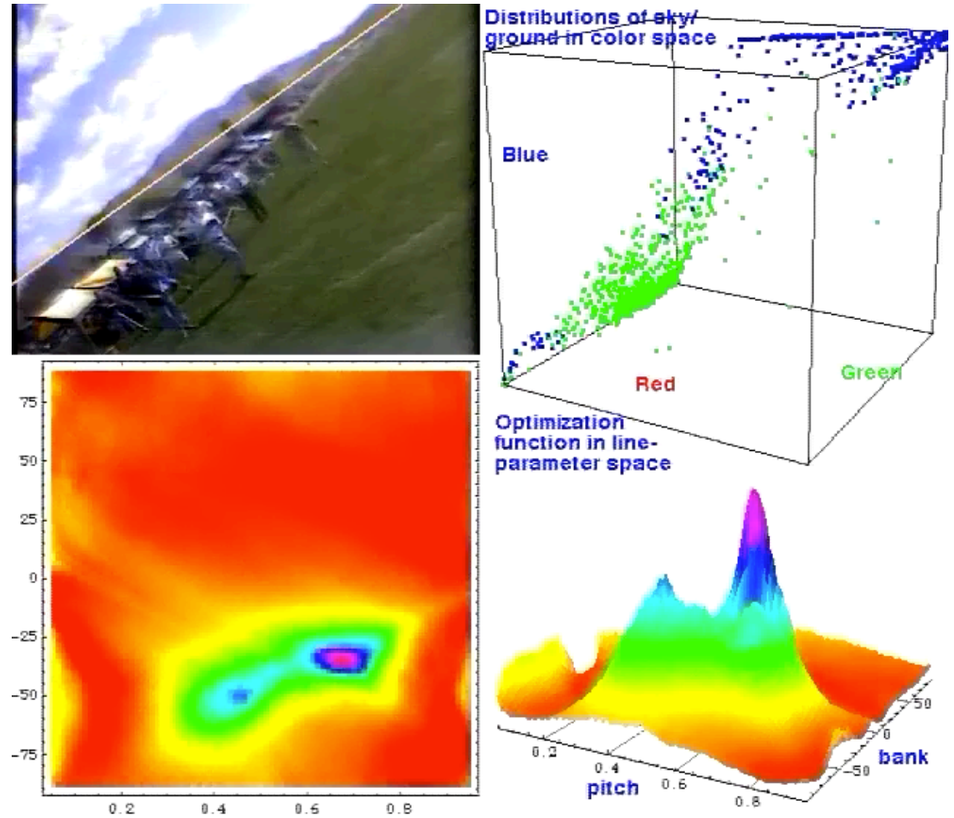
Source: M. Nechyba

Applications: Navigating UAVs









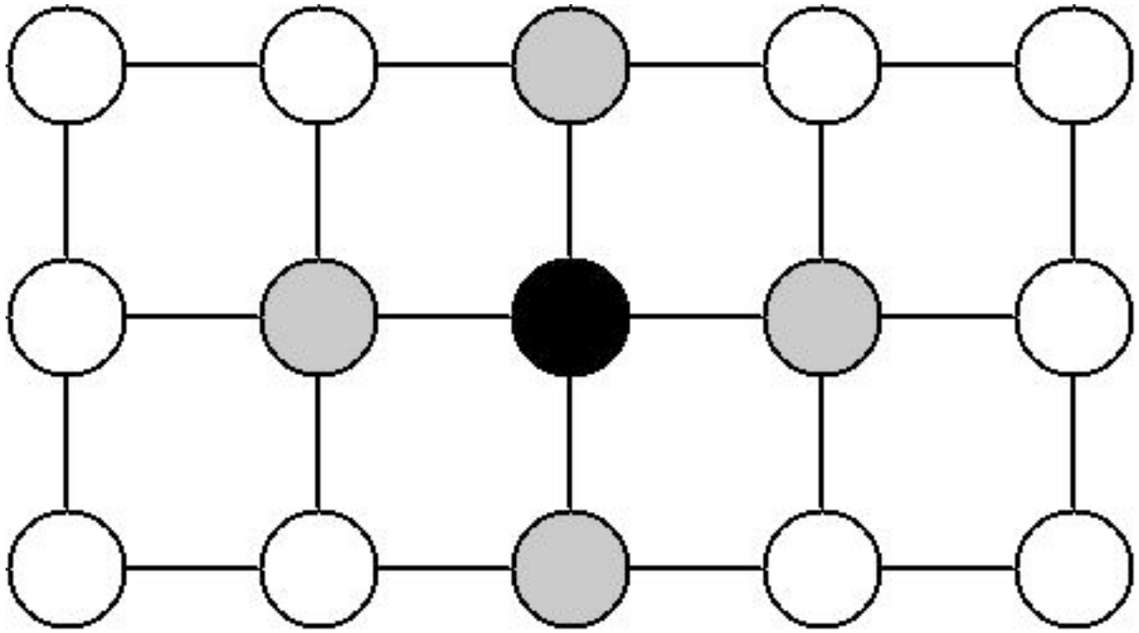
Flight stability and control of Micro Air Vehicles

