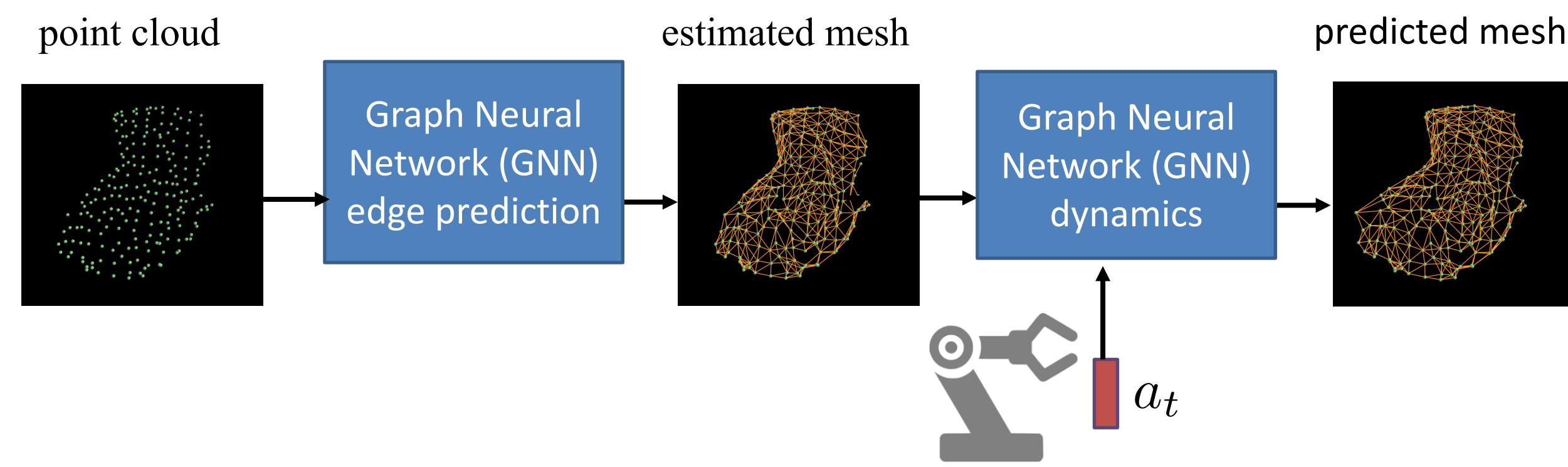# CAREER: Self-supervised Representation Learning for Deformable Object Manipulation
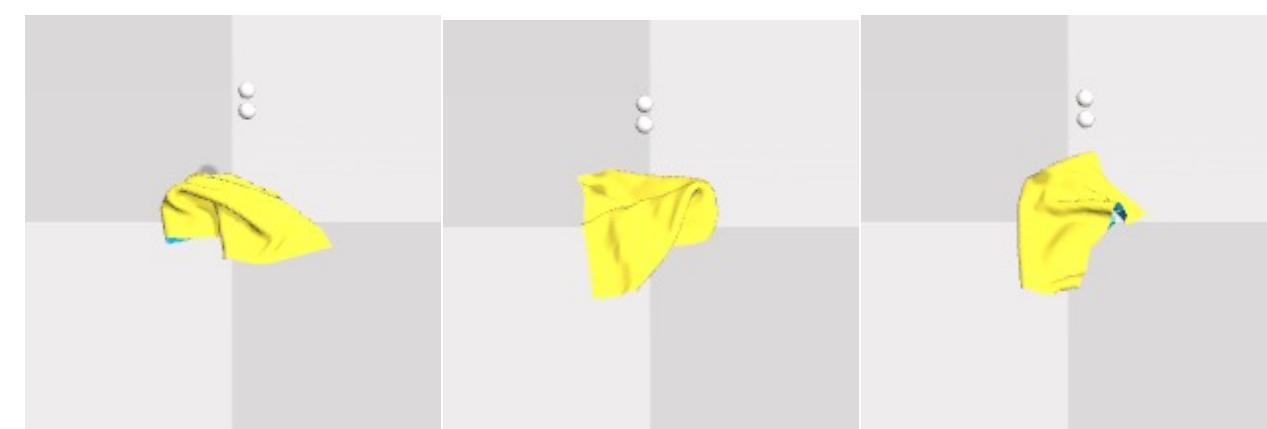
David Held, Carnegie Mellon University

Challenge: How can robots learn to represent deformable objects to enable manipulation tasks?

