CS63500
Capturing, Modeling, and Rendering 3D Structures

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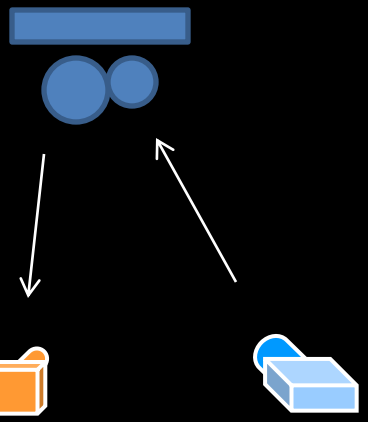
- Topic:
  - Covers fundamental problems and challenges encountered when capturing, modeling, and rendering 3D structures and objects.
  - Covers material in computer graphics, computer vision, and visualization
- Goal:
  - To bring students up to speed in latest methods (research)
  - To enable students to develop new and improved approaches

Syllabus

- Applied Optimization
  - Least squares, simulated annealing, MCMC, neural networks, etc.
- Light-Transport based Methods
- Geometry and Image-based Acquisition
- Deep Learning Based Reconstruction
- Computational Images and Displays
- 3D Printing
- …and more!

Light Transport Based Methods

- Can encode light (or projector) to camera “transport” in a large matrix T



Camera c Projector p

$$\begin{bmatrix} c \end{bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{bmatrix} p \end{bmatrix}$$

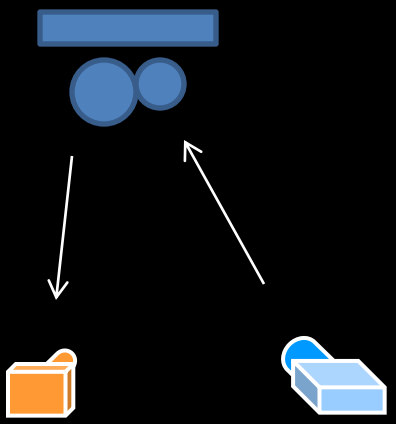
As seen from camera…

$$\begin{bmatrix} p \end{bmatrix} = \begin{bmatrix} T^t \end{bmatrix} \begin{bmatrix} c \end{bmatrix}$$

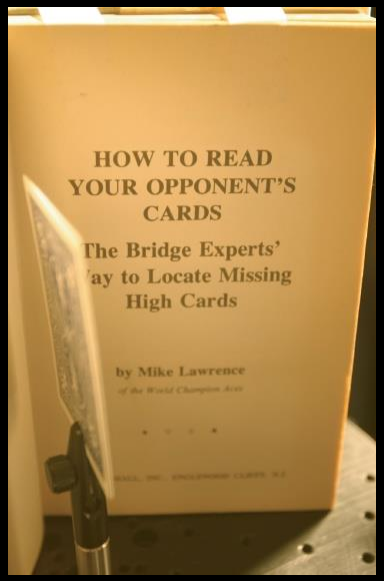
As seen from projector!!!