Source: M. Nechyba

Image Features

Image Structure

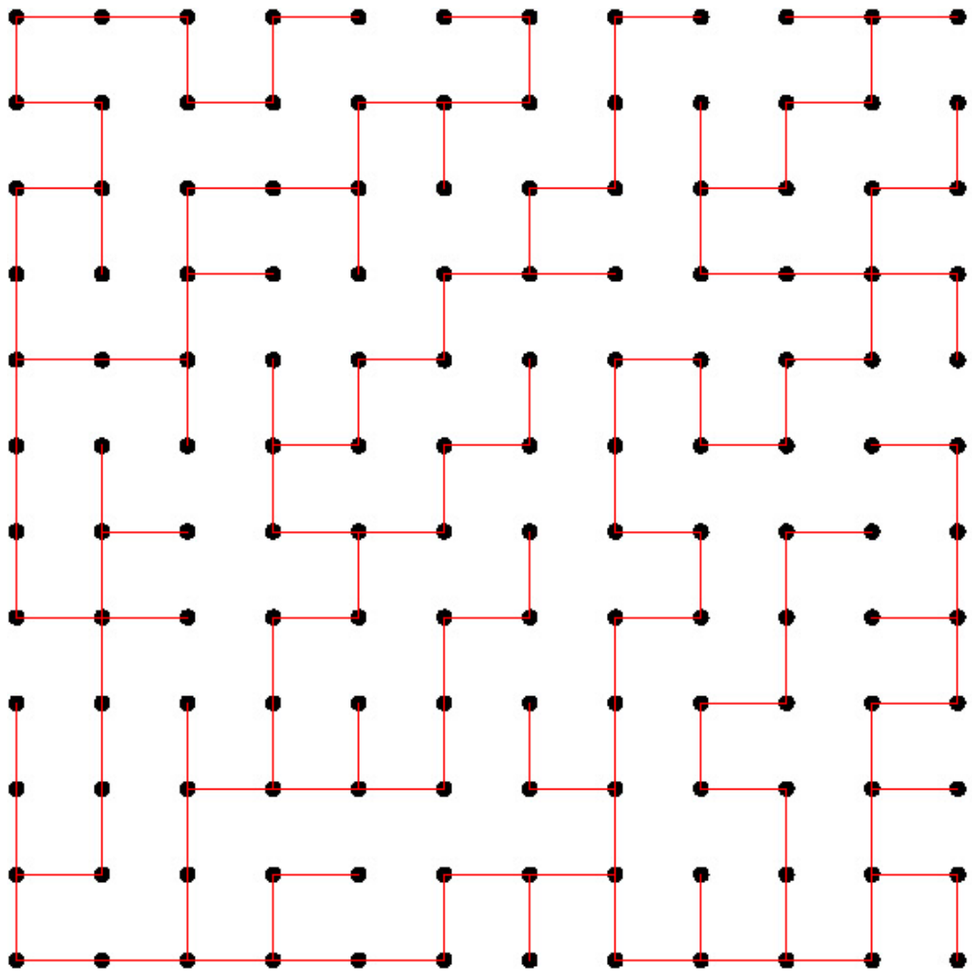
- Pixels, 4-adjacency, 8-adjacency, m-adjacency