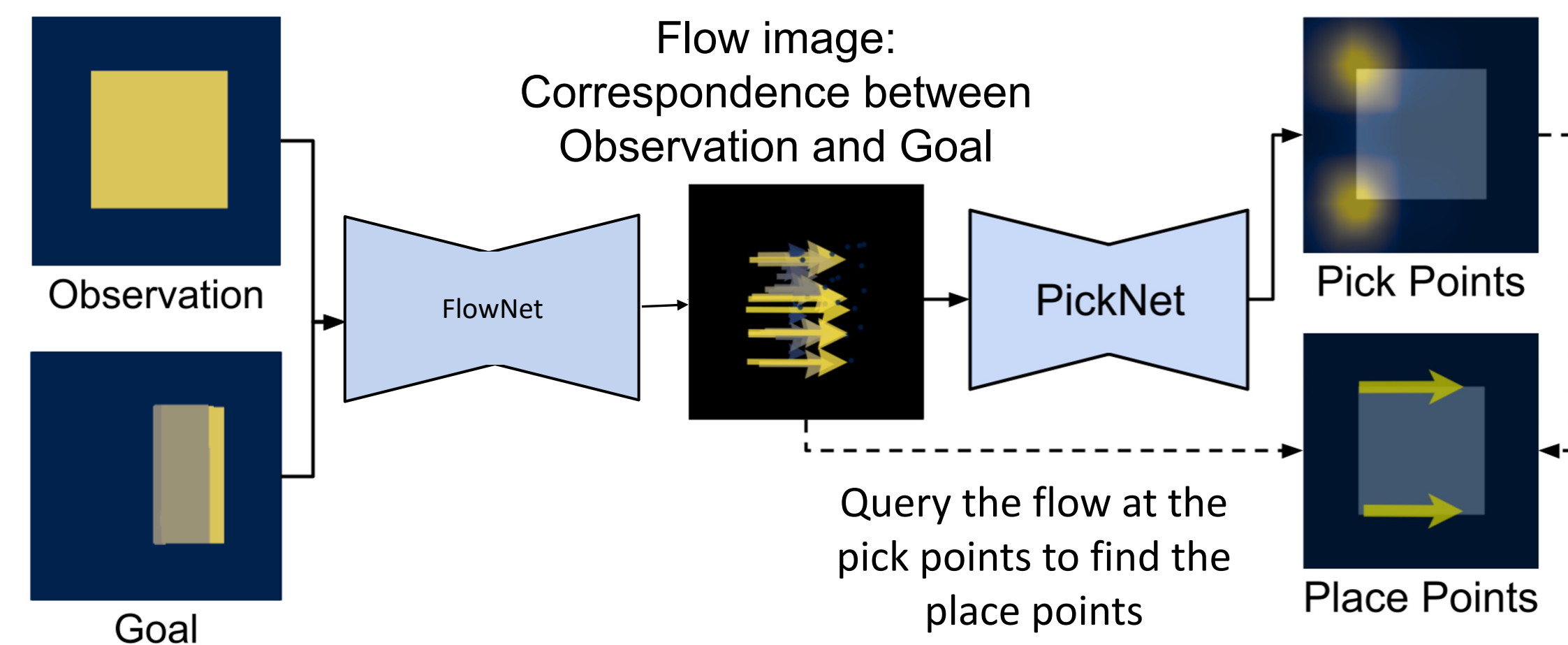## Mesh-based dynamics model for cloth smoothing (CoRL 2021)

