Robust Grasping
by Integrating Machine Learning with Physical Models

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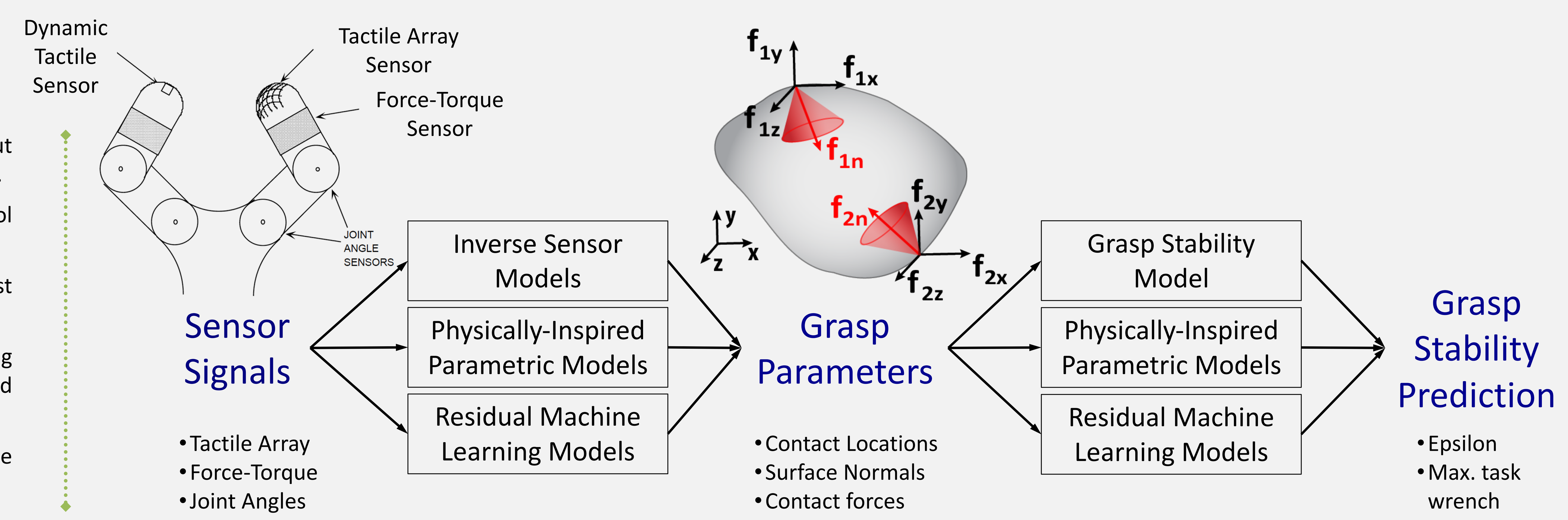
http://biorobotics.harvard.edu/research.html