4-adjacency

Image Structure

- Path -- directed, undirected, loop



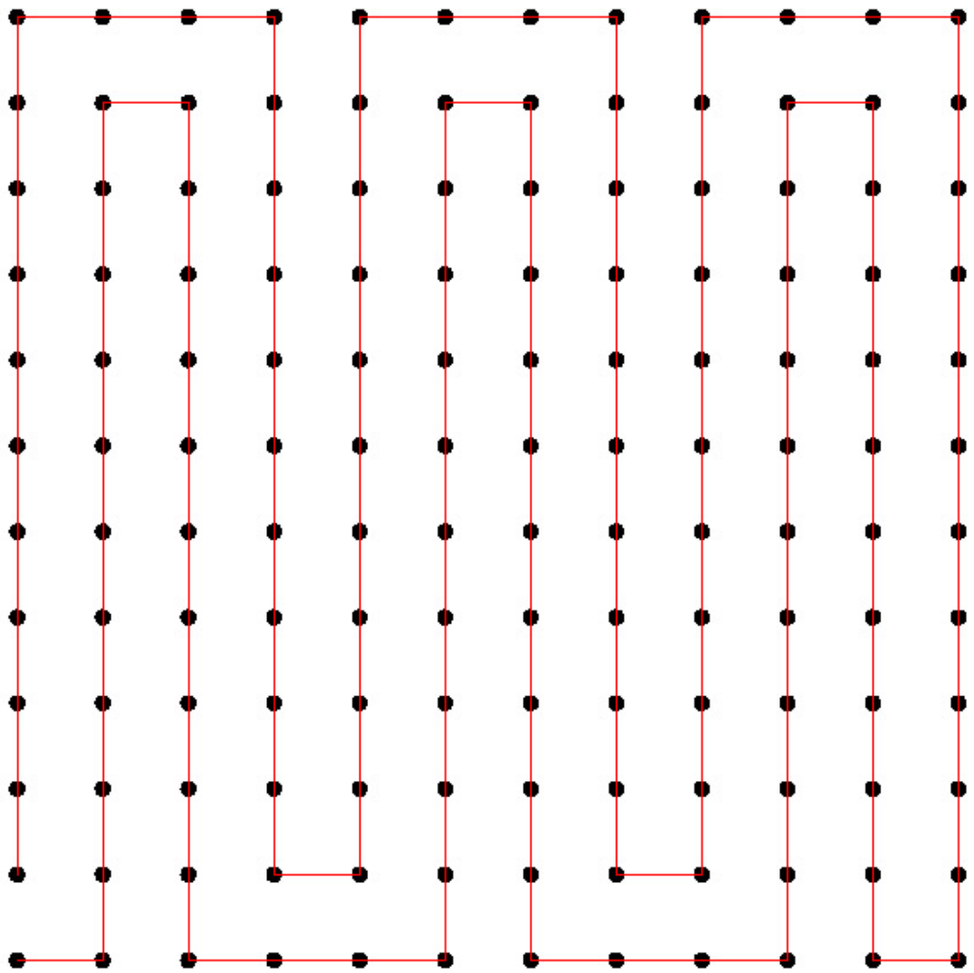


Image Structure

- Edge = Connected pixels with high gradient values

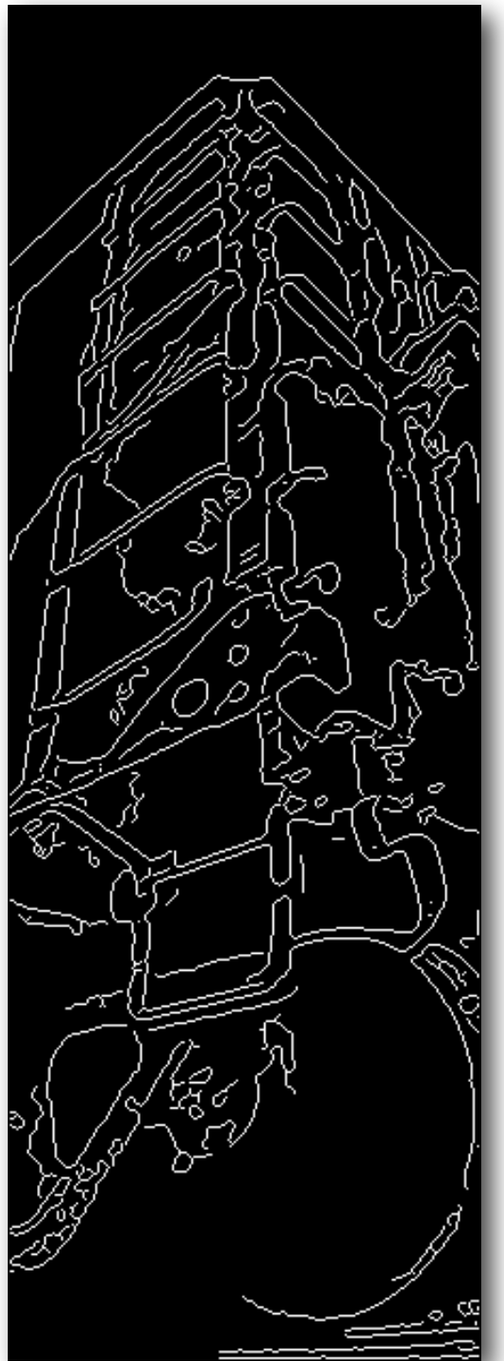


