Computer Vision for Mobile Robot Object Identification and Tracking

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In This Presentation

- Overview.
- Introduction.
- Vision-Based Navigation.
- Object Detection (or Segmentation)
- Object Identification (or Classification.)

Computer Vision Applications

- Zip Code Recognition (USPS)
- FBI Fingerprint Database
- Image Stabilization
- Autofocus

Medical Imaging

- Classification and Diagnosis
- MRI Image Segmentation
- Vision-Guided Surgery
- Modeling and Visualization

Material Handling

- Sorting
- Waste Management
- Packing

Industrial Applications

- Printed Circuit Boards
- Quality Assurance
- Automobile Assembly

Intelligent Transportation

- Landmark recognition
- Lane Following
- Road Sign Reading

Human-Computer Interaction

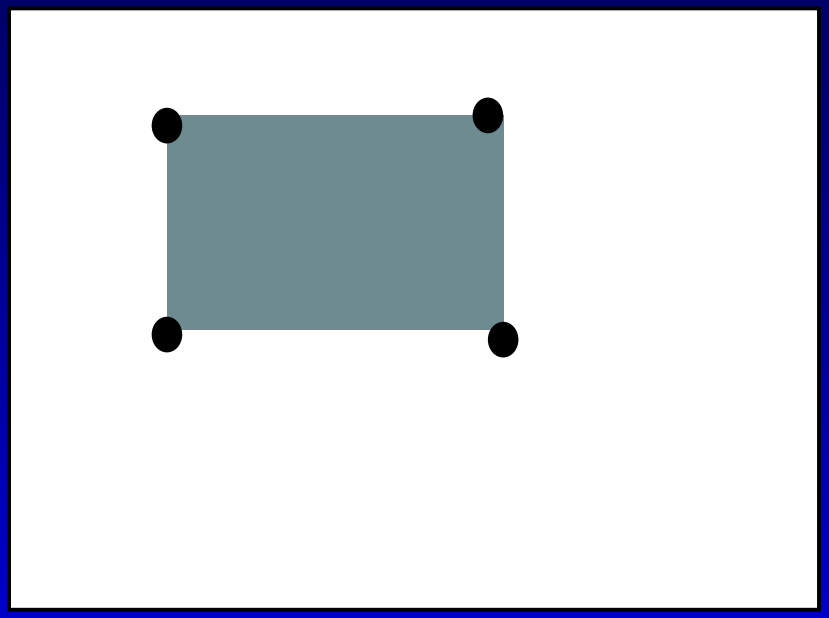
- Eye Tracking
- Lip Reading
- Face Recognition
- Gesture Recognition
- Signature Recognition

Navigation: Main Problems

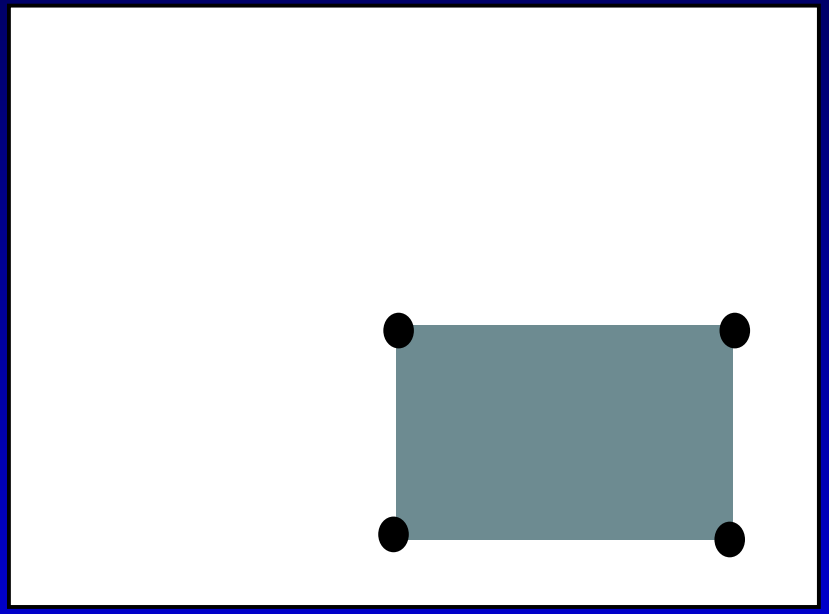
- Feature Correspondence
- Structure From Motion
- Obstacle Avoidance

Feature Correspondence

- Which corner feature is which (very difficult for the computer)?
- Need two Calibrated Cameras



