## NSF IIS: Div Of Information & Intelligent Systems
Award # 2046491 / March 15, 2021 / David Held, Carnegie Mellon University

Challenge

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

Solutions

- Mesh-based dynamics model for cloth smoothing

- Flow-based policy for cloth folding

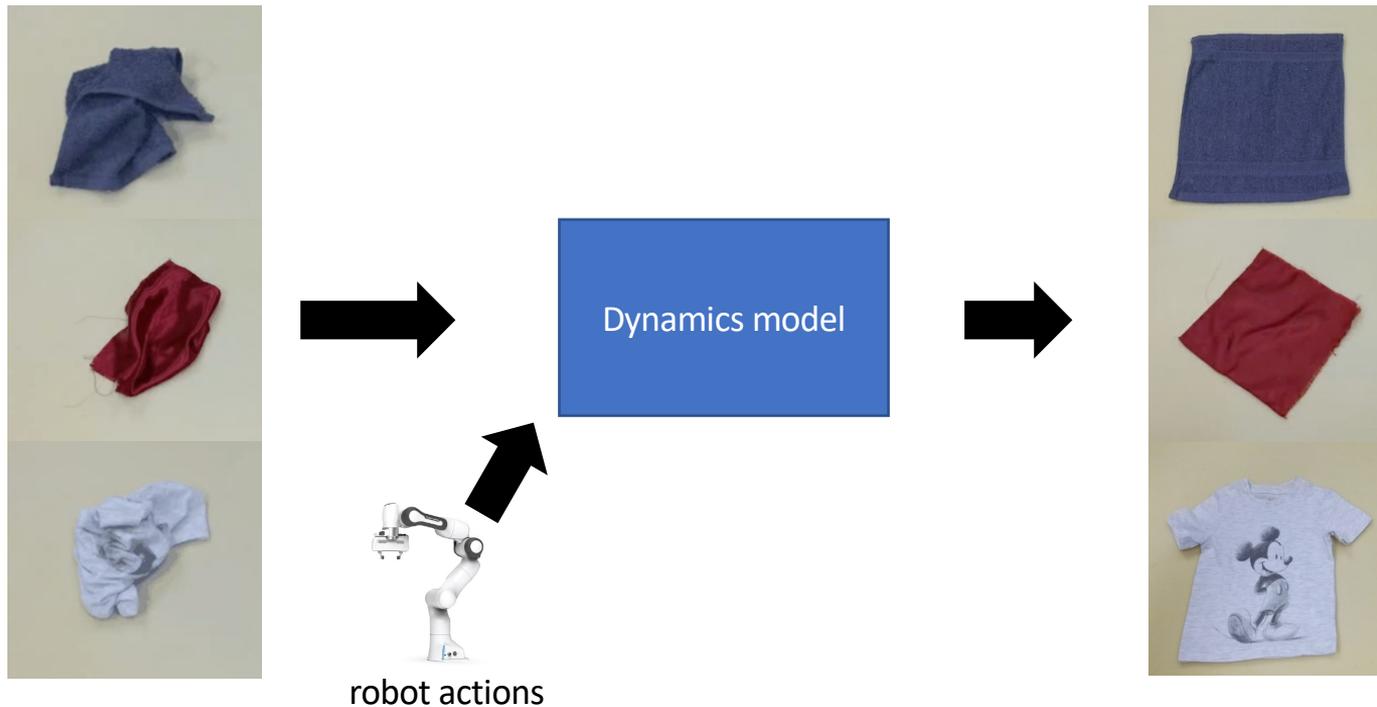- Self-supervised image translation for water segmentation
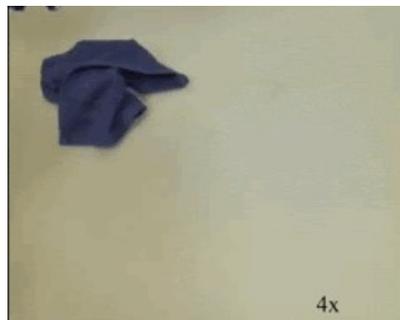
(CoRL 2021)