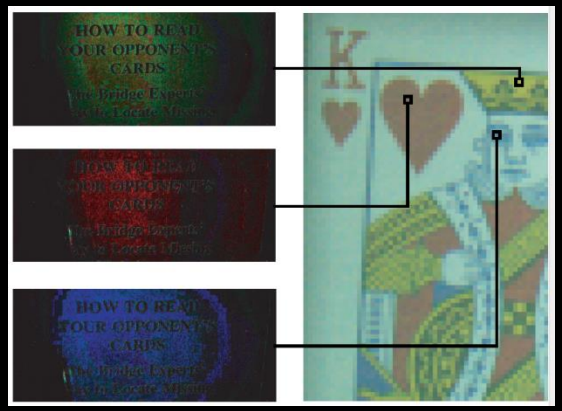
Light Transport Based Methods

- Can encode light (or projector) to camera “transport” in a large matrix T



Camera c Projector p





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As seen from camera…

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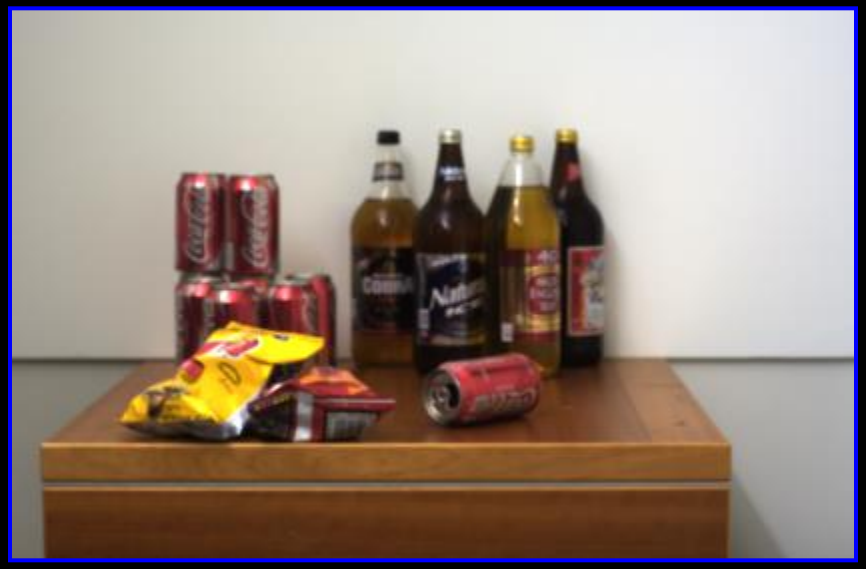
As seen from projector!!!

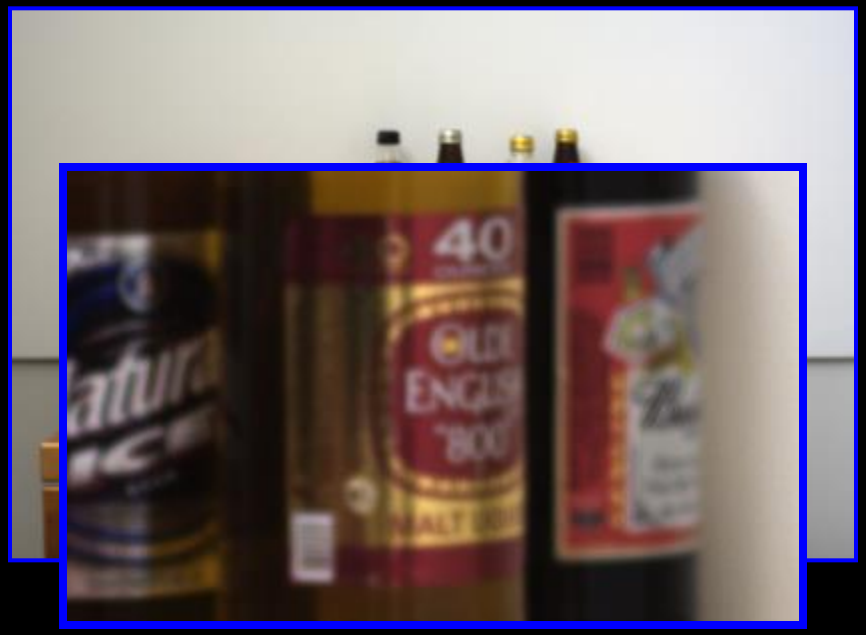
Output #1: Depth map

Single input image:

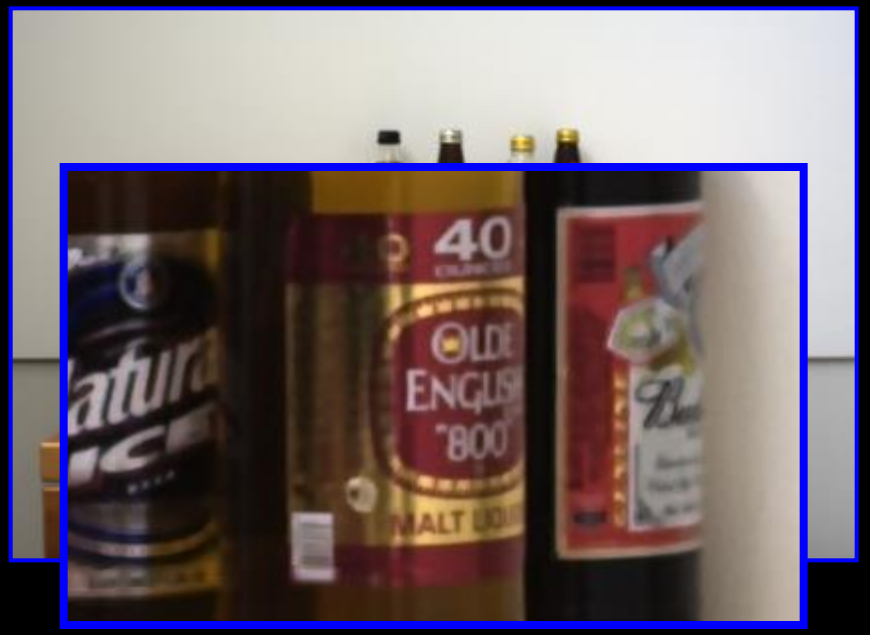


Output #1: Depth map

Single input image:



Output #2: All-focused image

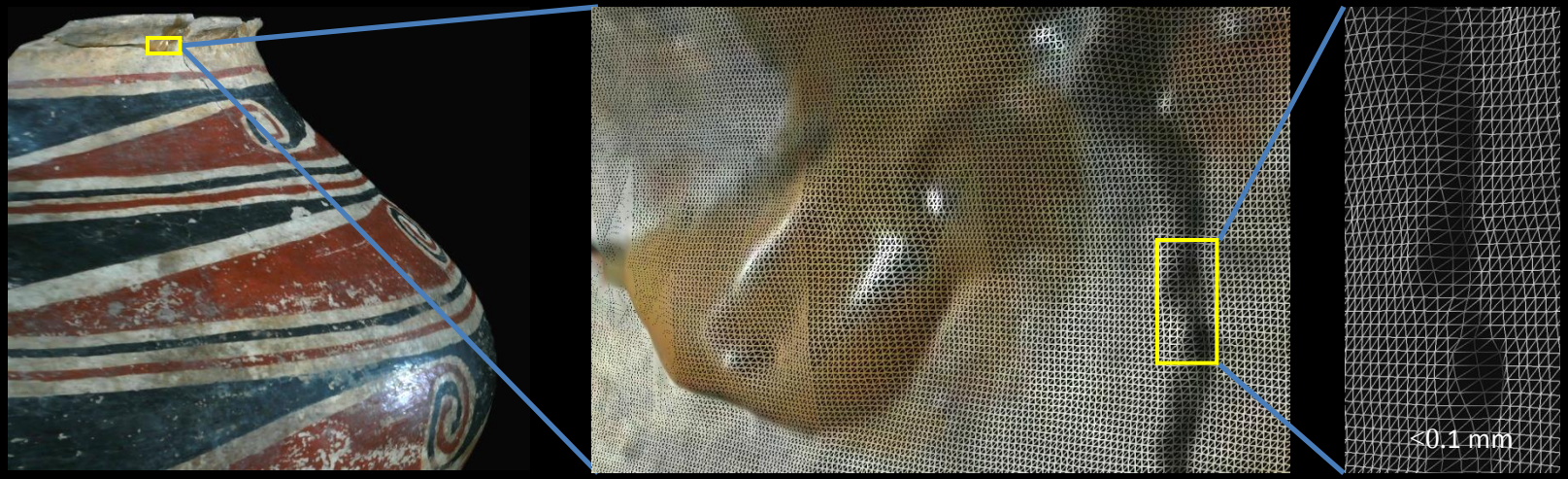


Light in Slow Motion

- https://www.youtube.com/watch?v=Y_9vd4HWlVA

Photogeometric Acquisition

To provide an easy-to-use and high-resolution acquisition platform for deployment