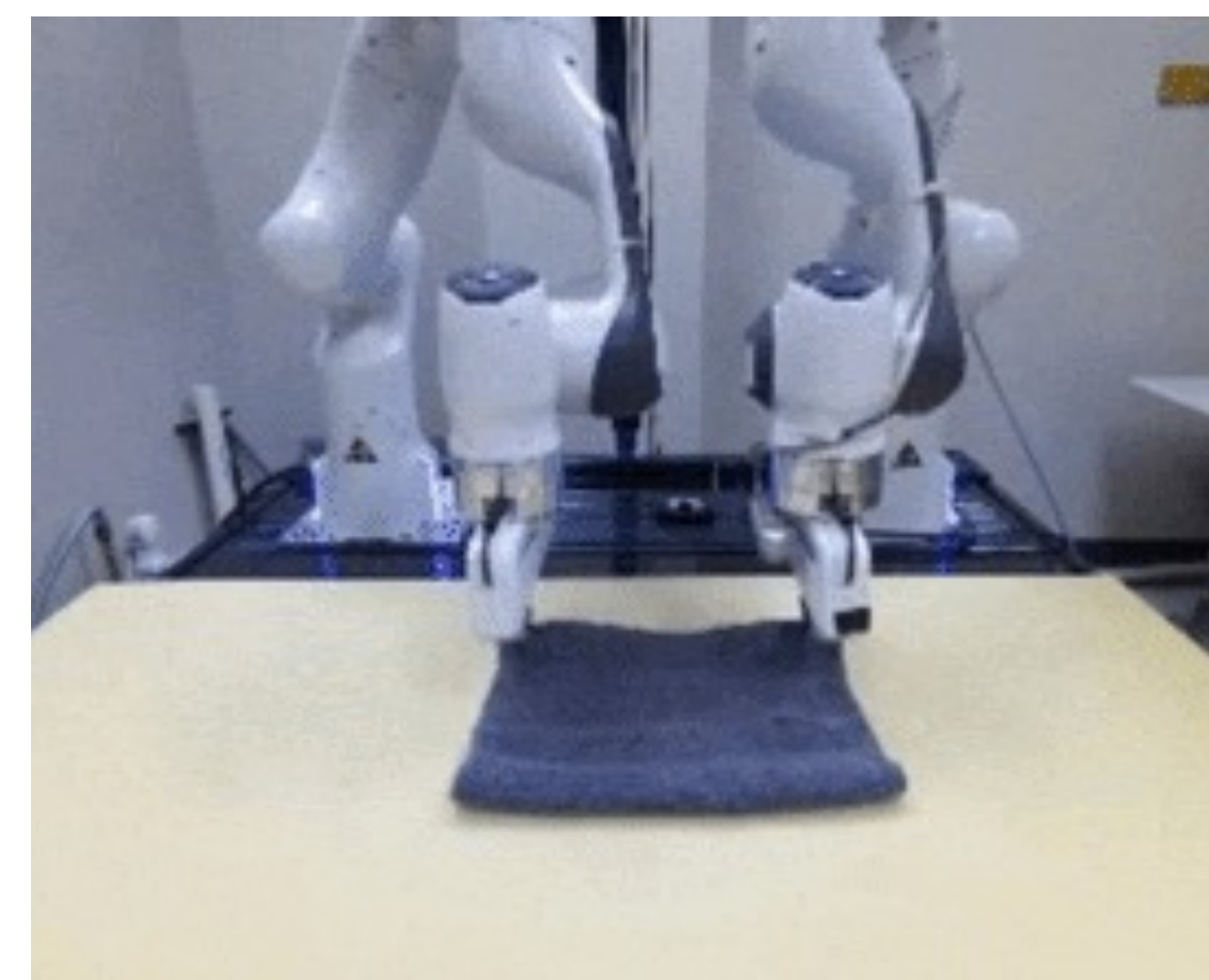point cloud → Graph Neural Network (GNN) edge prediction → estimated mesh → Graph Neural Network (GNN) dynamics → predicted mesh

a_t

Training:

Evaluation:

cotton square   silk square   cotton t-shirt

Flow-based policy for cloth folding (CoRL 2021)

Observation

Goal

FlowNet → Flow image: Correspondence between Observation and Goal → PickNet → Pick Points

