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CSE 190a: Winter 2009

March 11, 2009

PARKING SPACE VACANCY MONITORING


GENUINE
Ford
PARTS

Outline

- Approach
- Geometry of stereo vision
- System overview
  - 3D reconstruction
- Next steps

Approach

- Vision-based vs. sensors-based
- Other solutions
- Stereo vision
  - Vehicular occlusion

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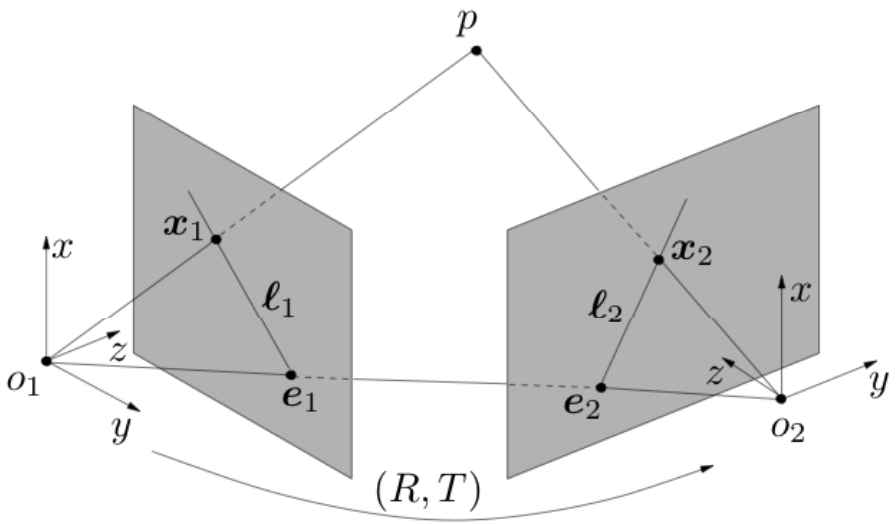
Geometry of stereo vision

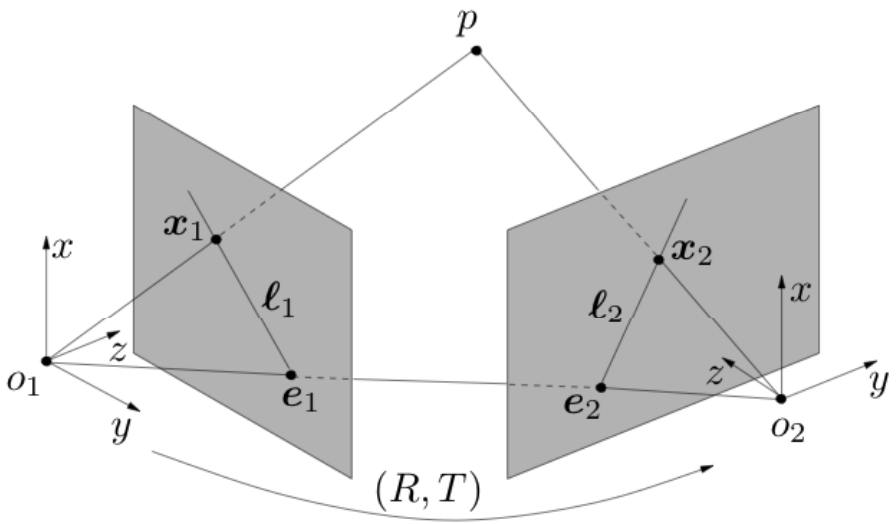
- Epipolar geometry
  - Focal points o_1 and o_2
  - Epipoles e_1 and e_2
  - Epipoles and focal points collinear
  - Baseline (o_1, o_2)

[MaSKS '03]



Geometry of stereo vision

- Epipolar geometry [MaSKS '03]
  - Epipolar lines l_1 and l_2
  - Image rectification – project camera images onto common image, making epipolar lines horizontal
  - Correspondence problem