Image Structure

- T-junctions

Image Structure

- T-junctions

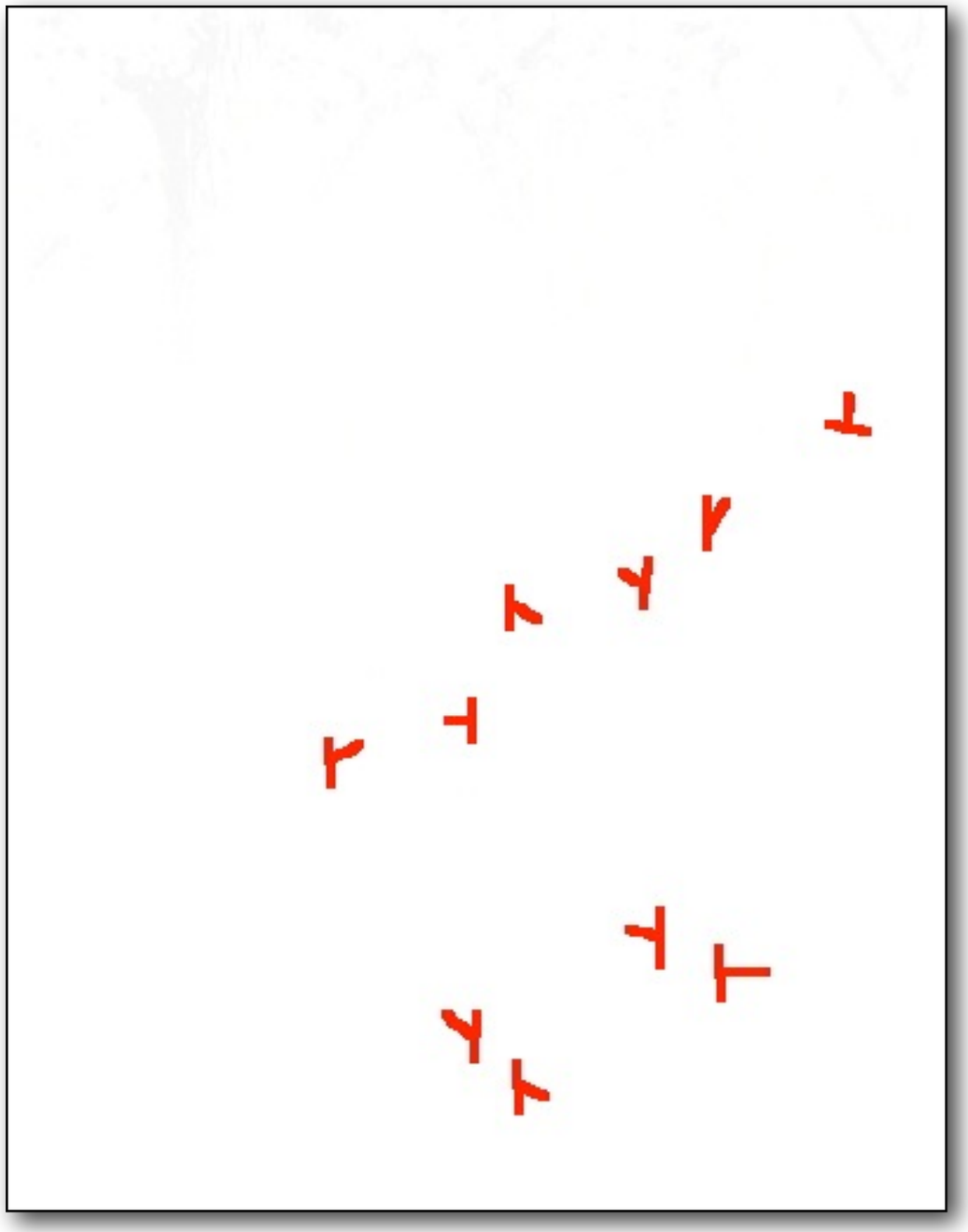


Image Structure

- T-junctions

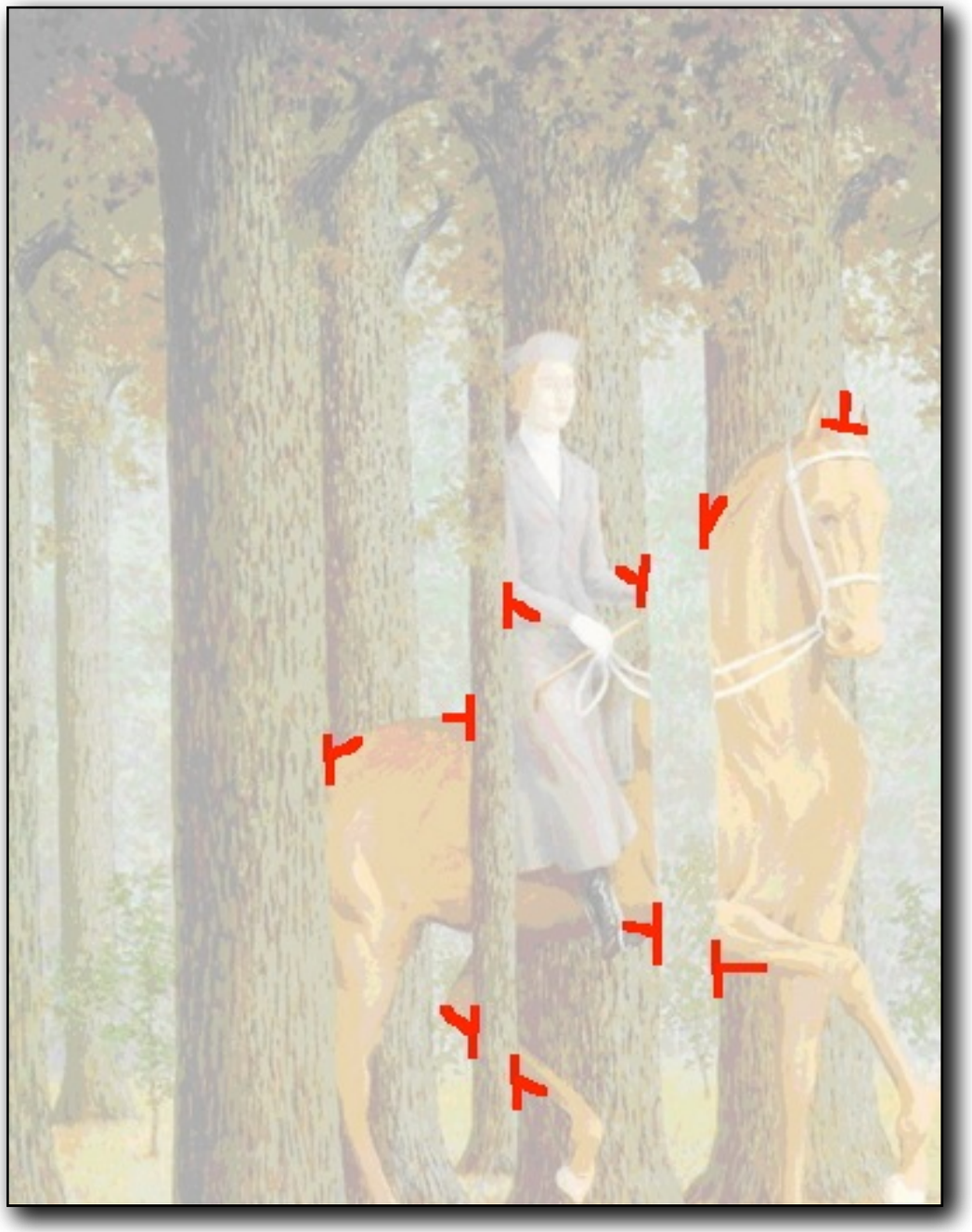


Image Structure

- Interest points = corners, textured patches

Image Structure

- Specularity = Highlights

Image Structure

- Lambertian surface = isotropic reflectance
- Specular surface = zero reflectance except at an angle