Abstract

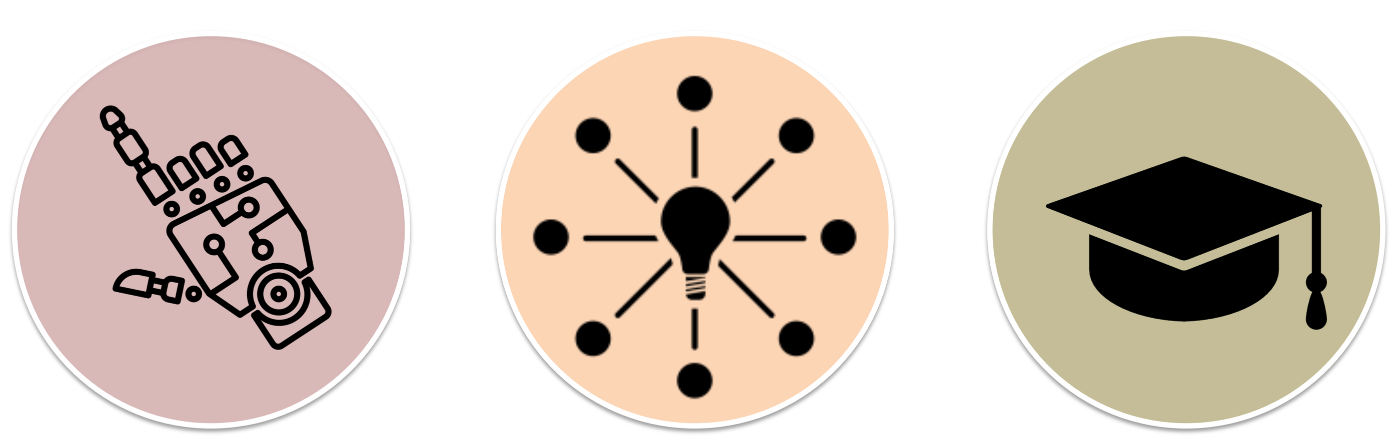
- **Contact sensing** is essential for reliable robotic grasping in unstructured environments, but existing methods have not been effective, and **requirements** for effective sensors are unknown.
- This project aims to establish the foundation for effective grasp stability prediction and control by developing new ways to integrate **machine learning** with **physical** sensor models.
- Physical sensor models will be characterized in grasping experiments and validated against independent **ground truth** measurements.
- **Physical models** based on mechanical principles (grasp analysis) will be **augmented** using parametric and nonparametric machine learning methods, allowing interpretability and generalizability.
- Analysis of these models will guide the **creation of a new sensor suite** that, together with the carefully-crafted models, will form the basis for reliable robotic grasping systems.



Intellectual Merit

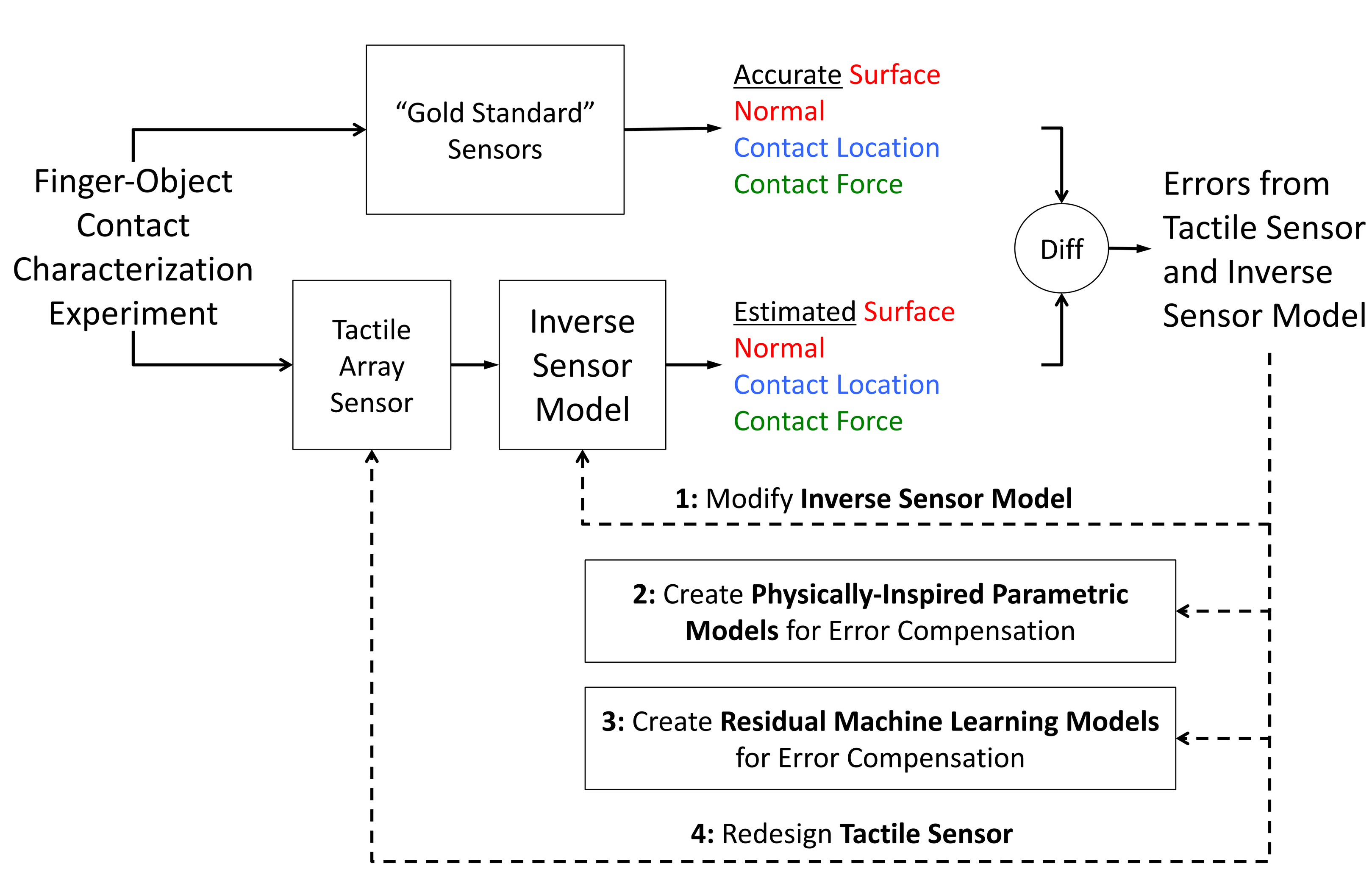
Interpretability | Generalizability | Clarify Hardware Requirements