Query the flow at the pick points to find the place points

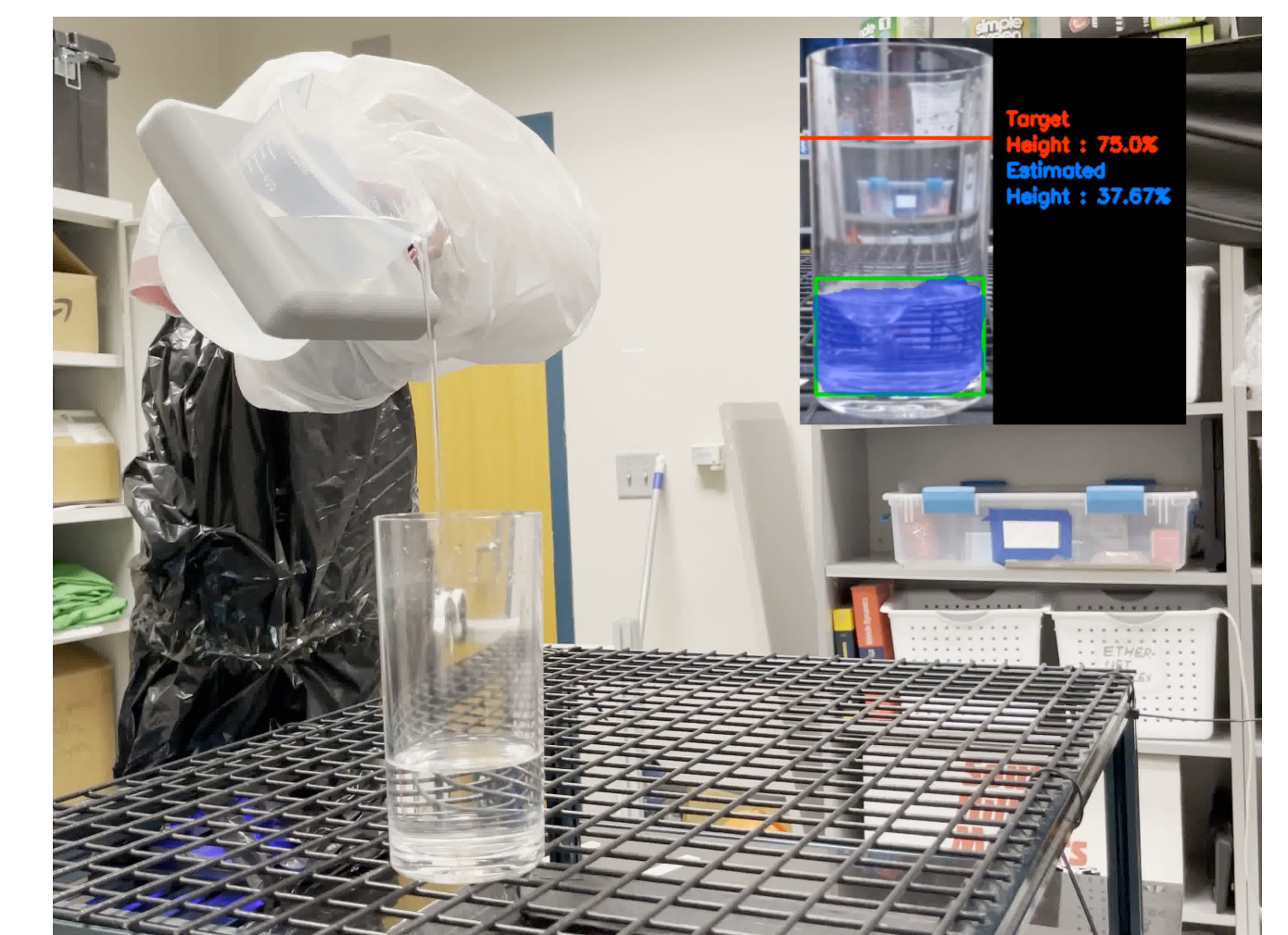Place Points

Bimanual goal-conditioned cloth folding

Self-supervised image translation for water segmentation (ICRA 2022)