(CoRL 2021)
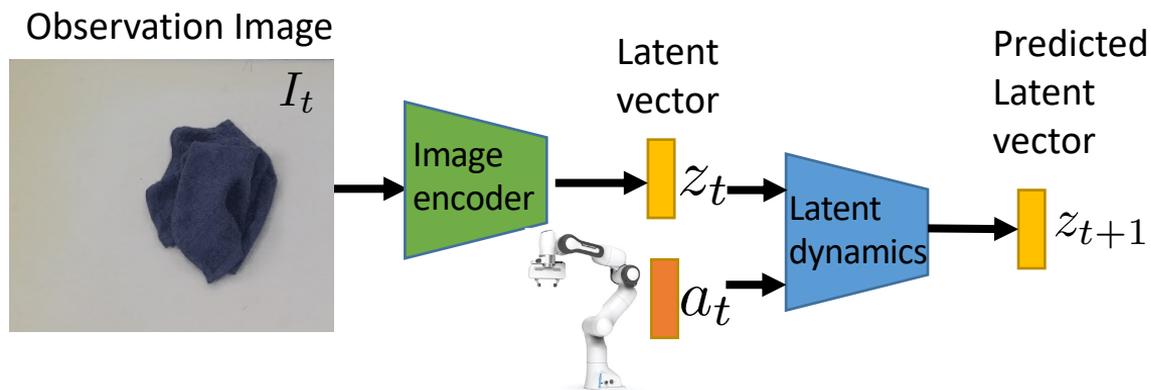

(ICRA 2022)

Broader Impacts

- Robot housekeeper

- Assistive dressing / feeding

- Tools for robots to manipulate deformable objects

(ICRA 2022)

How can we learn a dynamics model for cloth?
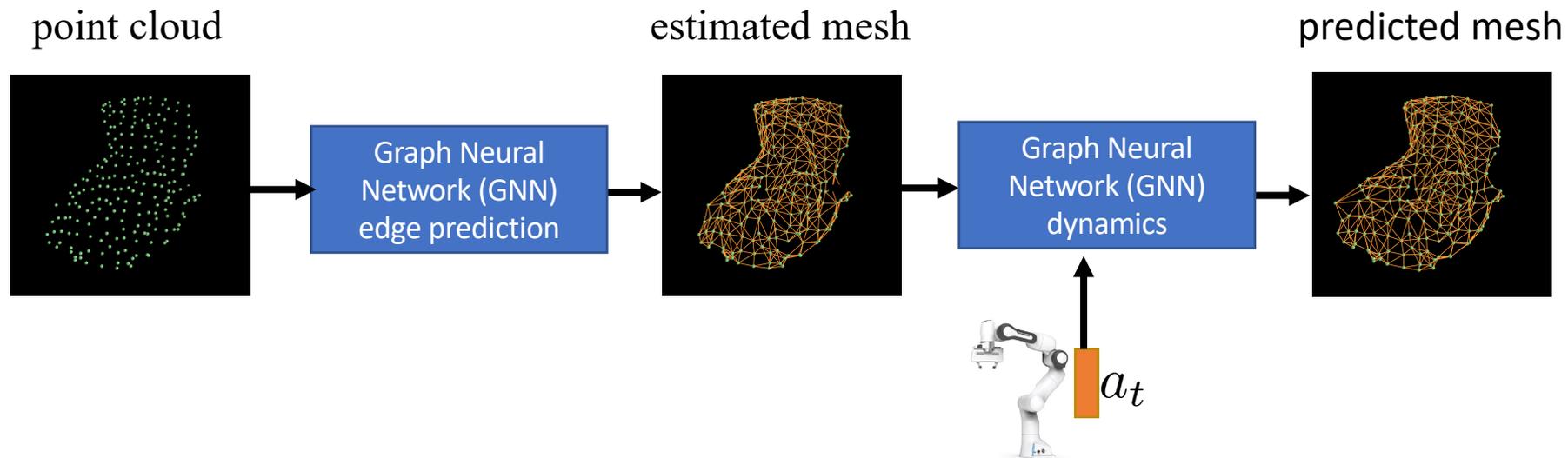
Approach 1: Learn a <u>latent vector</u> dynamics model
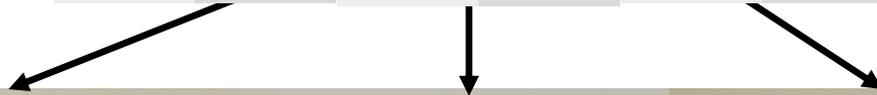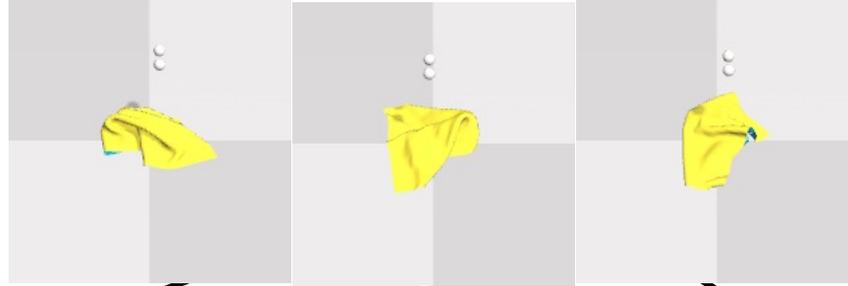
[Hafner, et al 2019, Yan et al. 2020]

