EE 596
Machine Vision
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Introduction

• What IS computer vision?

  The analysis of digital images by a computer

• Where do images come from?

  You tell me!
Applications: Medical Imaging

CT image of a patient’s abdomen
Visible Man Slice Through Lung
3D Reconstruction
of the Blood Vessel Tree
Robotics

- 2D Gray-tone or Color Images
  "Mars" rover

- 3D Range Images

What am I?
Robot Soccer
Google Driverless Car

**Under the bonnet**

*How a self-driving car works*

Signals from **GPS (global positioning system)** satellites are combined with readings from tachometers, altimeters and gyroscopes to provide more accurate positioning than is possible with GPS alone.

**Lidar (light detection and ranging)** sensors bounce pulses of light off the surroundings. These are analysed to identify lane markings and the edges of roads.

**Radar sensors** monitor the position of other vehicles nearby. Such sensors are already used in adaptive cruise-control systems.

**Video cameras** detect traffic lights, read road signs, keep track of the position of other vehicles and look out for pedestrians and obstacles on the road.

**Ultrasonic sensors** may be used to measure the position of objects very close to the vehicle, such as curbs and other vehicles when parking.

The information from all of the sensors is analysed by a **central computer** that manipulates the steering, accelerator and brakes. Its software must understand the rules of the road, both formal and informal.

*Source: The Economist*
Image Databases:

Images from my Ground-Truth collection:
http://www.cs.washington.edu/research/imagedatabase/groundtruth

• Retrieve images containing trees
Some Features for Image Retrieval

Original Images | Color Regions | Texture Regions | Line Clusters
Documents:
Science

Previous Classification Results:

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<tr>
<td>Dor</td>
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UW and Oregon State University
Surveillance: Event Recognition in Aerial Videos

Original Video Frame

Color Regions

Structure Regions
2D Face Detection
Face Recognition
2D Object Recognition from “Parts”

Part 1 – Det:5e−18

Part 2 – Det:8e−22

Part 3 – Det:6e−18

Part 4 – Det:1e−19

Part 5 – Det:3e−17

Part 6 – Det:4e−24

Background – Det:5e−19
Object Recognition from “Parts”

Part 1 – Det:5e-18

Part 2 – Det:8e-22

Part 3 – Det:6e-18

Part 4 – Det:1e-19

Part 5 – Det:3e-17

Part 6 – Det:4e-24

Background – Det:5e-19

Motorbike shape model

Oxford University
Action Recognition

*Using an* **egocentric** *and multiple static cameras*
Graphics: Special Effects

Andy Serkis, Gollum, Lord of the Rings
3D Reconstruction and Graphics Viewer
3D Craniofacial Shape Analysis from Meshes of Children’s Heads
Digital Breast Biopsy Image Showing Regions of Interest
Digital Image Terminology:

- binary image
- gray-scale (or gray-tone) image
- color image
- multi-spectral image
- range image
- labeled image
The Three Stages of Computer Vision

• low-level

  image  \rightarrow  image

• mid-level

  image  \rightarrow  features

• high-level

  features  \rightarrow  analysis
Low-Level

sharpening

blurring
Low-Level

original image

Mid-Level

data structure

circular arcs and line segments
Mid-level

K-means clustering (followed by connected component analysis)

original color image

data structure

regions of homogeneous color
Low- to High-Level

low-level \rightarrow \text{edge image} \rightarrow \text{mid-level} \leftarrow \text{consistent line clusters} \leftarrow \text{high-level}
We will study

- binary machine vision
- some gray scale operators
- color, texture
- region segmentation
- appearance-based recognition
- interest operators
- content-based image retrieval
- 2D object (shape) recognition
- motion (video) analysis
- 3D reconstruction
- 3D shape analysis