Multilayer, Patchwise Contrastive Loss

Input → G → Output → G_{enc} → Segmentation Network → Output

Ground Truth
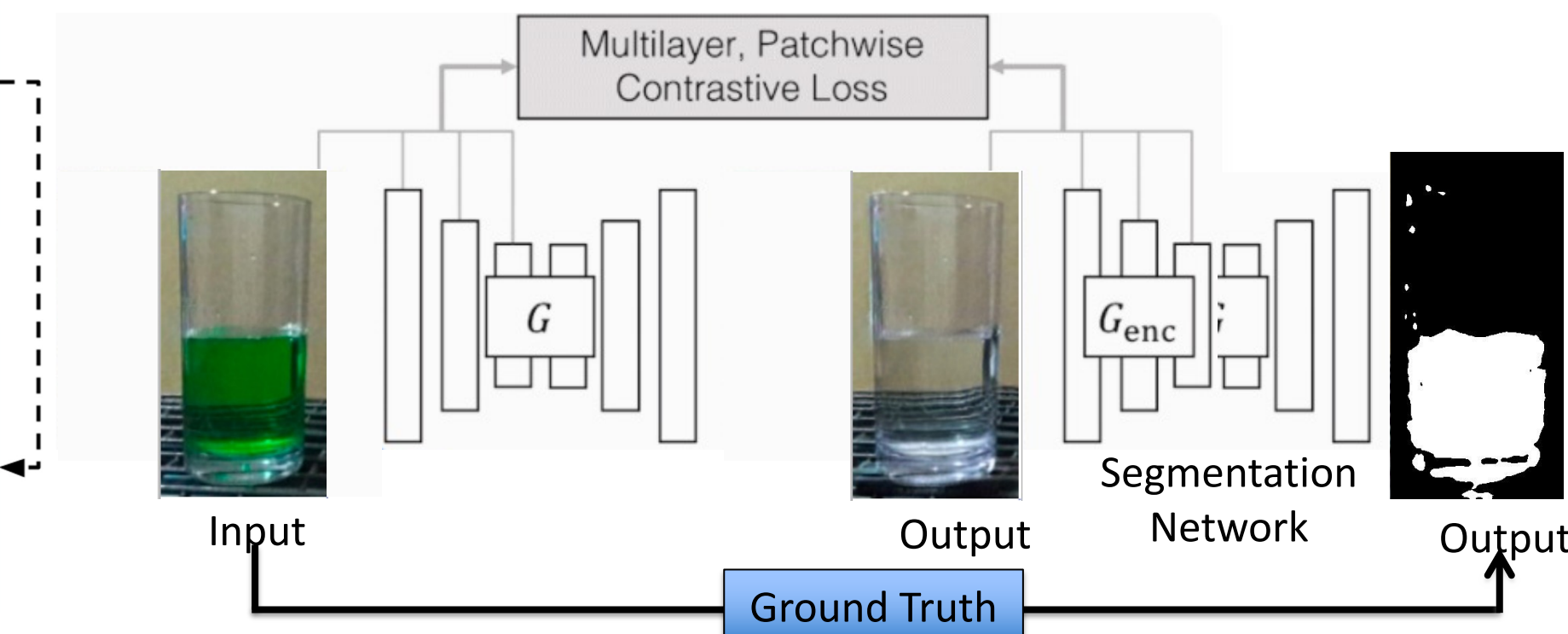
Pouring Transparent Liquid

Potential Broader Impact (society):

- Robot housekeeper
- Assistive dressing / feeding
- Tools for robots to manipulate deformable objects

Broader Impact (education / outreach):

- Several post-docs, graduate students, and undergraduate students have been trained under this grant
- PI Held has participated in AI4ALL in the summer of 2021. This three week program for 20 high school students from disadvantaged local schools exposes them to the excitement of AI, its potential societal impact.
- Held organized a mentor-matching program, which matches undergraduate students from underrepresented groups with graduate student mentors.
- Held is a mentor of the CMU's Tartan Scholars program, which supports first-year students from low-income backgrounds.
- PI Held has added curricular content to increase understanding of ethics in AI.