Lacks environmental structure, making generalization difficult

Our approach: Learn a **mesh** dynamics model

point cloud   estimated mesh   predicted mesh

One mesh dynamics model
(one set of weights)

Training:

Evaluation:

cotton square   silk square   cotton t-shirt
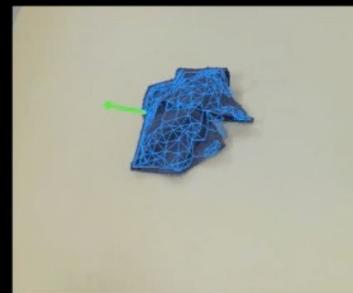
Cloth smoothing with a Franka arm
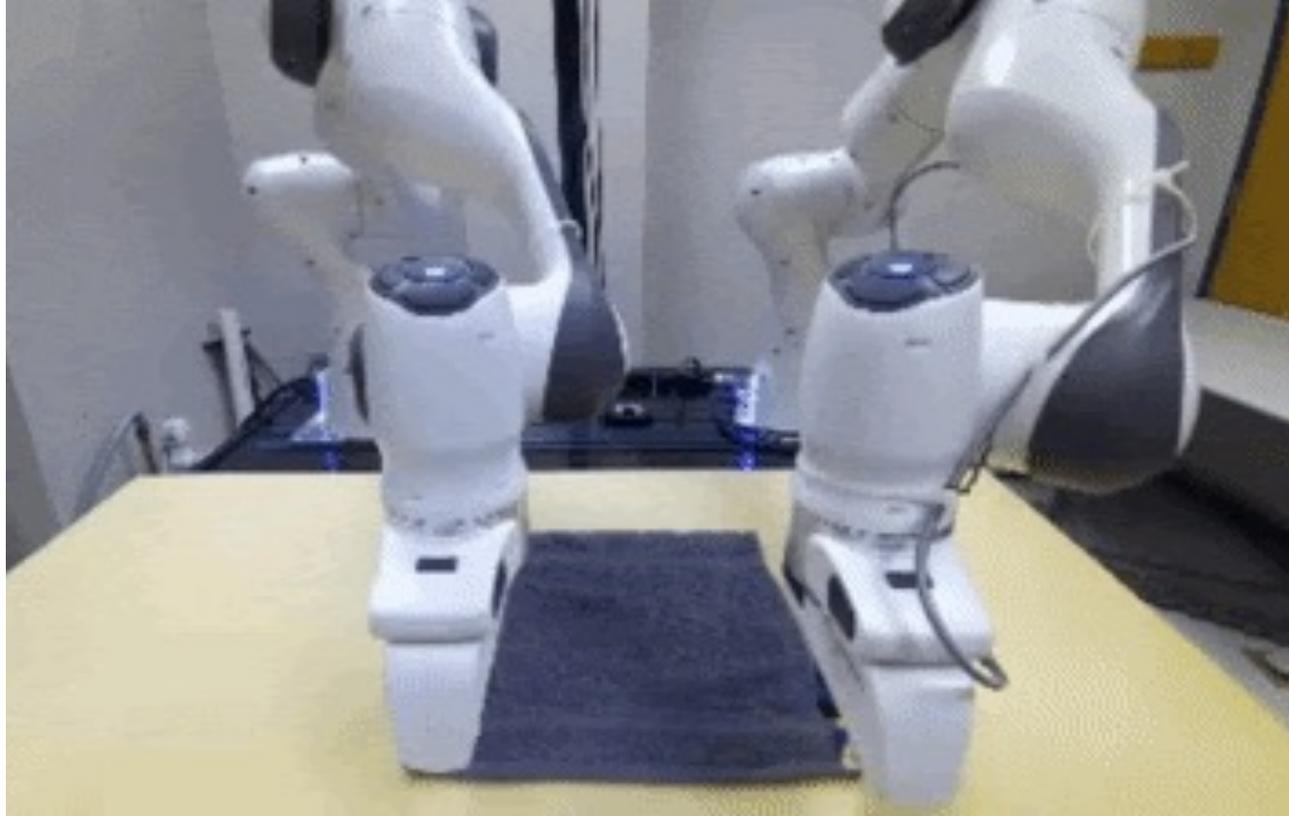

