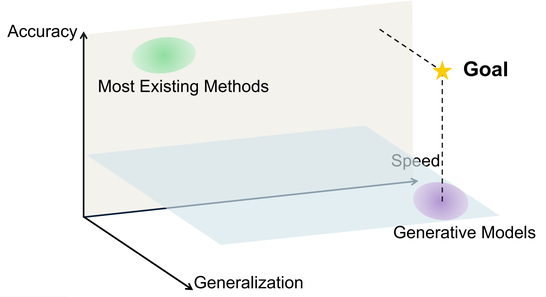
PhysCoRe: Physics-Corrected Residual World Models for Material-Aware Deformable Dynamics

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Motivation

Challenges

- Physics-based simulators require time-consuming per-object optimization to calibrate materials.
- Generative models generalize across objects but struggle to predict physically accurate motion.

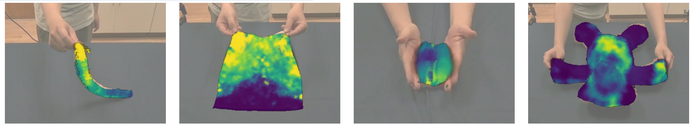


Contributions

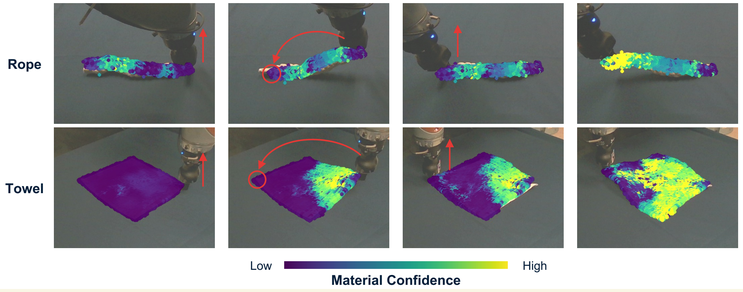
- *Material from Motion* (MfM) — infers material properties from observed motion across different objects.
- *Residual from Dynamics* (RfD) — corrects the simulator's dynamics to narrow the sim-to-real gap.
- *Confidence-Guided Exploration* — provides a self-supervised signal for active material learning.