Image Structure

- Region = Connected set of pixels
- Region boundary, inner and outer contour

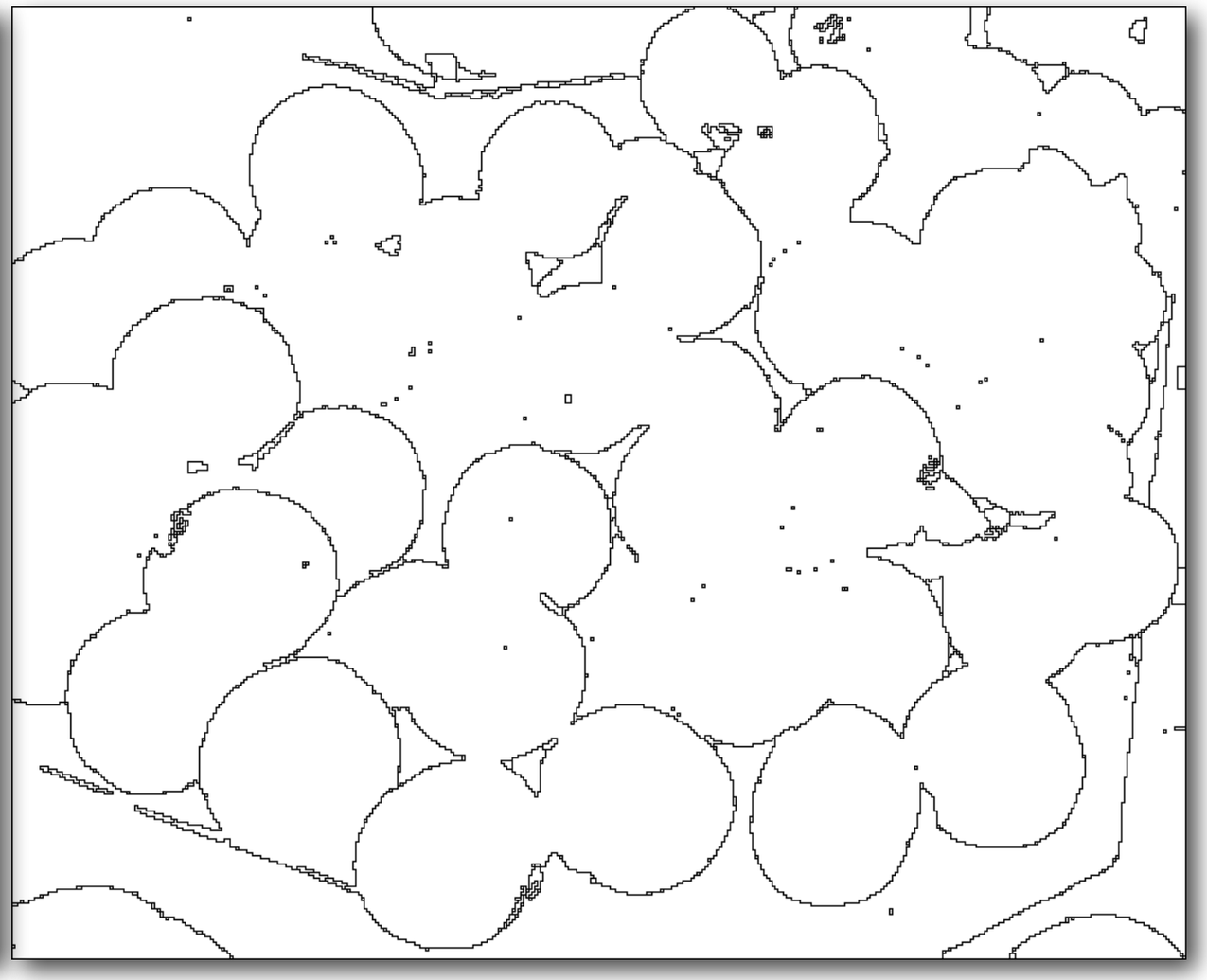


Image Structure

- Texture

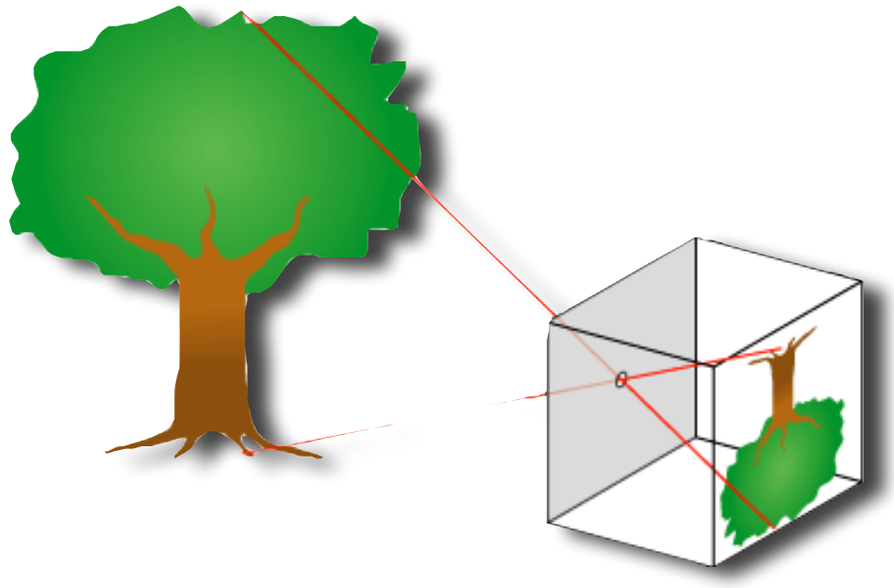
Image Structure

- Dynamic texture

Image Structure

- Foreground - Background