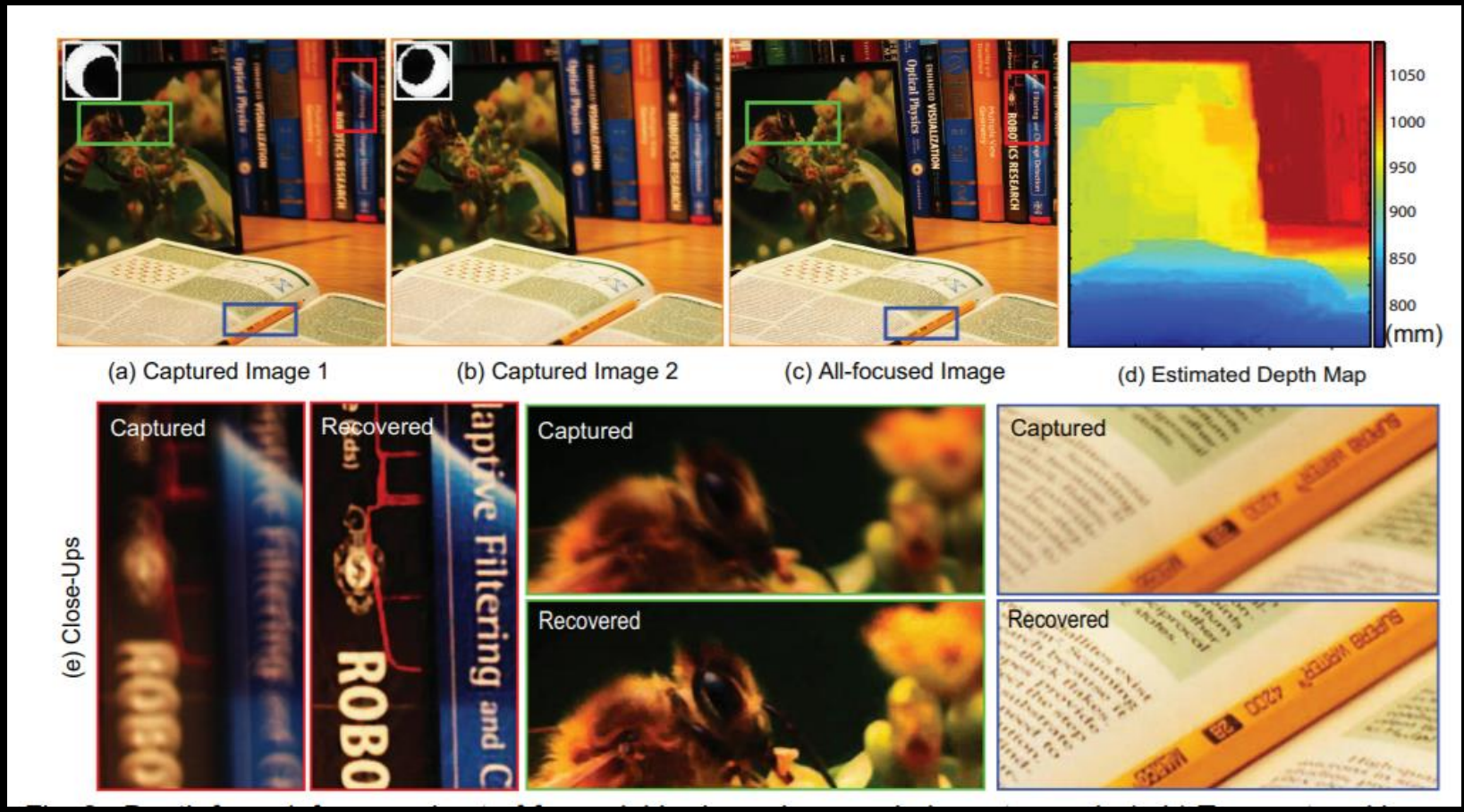
Deblurring and Precorrection (to prevent blurring)

- Some approaches:
  - Inverse Filter
  - Wiener Filter
  - Lucy Richardson
  - And more!

Build your own coded aperture

Voila!