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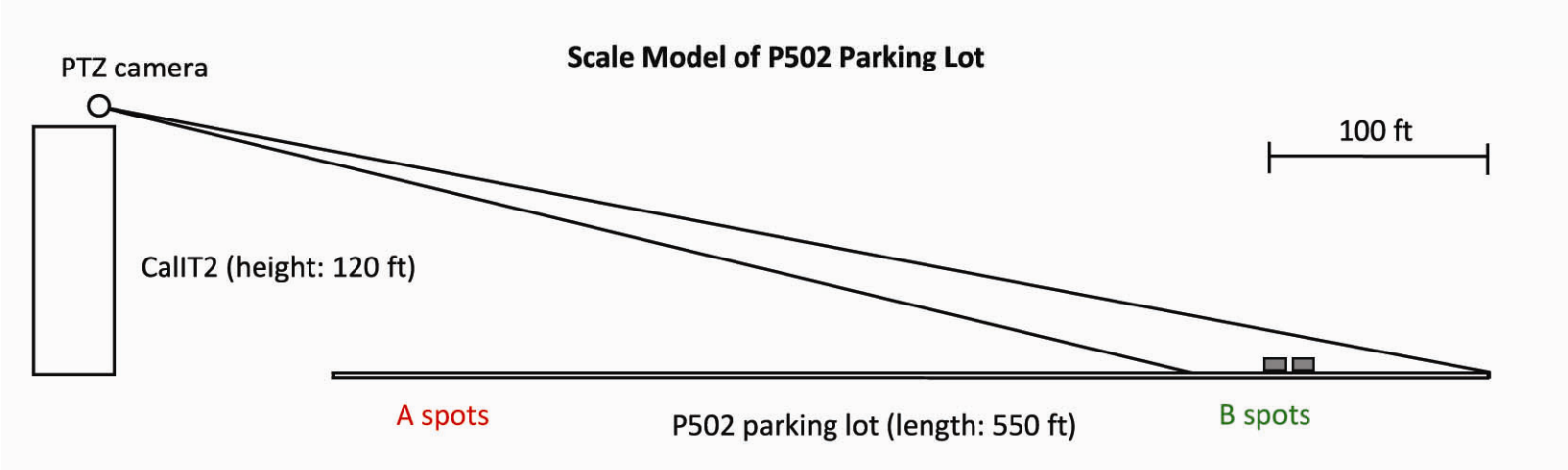
System overview

1. Image capture
2. Feature extraction
3. Reconstruction from stereo pairs
4. Determine vacancy status
5. Driver notification

Image capture

- Roof-mounted PTZ cameras
- Periodic raster scans of the lot
- 1:64 scale model



Feature Extraction

- Harris Corner Detector
- RANSAC-based stereo matching

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3D Reconstruction

- Vehicular occlusion
- By using stereo pairs of images, we can recover metric information from the fixed length of the baseline

- Uncalibrated vs. calibrated?

Uncalibrated reconstruction

- Feature detection
- Find correspondences
- RANSAC to find fundamental matrix
- Triangulation
- Direct upgrade