Cotton square cloth

4x

Franka execution
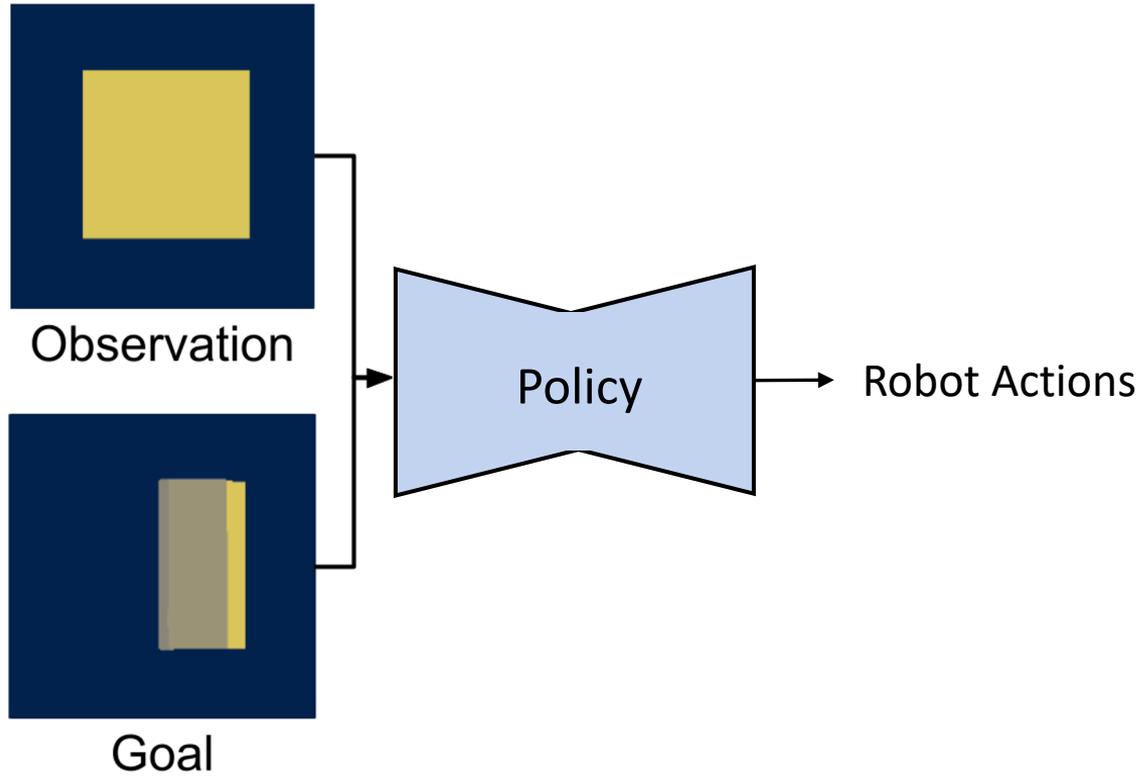