Coded Aperture Deblurring

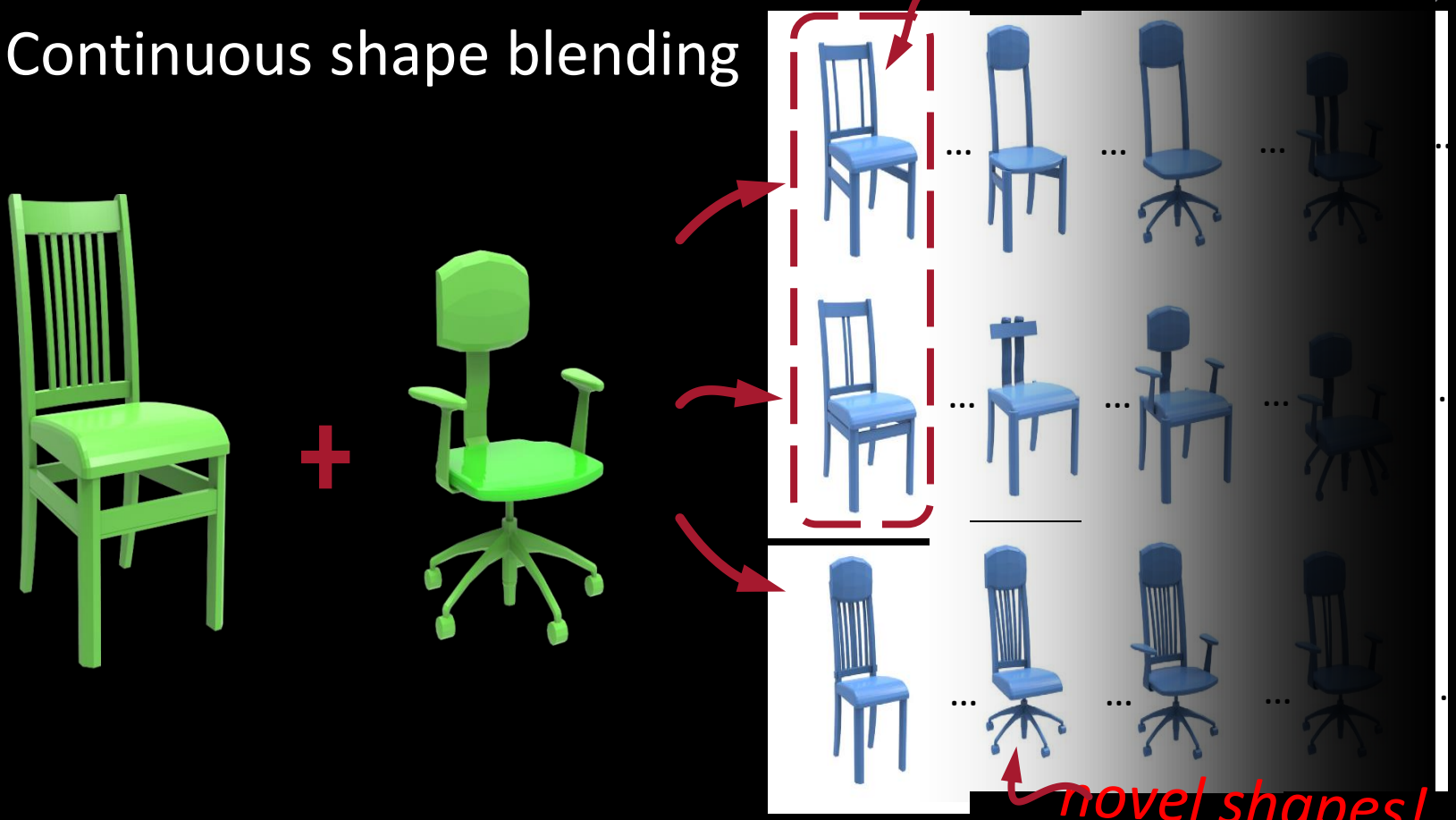


Rectified Crop

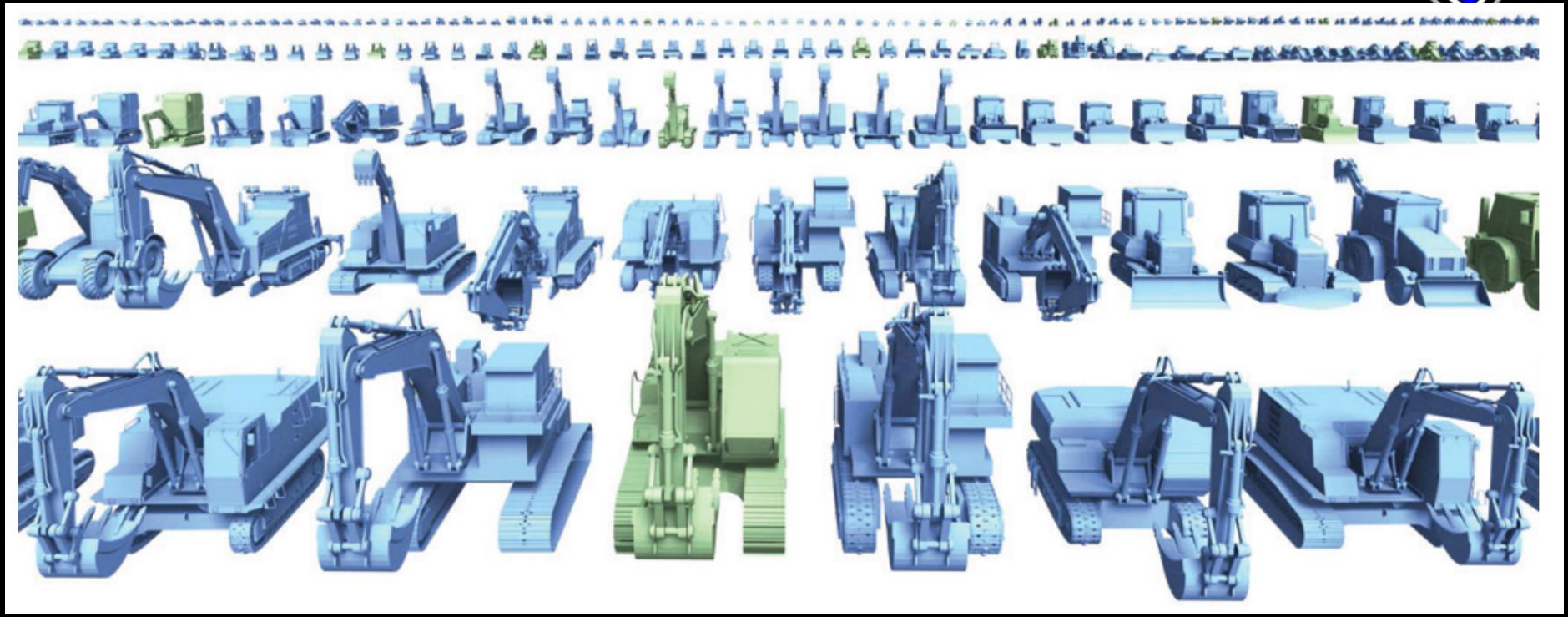
Deblurred Result