Confidence-Guided Exploration

Confidence Grows with Observed Motion

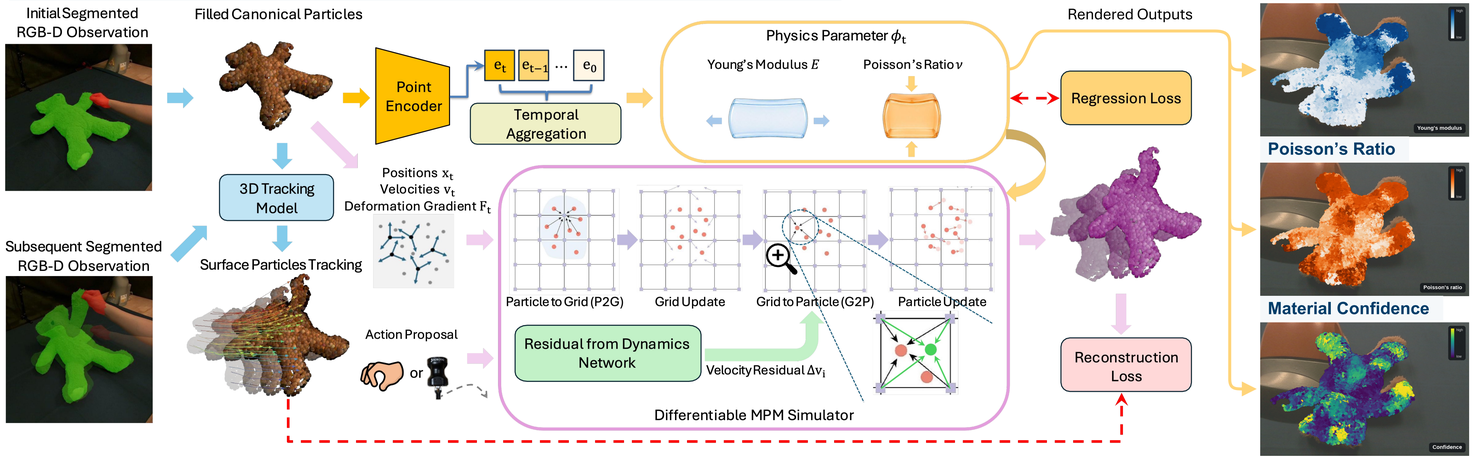


Robot Interaction Reveals Where to Probe Next



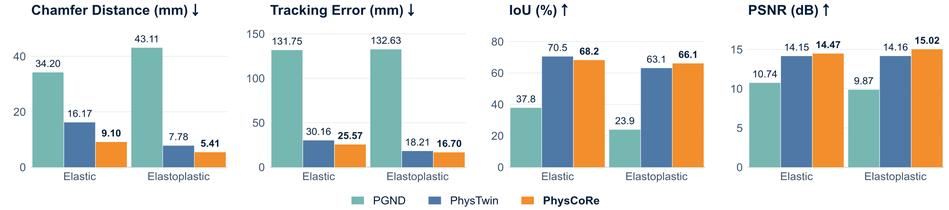
Method

Physics-Based Simulator (MPM) at the Core, Augmented with 2 Feedforward Modules (MfM and RfD)

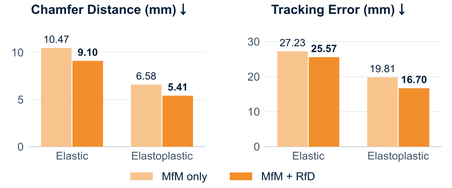


Results

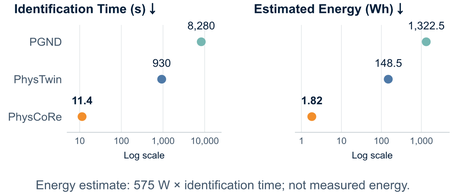
Future Prediction on Held-Out Motion



Effect of Residual Correction (RfD Module)

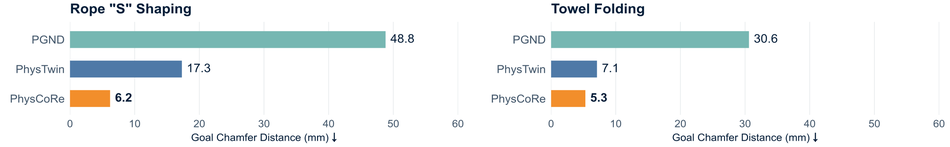


Material Identification Cost

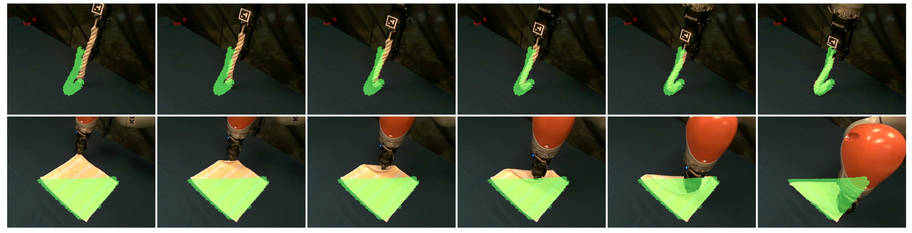


Energy estimate: 575 W × identification time; not measured energy.

Planning Accuracy



Goal-Conditioned Robot Execution



Takeaway

PhysCoRe combines learned material inference and residual correction modules with an MPM simulator for fast, generalizable object material estimation and accurate dynamics prediction.

Scan the QR code or visit our project page for the paper, code, dataset, and demos.

https://lunarlab-gatech.github.io/PhysCoRe-website/

Project page