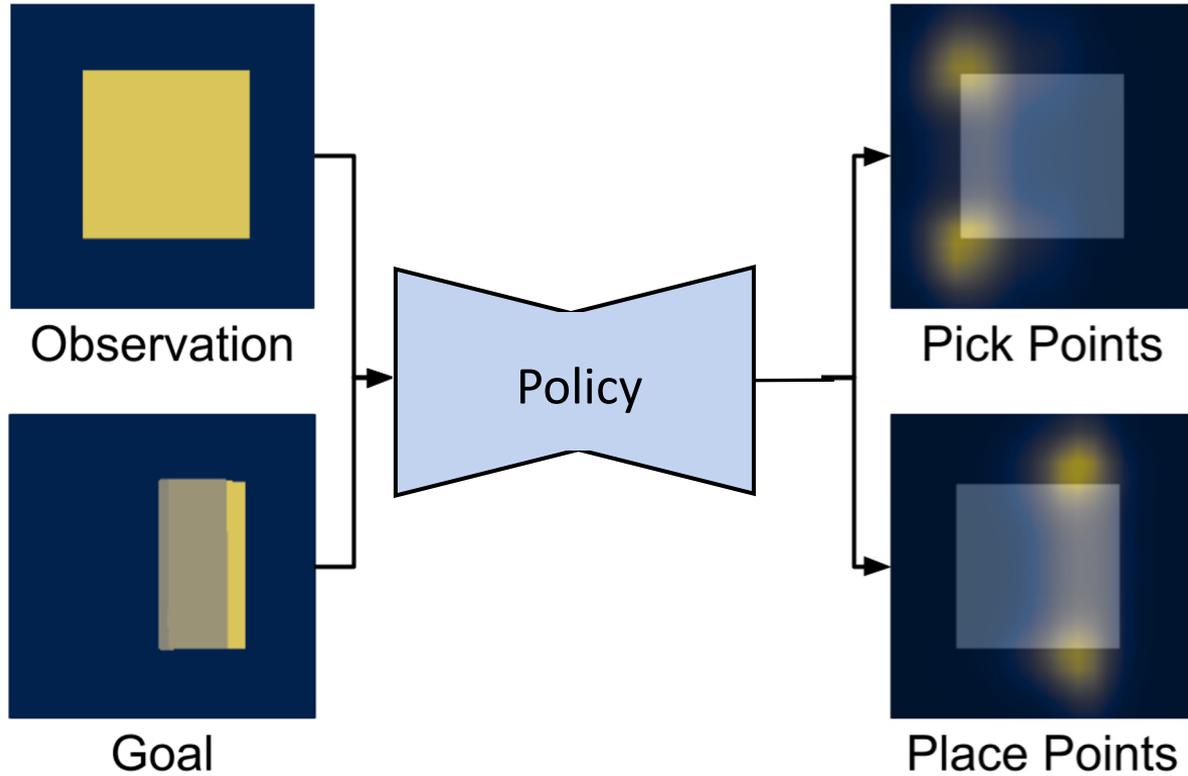Scores of sampled actions (greener is higher)

