ARIA
APPLIED RESEARCH IN ACTION

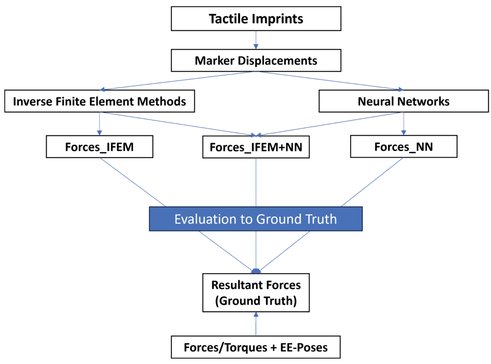
Accurate and Precise Force Estimation Algorithm for Robot Manipulation

Combining inverse finite element methods with neural networks to provide a robust and data-efficient algorithm for force estimation.

Rui Heng Yang

Florian Shkurti
ACADEMIC SUPERVISOR

Francois R. Hogan and Gregory L. Dudek
INDUSTRY SUPERVISORS



PROJECT SUMMARY

Robotic manipulation tasks require accurate information of the environment and precise control of robot actions. We investigate a novel approach to enhance the manipulation capabilities of robots through an accurate force estimation algorithm. Leveraging the innovative "see-through skin (STS)" sensor developed by SAIC (Hogan et al., 2021), we acquire tactile data imprints of objects and subsequently extract marker displacements from these tactile imprints. Following the method proposed by (Ma et al., 2019), we investigate the utilization of inverse finite element models to reconstruct the forces from the extracted marker displacements recorded by the new tactile sensor. Our research revealed that the mainstream state-of-the-art inverse finite element methods we examined exhibited significant sensitivity to displacement noise, rendering them unsuitable for the STS sensor, despite our persistent efforts to mitigate this issue. As a solution, we propose a novel algorithm that combines data-driven techniques with the model-based approach to reconstruct the forces. We anticipate that this combination will enhance the robustness of the model-based method against displacement noise sensitivity while also improving the data-efficiency of the data-driven method. Our preliminary results with the data-driven techniques indicate promising capabilities in accurately modeling forces.

REFERENCES

Hogan, F. R., Jenkin, M., Rezaei-Shoshtari, S., Girdhar, Y. A, Meger, D. and Dudek, G. (2021). Seeing through your skin: recognizing objects with a novel visuotactile sensor. Proc. WACV: 1217-1226.

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Samsung AI Center-Montreal

Computer Science
UNIVERSITY OF TORONTO
Master of Science in Applied Computing