From Image Formation to Image Interpretation



From Image Formation to Image Interpretation

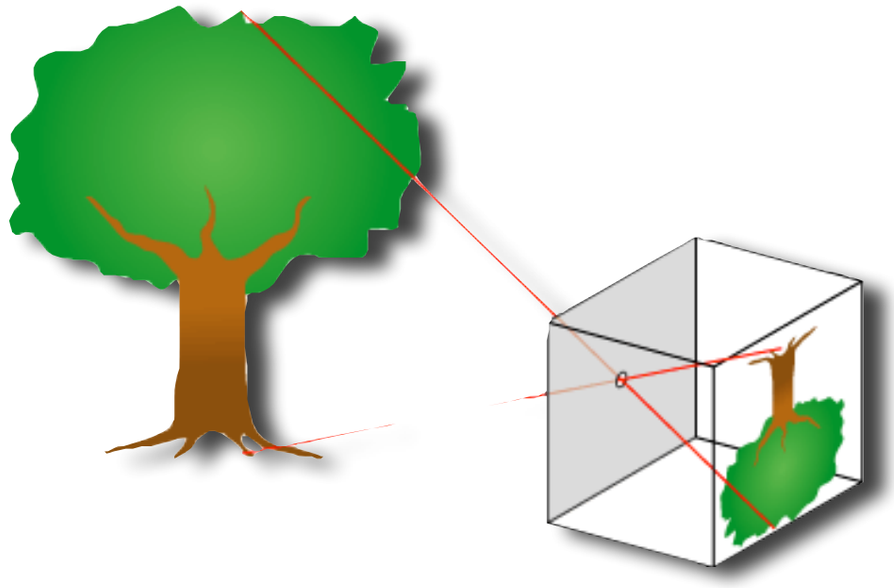


Image interpretation is usually defined in terms of

- Objects, scenes, activities, events
- Spatiotemporal relations between objects, scenes, ...