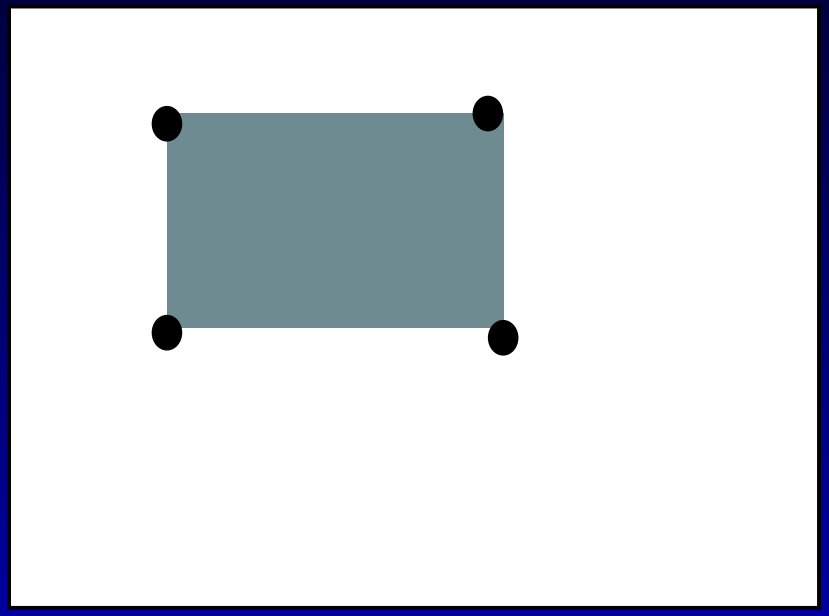
Left Camera



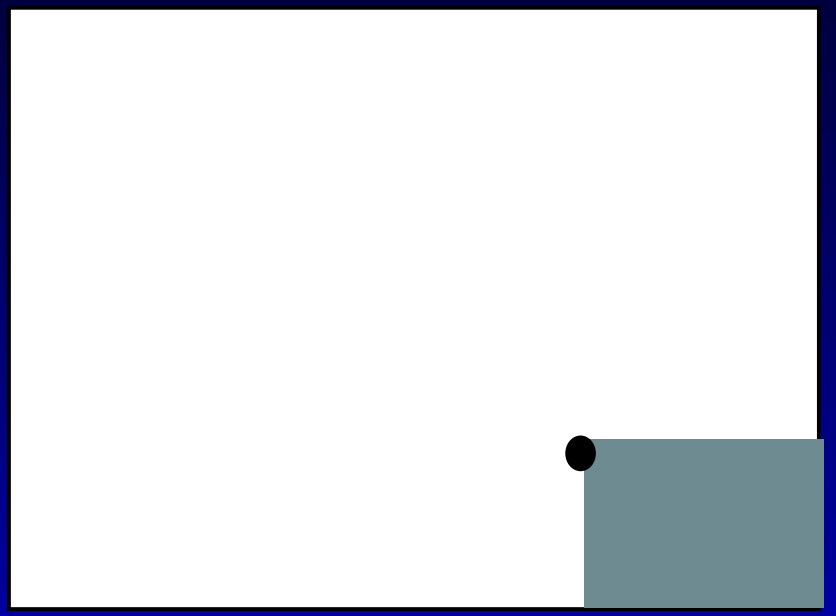
Right Camera

Feature Correspondence

Sometimes it is even worse.



Left Camera



Right Camera

Structure From Motion

- Problem: Need to estimate the depth, z

$$\mathbf{x}_{left} = \mathbf{R}.\mathbf{x}_{right} + \mathbf{T} \quad (1)$$

- $\mathbf{R}$ is a 3×3 rotation matrix
- $\mathbf{T}$ is a 3×1 translation vectors
- Need at least 6 matched feature points to solve for $\mathbf{R}$ and $\mathbf{T}$

Object Detection

Some Famous Methods:

- Background Subtraction
- Thresholding
- Statistical Methods
- Snakes

Background Subtraction

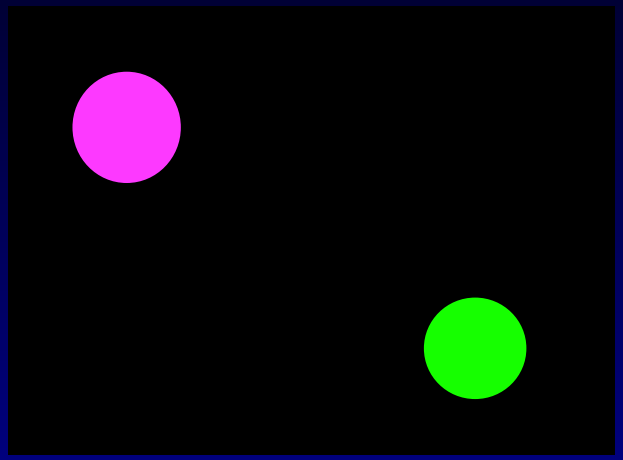
Subtract a well known background image from the current image frame

$$Object = Image_{Current} - Image_{Background} \quad (2)$$

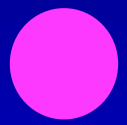
Thresholding

- All pixels with intensity greater than a certain threshold are object pixels.
- Or, all pixels with intensity in a certain range are object pixels.

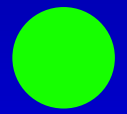
Thresholding



Original Image



Thresholding for the red object



Thresholding for the green object

Object Classification

- After segmenting out the object, we need to classify it (car, ball, dog, or what?)
- Famous Methods
  - Neural Networks
  - String Matching
  - Texture Analysis

Neural Networks

A simple scheme is to feed the network with the object colors and let it decide what object this is.

String matching

The boundary of the object is treated as a string of angels and the similarity between the object's string and the known string is measured. The object is classified to the class with which it gave maximum similarity.

Texture Analysis

The texture of the object is analyzed using tools such as Fourier transform to detect certain patterns of frequencies. The assumption is that different objects have different frequency patterns.

Object Tracking

The main problem is to locate the object from frame to another in the image sequence or the video. One famous method is Active Deformable Models, more commonly known as snakes.

Object Tracking

Figure 1: Target Tracking

Object Tracking

Figure 2: Target Tracking