Structure Aware Modeling

- Continuous shape blending



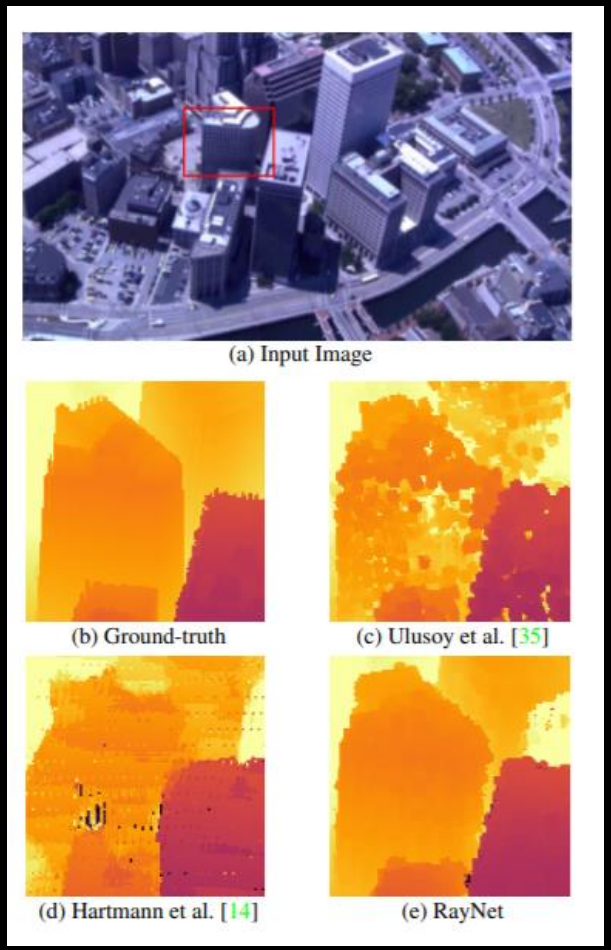
Structure Aware Modeling: Probabilistic synthesis



