CS331B (3 units)

3dRR: Representation and Recognition

Lecture 3
CS331B (3 units)

3dRR: Representation and Recognition

Announcements:
- Project proposal deadline coming up in 10 days!
- Look at the syllabus for updates
Understanding the 3D world

- 3D Object detection
- 3D scene understanding
- Activity understanding
Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
- Depth maps (from Stereo, D-RGB, etc.... )

From X. Ren et al., CVPR 11, UW-dataset
Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
- Depth maps (from Stereo, D-RGB, etc....)
- Orientation maps (from single view)

Hoiem et al. 05
Representing the 3D space

- Retinotopics (each 2D pixel is associated to a depth value)
- Depth maps (from Stereo, D-RGB, etc.... )
- Orientation maps (from single view)
Representing the 3D space
- 3D point clouds (2D features are associated to 3D points)

From sparse images (SFM)

- Lucas & Kanade, 81
- Chen & Medioni, 92
-Debevec et al., 96
-Levoy & Hanrahan, 96
-Levoy et al., 00
-Hartley & Zisserman, 00
-Dellaert et al., 00
-Rusinkiewic et al., 02
-Nister, 04
-Brown & Lowe, 04
-Schindler et al., 04
-Lourakis & Argyros, 04
-Colombo et al., 05
-Savarese et al., IJCV 05
-Savarese et al., IJCV 06
-Saxena et al., 07-09
-Snavely et al., 06-08
-Schindler et al., 08
-Agarwal et al., 09
-Frahm et al., 10
-Golparvar-Fard, et al. IAEI 10
-Pandey et al. IFAC, 2010
-Pandey et al. ICRA 2011
Representing the 3D space

- 3D point clouds (2D features are associated to 3D points)

From video frames (SLAM)

Fitzgibbon & Zisserman, 98
Triggs et al., 99
Pollefeys et al., 99
Kutulakos & Seitz, 99
Lucas & Kanade, 81
Chen & Medioni, 92
Debevec et al., 96
Levoy & Hanrahan, 96
Levoy et al., 00
Hartley & Zisserman, 00
Dellaert et al., 00
Rusinkiewicz et al., 02
Nister, 04
Brown & Lowe, 04
Schindler et al., 04
Lourakis & Argyros, 04
Colombo et al., 05
Savarese et al., IJCV 05
Savarese et al., IJCV 06
Saxena et al., 07-09
Snavely et al., 06-08
Schindler et al., 08
Agarwal et al., 09
Frahm et al., 10
Golparvar-Fard, et al. JAEI 10
Pandey et al. IFAC, 2010
Pandey et al. ICRA 2011
Representing the 3D space

- Ground-plane models

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013
- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12
Representing the 3D space

- Ground-plane models
Representing the 3D space

- Ground-plane + walls

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
- Hedau et al. 09
- Bao, et al. CVPR 2010
- Choi et al., 2013

- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12
Representing the 3D space

- Block-world models

• Hoiem et al. 06-10
• Saxena et al. 06-09
• Gould et al. 09
• Hedau et al. 09
• Bao, et al. CVPR 2010
• Choi et al., 2013
• Lee et al. 09,10
• Gupta et al. 10, 11
• Koppula et al. 11
• Guo & Hoiem 12
• Del Pero et al., 12
• Schwing & Urtasun, 12
Representing the 3D space

- Box model

  - Hoiem et al. 06-10
  - Saxena et al. 06-09
  - Gould et al. 09
  - Hedau et al. 09
  - Bao, et al. CVPR 2010
  - Choi et al., 2013
  - Lee et al. 09,10
  - Gupta et al. 10, 11
  - Koppula et al. 11
  - Guo & Hoiem 12
  - Del Pero et al., 12
  - Schwing & Urtasun, 12
Representing the 3D space

- Box model

- Hoiem et al. 06-10
- Saxena et al. 06-09
- Gould et al. 09
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- Bao, et al. CVPR 2010
- Choi et al., 2013

- Lee et al. 09,10
- Gupta et al. 10, 11
- Koppula et al. 11
- Guo & Hoiem 12
- Del Pero et al., 12
- Schwing & Urtasun, 12
Representing the observer

• Perspective (pinhole) camera models
  (typically used in methods for 3D reconstruction such as SFM or SLAM)

\[(x, y, z) \rightarrow (f \frac{x}{z}, f \frac{y}{z})\]
Representing the observer

- Perspective (pinhole) camera models
  (typically used in methods for 3D reconstruction such as SFM or SLAM)
Representing the observer

- **Affine camera models**
  (typically used in simplified 3D reconstruction methods such as affine-SFM)

\[
\begin{align*}
x' &= -\frac{f'}{z} x \\
y' &= -\frac{f'}{z} y
\end{align*}
\]

\[
\begin{align*}
x' &= -x \\
y' &= -y
\end{align*}
\]
Representing the observer

- Affine camera models
  (typically used in simplified 3D reconstruction methods such as affine-SFM)
Representing the observer

- Simplified camera models
  Approximated but enable simple relationships between objects, space and observer