VCD prediction

Flow-based Policy for Bimanual Goal-conditioned Cloth Flattening
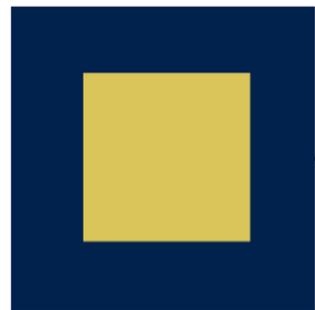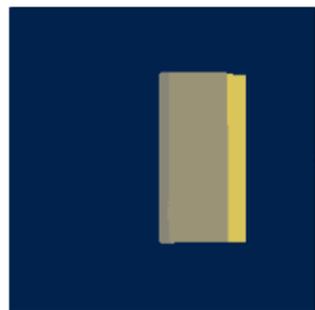
Previous Work:

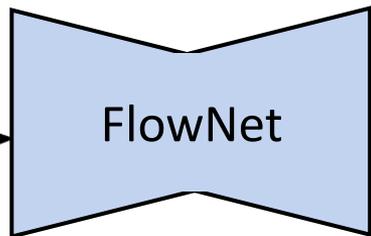# Previous Work:

Our Main Insight:
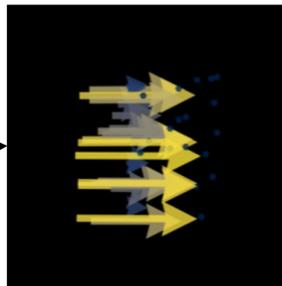
First infer desired
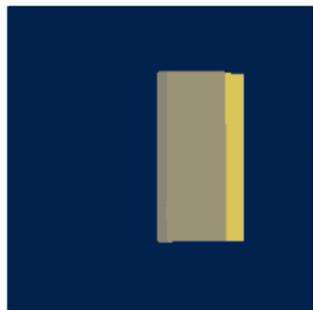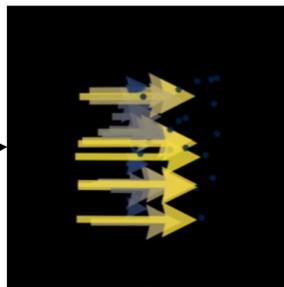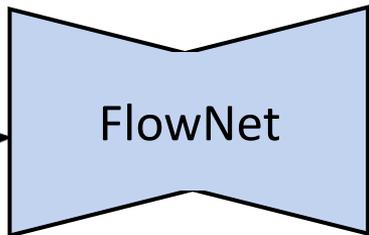**object** motion

Observation

Goal

FlowNet

Desired cloth motion

Our Main Insight:

First infer desired **object** motion

Observation

Goal

FlowNet

...then infer desired **robot** actions

Desired cloth motion

PickNet
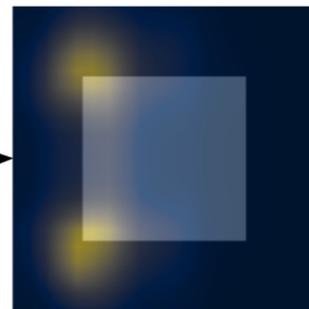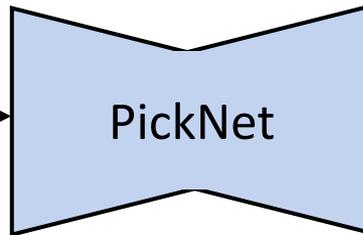
Pick Points
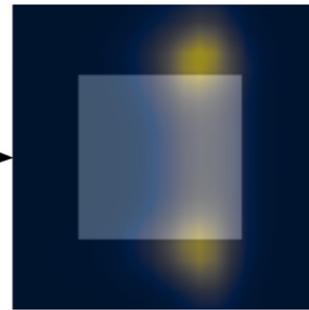
Place Points

Real folding videos

4x speed

Challenge

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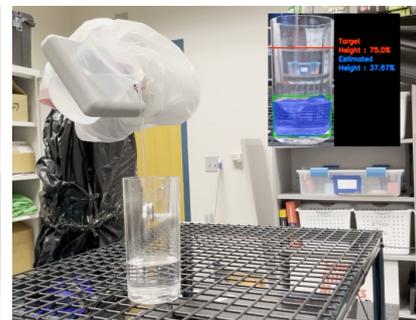

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