Green models are from the training set; blue ones are synthesis results

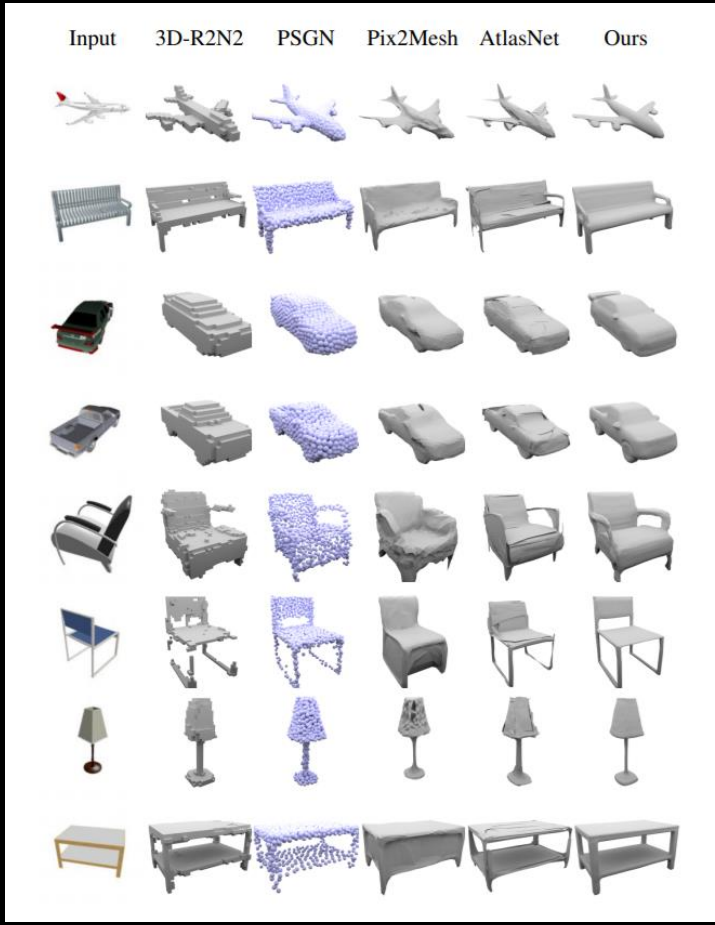
Deep Learning and 3D Reconstruction

- RayNet: volumetric 3D reconstruction



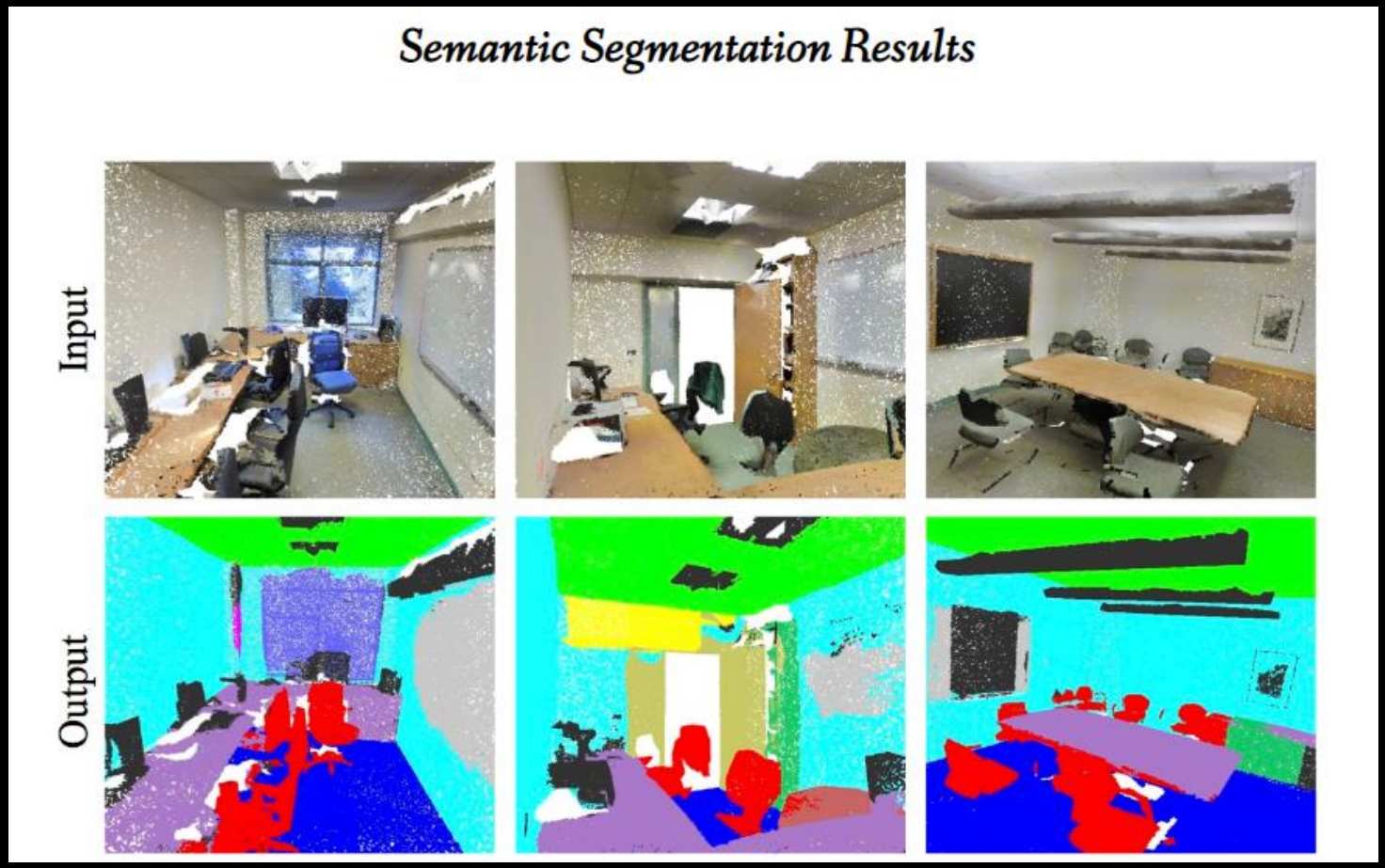
Deep Learning and 3D Reconstruction

- OccNet: occupancy-based reconstruction



Deep Learning and 3D Reconstruction