Broader Impacts



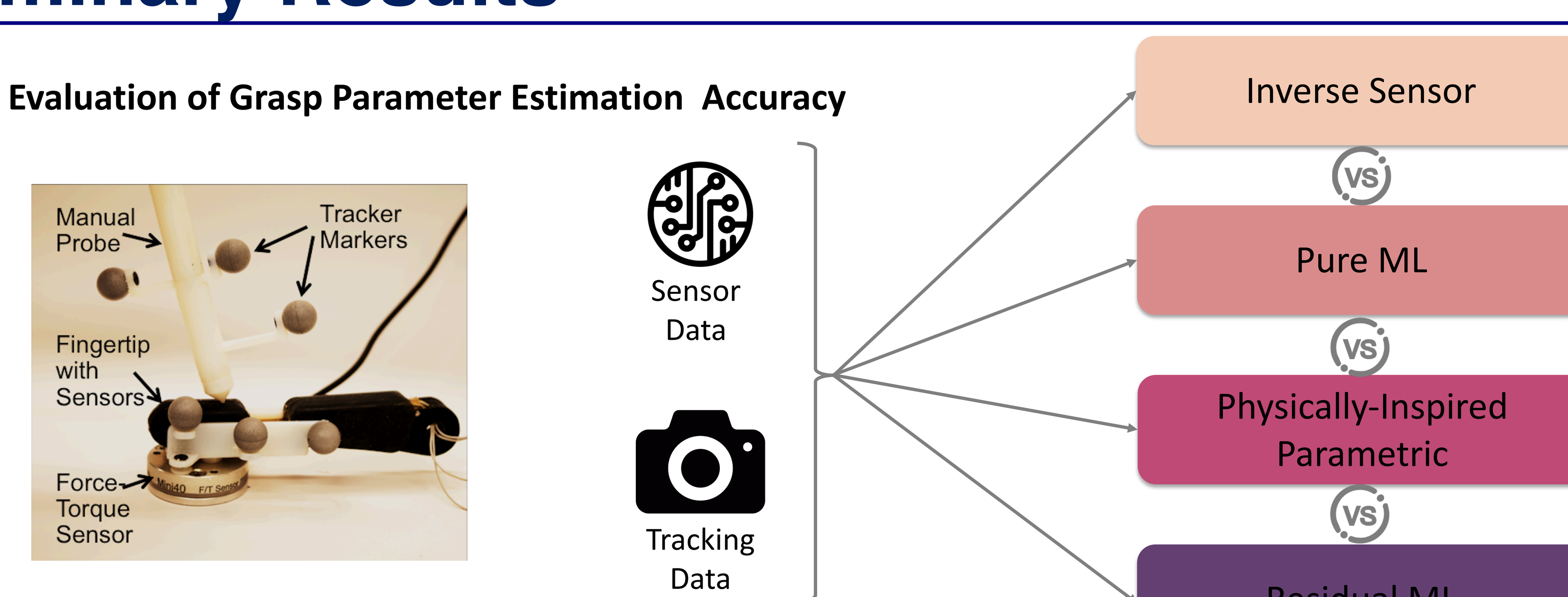
Reliable Robot Grasping | Data & Design Made Available | Undergraduate Involvement

