NRI: Integrating Perception and Manipulation of Deformable Objects by Learning Implicit Representations

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We extend implicit function learning to model, perceive, and manipulate elastically deformable objects. Towards their successful integration, we will develop methods to integrate visio-tactile sensing modalities, represent dynamics of motion and deformation, quantify uncertainty, and perform implicit space control.

Key Problems in Deformable Object Manipulation:

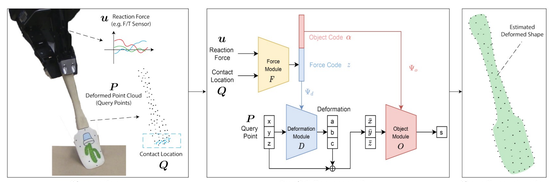
1- Perception from partial and multimodal sensory feedback with unobservable boundary conditions.

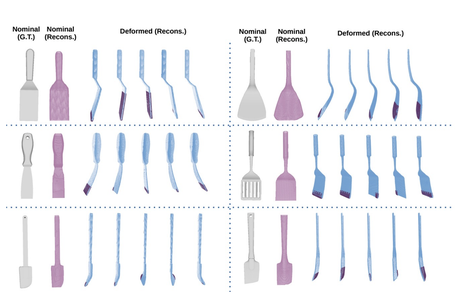
2- Dense object state-estimation and prediction in contact-rich and forceful interactions.

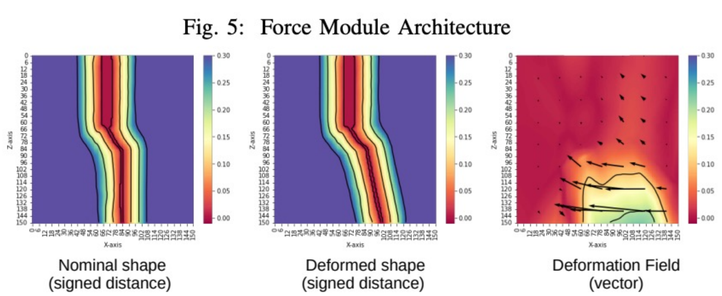
3- Joint control and planning of object geometry and force transmitted through contact.

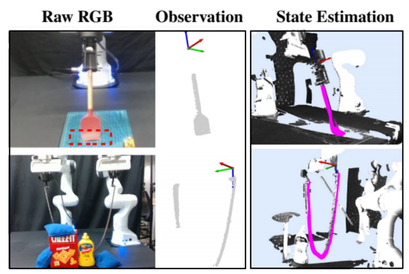
Scientific Impact: These outcomes contribute to several related fields including continuum mechanics, computer vision, and learning theory where object deformations subject to boundary conditions and/or implicit function theory are studied by offering a flexible, generalizable, and computationally-efficient alternative to the current methods using finite element analysis or particle models.

Technical Approach:









Broader Impact on Society: Assistive care and Industry 4.0. We expect to improve independence and quality of life of elderly through automation of difficult tasks and address the demand for rapidly changing manufacturing lines and warehouse logistics in the age of online shopping.

Broader Impact Education: Disseminated as part of ``Introduction to Robotic Manipulation", and “Robot Learning”, two new courses at UM. Extend outreach in collaboration with UM's Women in Science and Engineering and Michigan Engineering Zone for under-represented groups.

Broader Impact Quantification: We will evaluate via the # of students/URM engagements activities, # of workshops, and opportunities offered. Industry collaborations for societal level impact and evaluate with the number of joint projects and collaborations.

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