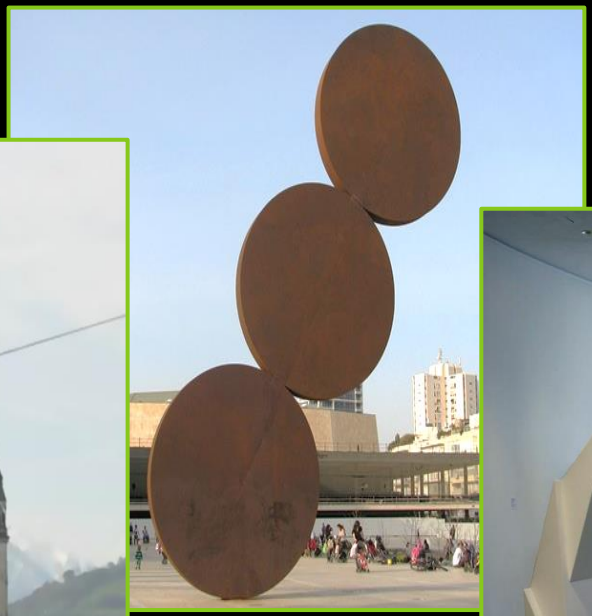
- Semantic Segmentation



Computational Displays

- http://gl.ict.usc.edu/Research/3DDisplay/

3D Printing: Self Standing



3D Printing: Self Standing

- Automatic balancing
  - Stability & shape preservation
  - Inner carving & shape deformation

Questions?

Come to CS635 in the Spring!

or email aliaga@purdue.edu...