Technical Approach

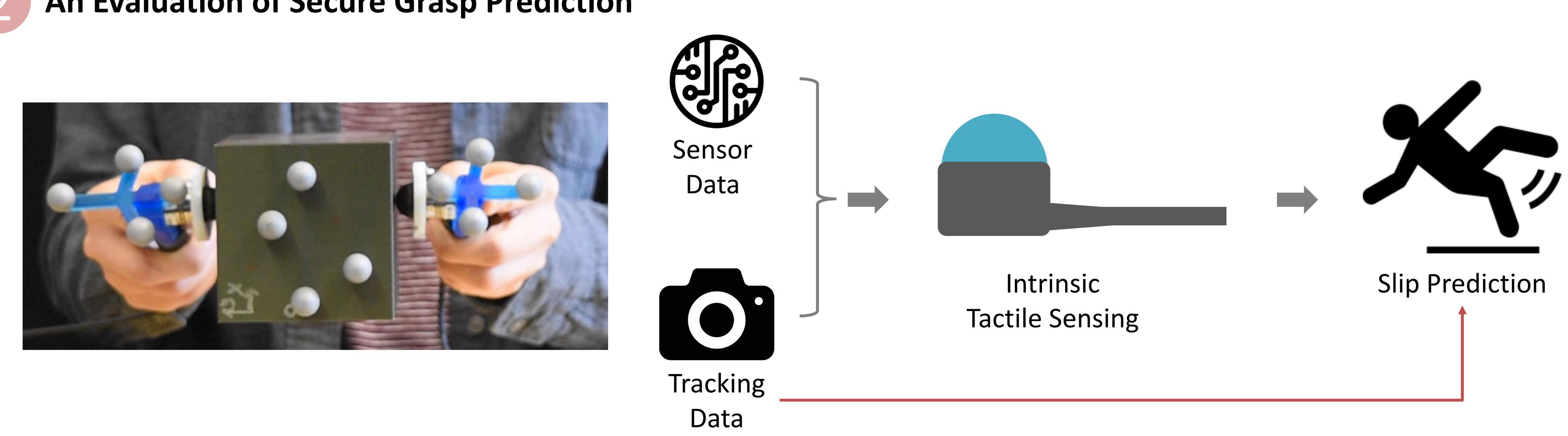


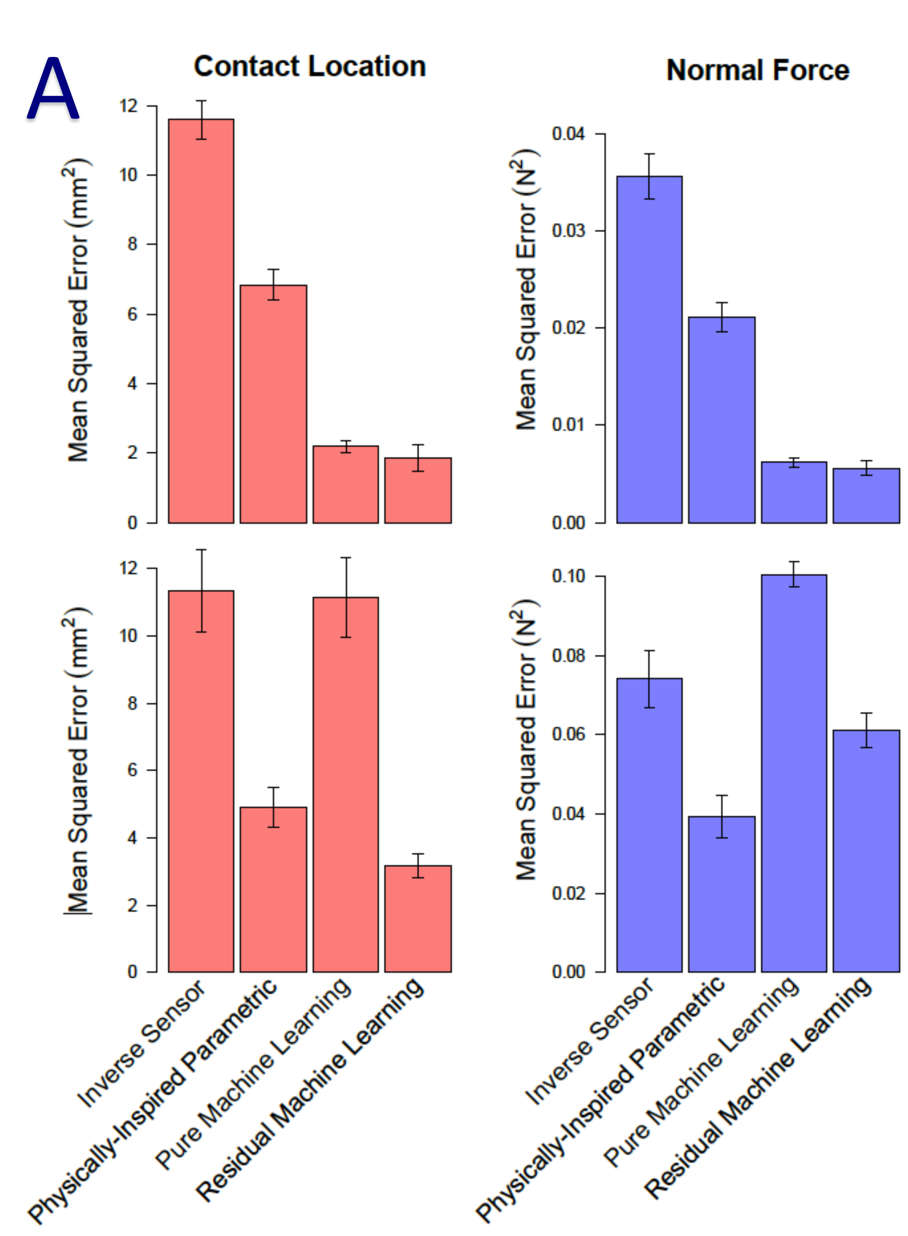
Preliminary Results

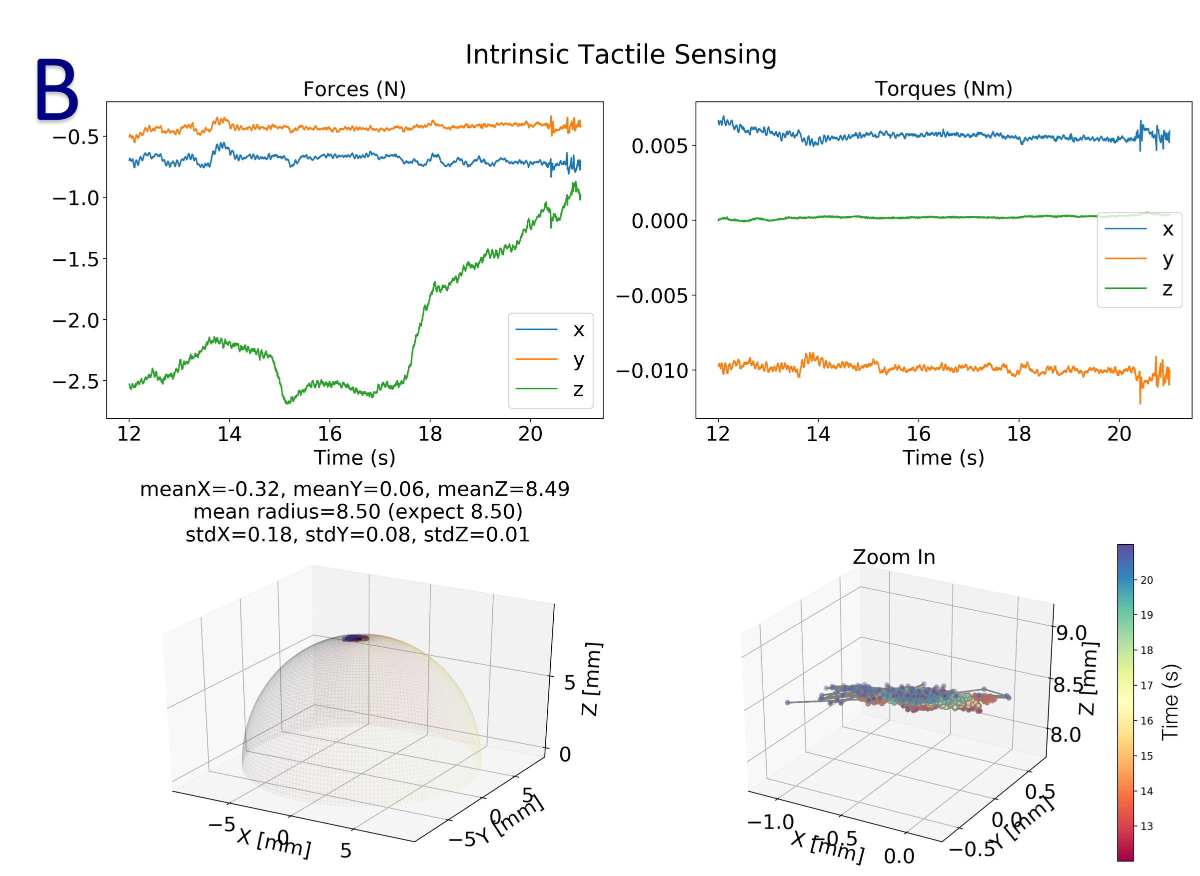
1 An Evaluation of Grasp Parameter Estimation Accuracy

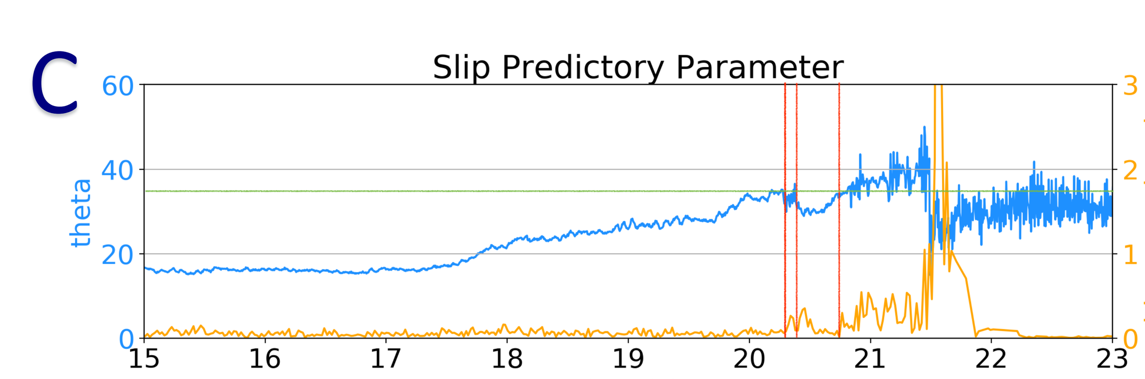


2 An Evaluation of Secure Grasp Prediction









Results from the first experiment: (A) First row: 10-fold cross-validation error ±1s.e. for the four types of model on the two grasp parameters. Second row: same as first row but with all models fitted to only data with weights 20-100g and tested on data with weight 120g.
Results from the second experiment: (B) Intrinsic tactile sensing results showing the trajectory of the estimated contact location.
(C) Theta is the angle between contact surface normal and contact force, an indicator of the relative location of force with respect to friction cone. Object acceleration is an indicator of when slip occurs.

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