From Image Formation to Image Interpretation

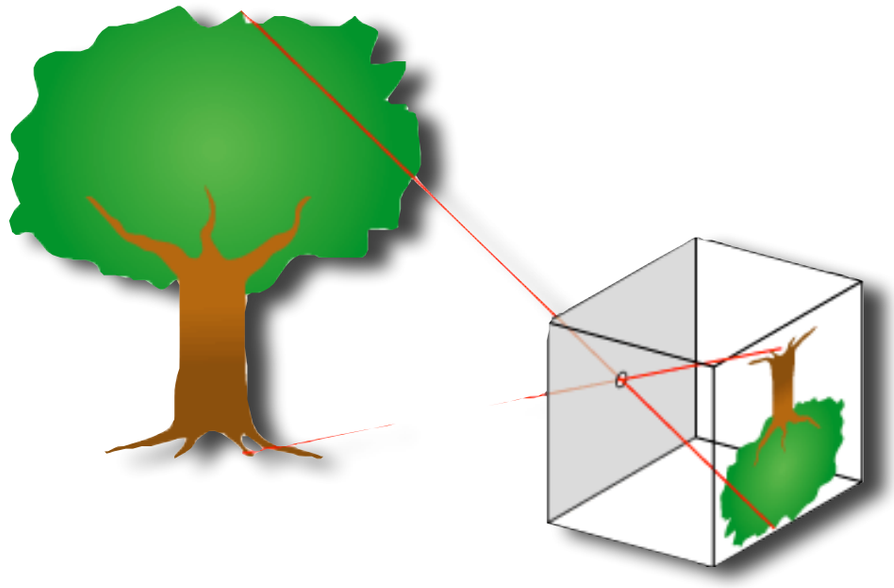
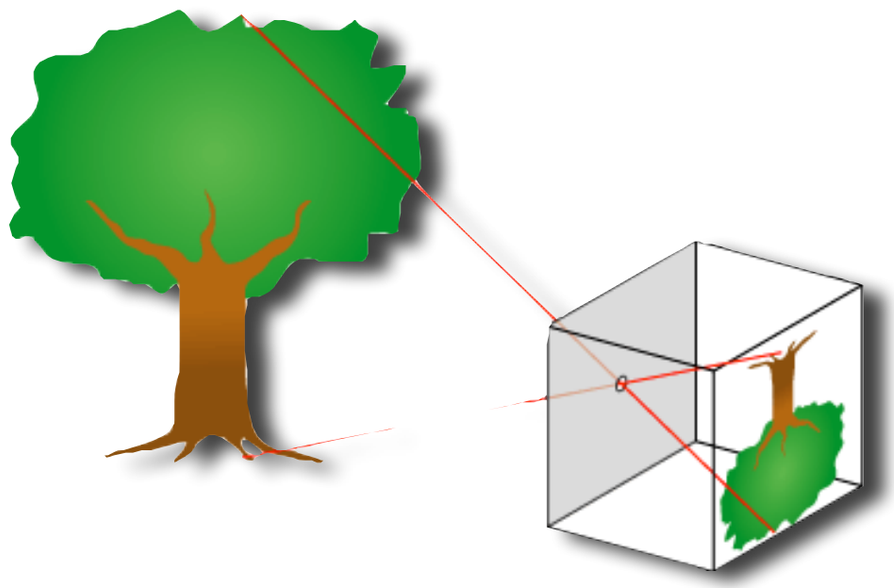


Image properties depend on:

- Imaging conditions
- Visual properties of the 3D world

From Image Formation to Image Interpretation



- Image acquisition parameters:
- Camera distance, viewpoint, motion
- Camera intrinsic parameters (e.g., lens)
- Illumination or Brightness
- Occlusion and Clutter