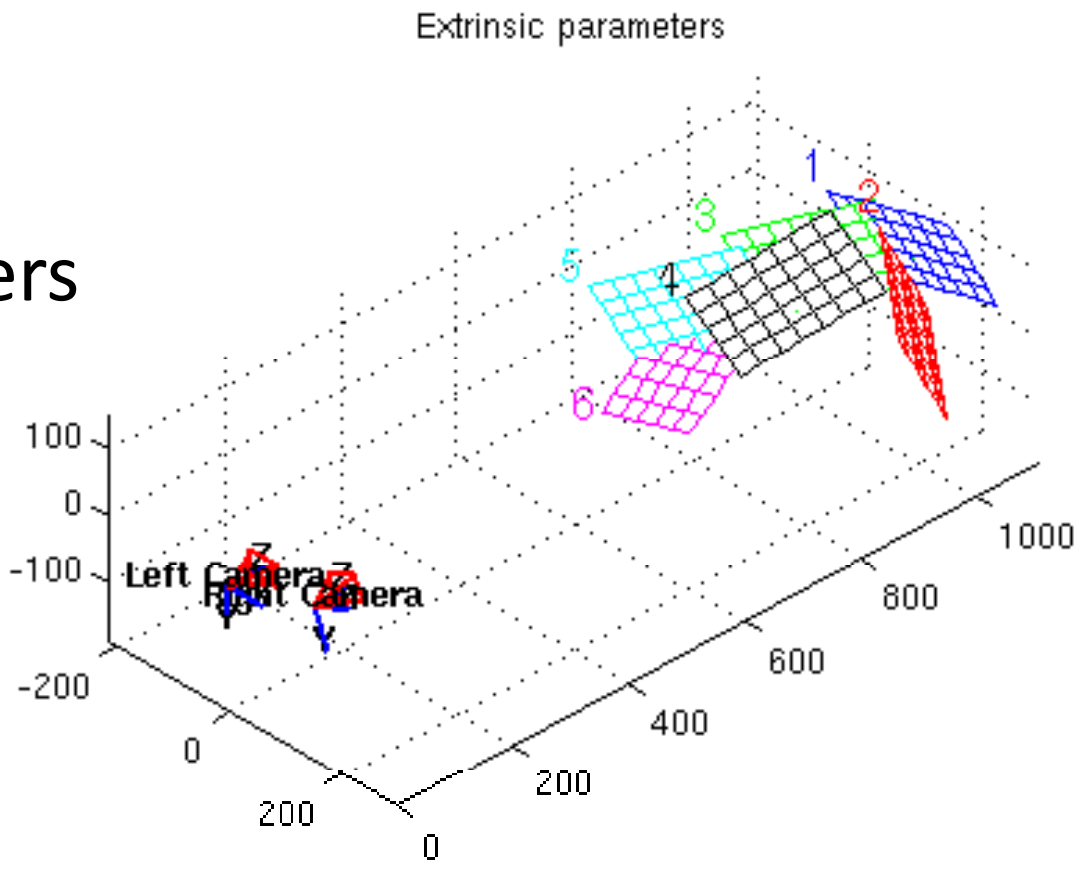
Problems

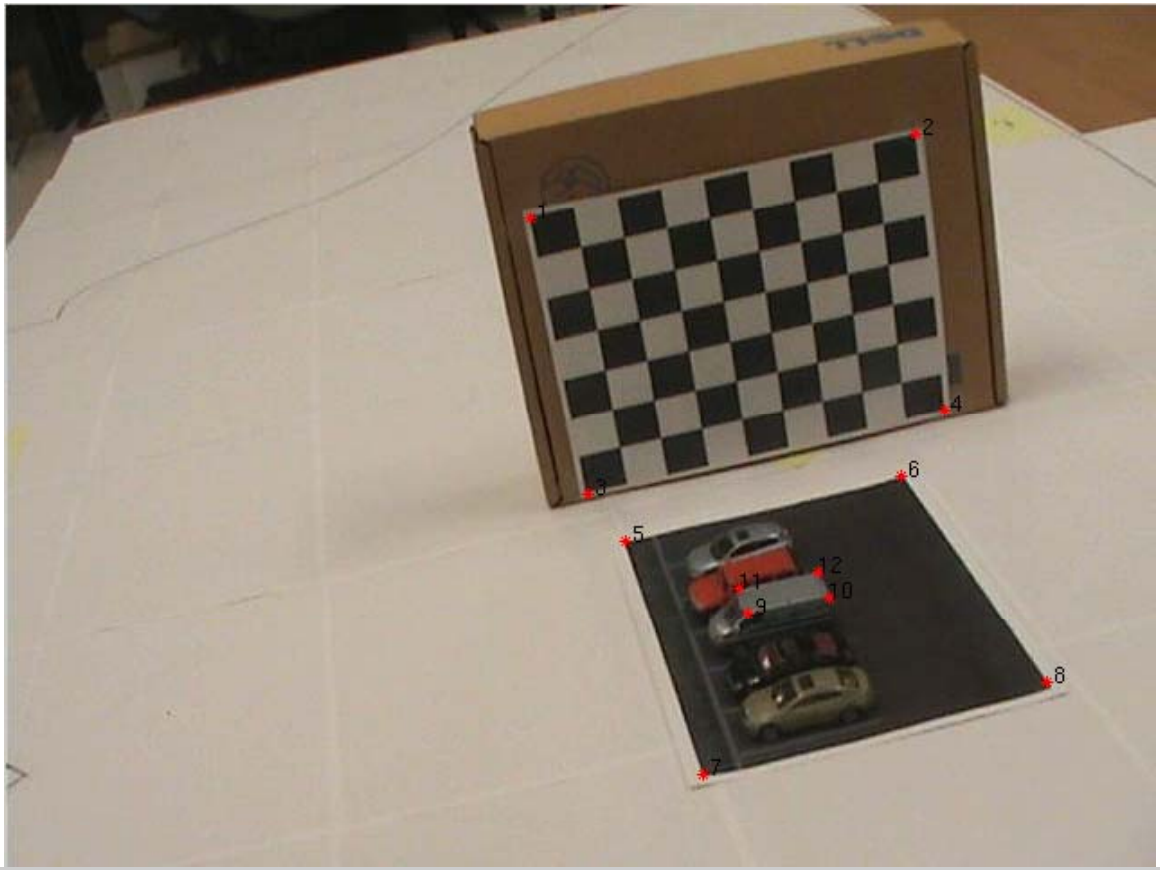
- Spurious features
- Baseline

Calibrated reconstruction

- Extrinsic parameters
  - Rotation
  - Translation
- Intrinsic parameters
  - Focal length
  - Skew
  - Principal point

[Bouguet '00]

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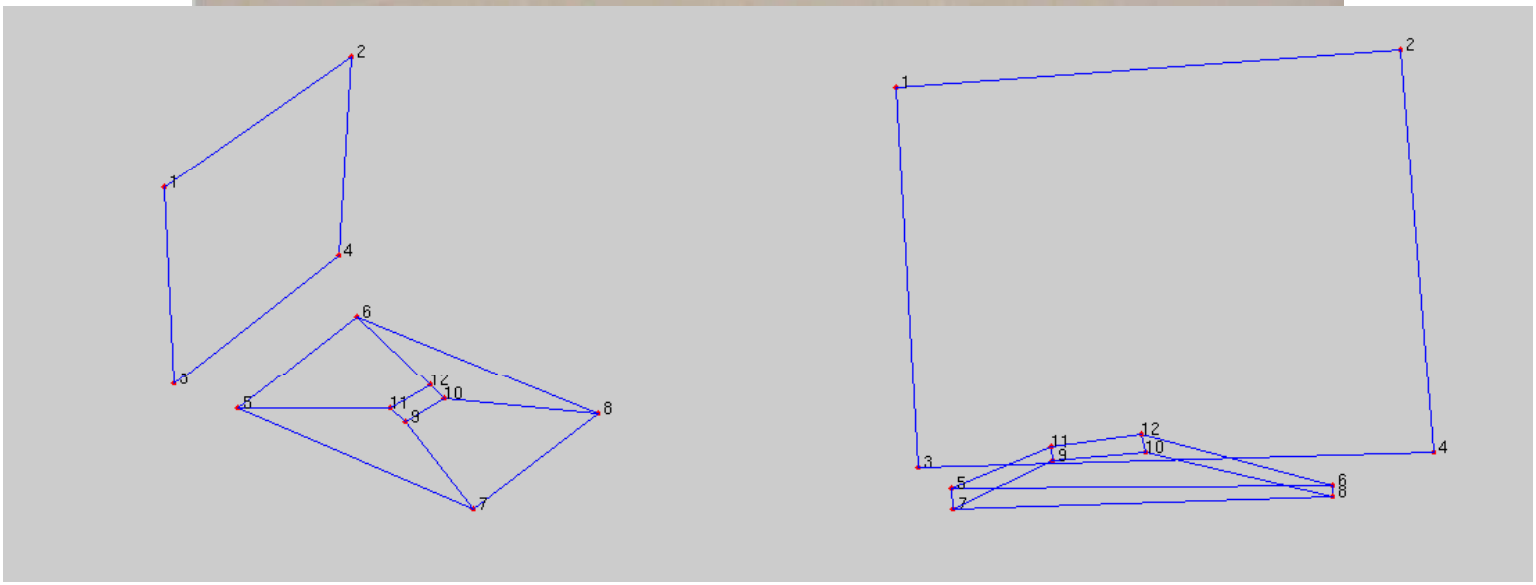
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Image rectification

- Camera pose $g = (R, T)$
- Essential matrix

$$E = \hat{T}R \in \mathcal{R}^{3\times 3}$$

- Epipolar constraint

$$x_2^{\mathsf{T}} E x_1 = 0$$

Vacancy status

- Identification of vacancies
  - Statistical notion of vacancy
- User notification via mobile phone
  - SMS
  - Voice-activated dialing using VoiceXML

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Next steps

- Calibrated reconstruction for automatic correspondences
- Camera calibration for varying focal lengths

QUESTIONS?