CS331B (3 units)

3dRR: Representation and Recognition
CS331B (3 units)

3dRR: Representation and Recognition

Announcements:

- Syllabus will be uploaded today
- Important dates (see also syllabus):
  - 10/17: project proposal is due
  - 11/5: project mid-term report is due
  - 12/13: final project report is due
- After the syllabus is ready, pick up 3 papers you want to present and send your choice to Scott. Rank the papers based on your preference.
- Proposal: change class room to Gates
WHERE
- 3D shape modeling
- 3D scene reconstruction
- Camera localization

WHAT
- Material classification
- Object recognition
- Scene classification
- Target tracking
- Activity recognition

Understanding the 3D world
- 3D Object understanding
- 3D scene understanding
- Activity understanding
WHERE
- 3D shape modeling
- 3D scene reconstruction
- Camera localization

WHAT
- Material classification
- Object recognition
- Scene classification
- Target tracking
- Activity recognition

Understanding the 3D world
- 3D Object understanding
- 3D scene understanding
- Activity understanding
3D object understanding
3D object understanding
Properties of a 3D object detector

- Detect objects under generic view points
- Estimate object pose & 3D shape

Azimuth $\theta$, Zenith $\varphi$
Properties of a 3D object detector

- Detect objects under generic view points
- Estimate object pose & 3D shape
- Work for object categories
Properties of a 3D object detector

- Detect objects under generic view points
- Estimate object pose & 3D shape
- Work for object categories
- Limited amount of supervision
Models for 3d Object detection

- Supervision
- Degree of 3D
- Intra-class variability

Mixture of 2D single view models
Mixture of 2D models

- Weber et al. ‘00
- Schneiderman et al. ‘01
- Ullman et al. ‘02
- Fergus et al. ‘03
- Torralba et al. ‘03

- Felzenszwalb & Huttenlocher ‘03
- Leibe et al. ‘04
- Shotton et al. ‘05
- Grauman et al. ‘05

- Savarese et al, ‘06
- Todorovic et al. ‘06
- Vedaldi & Soatto ‘08
- Zhu et al. ‘08
- Gu & Ren, ‘10

Single view Model

3D Category model

Single view Model
State of the art object detection

“Car” model

PROS: Flexible and easy to learn • Limited supervision • High accuracy
CONS: Single view models are independent • Many false alarms • Non scalable to large number of categories/view-points • Cannot estimate 3D pose or 3D layout
Models for 3D Object detection

- Single instance models
- Mixture of 2D single view models

Axes:
- Supervision
- Degree of 3D
- Intra-class variability
Where is the crunchy nut?
Single instance of 3D models

3D single instance model

• Ballard, ‘81
• Kanade ‘81
• Grimson & L.-Perez, ’87
• Lowe, ’87
• Edelman et al. ‘91
• Ullman & Barsi, ’91
• Rothwell ‘92
• Linderberg, ’94
• Murase & Nayar ‘94
• Zhang et al ‘95
• Schmid & Mohr, ‘96
• Schiele & Crowley, ’96
• Lowe, ‘99
• Jacob & Barsi, ’99
• Rothganger et al., ‘04
• Ferrari et al, ’05
• Brown & Lowe ’05
• Yin & Collins, ’07
• Collet et al. 09-11
• Hsiao et al. 10-12
Single instance of 3D models

PROS: Accurate single instance detection results • Enable 6 DOF pose estimation;
CONS: Cannot generalize to categories • Require large degree of supervision

Lowe, ’87
Models for 3d Object detection

- Single instance models
- 2D ½ implicit models
- Mixture of 2D single view models
2D ½ implicit models

- Savarese & Fei-Fei, ICCV 07
- Savarese & Fei-Fei, ICCV 07
- Su, Sun, Fei-Fei, Savarese, CVPR 2009
- Sun, Su, Fei-Fei, Savarese, ICCV 2009
- Thomas et al. ’06-09
- Kushal, et al., ’07
- Farhadi ’09
- Zhu et al. ’09
- Ozuysal et al. ‘10
- Stark et al.’10
- Payet & Todorovic, 11
- Glasner et al., ‘11

\[ H_{ij} \]
2D ½ implicit models

- Savarese & Fei-Fei, ICCV 07
- Savarese & Fei-Fei, ECCV 08
- Su, Sun, Fei-Fei, Savarese., CVPR 2009
- Sun, Su, Fei-Fei, Savarese, ICCV 2009
- Thomas et al. ‘06-09
- Kushal, et al., ‘07
- Farhadi ‘09
- Zhu et al. ‘09
- Ozuysal et al. ‘10
- Stark et al.’10
- Payet & Todorovic, 11
- Glasner et al., ‘11

Object is represented by a collection of parts

Parts relationship are learnt from training images with little supervision

**PROS:** Generalize well to categories • Little supervision

**CONS:** 2D ½: cannot easily infer 3D part configurations
Models for 3d Object detection

- Single instance models
- 3D explicit models
- 2D ½ implicit models
- Mixture of 2D single view models

Supervision vs. Intra-class variability vs. Degree of 3D
3D explicit models

- Sun, Xu, Bradski, Savarese, ECCV 2010
- Sun, Kumar, Bradski, Savarese, 3DIM-PVT 2011
- Kumar, Sun, Savarese, CVPR 12
- **Xiang & Savarese, CVPR 12**

PROS: Enable estimation of 6DOF object pose and 3D part configuration

CONS: Larger degree of supervision