Human-robot collaborative framework for planning with corrective feedback

Summer Internship project

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Motivation

Even in collaborative robots human interaction is considered as a *disturbance* rather than useful feedback

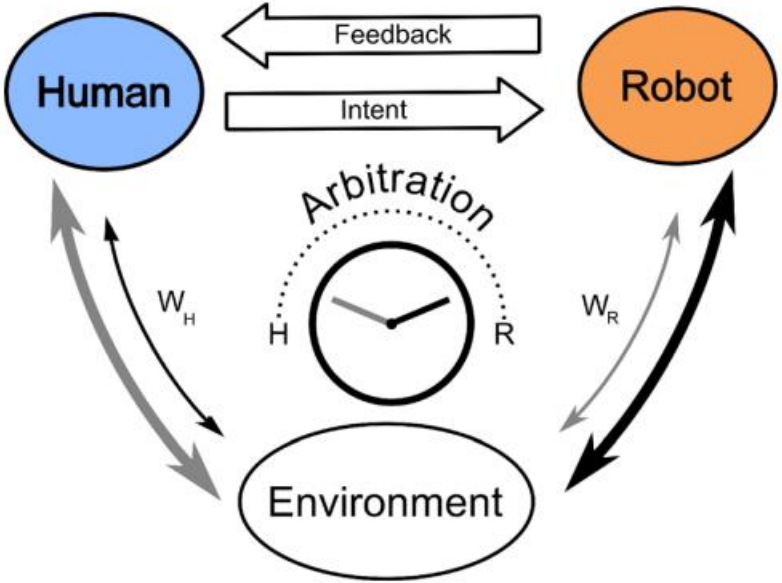
Human-Robot Interaction

State-of-the-art:

- **Controllers reacting to pHRI without learning**
- **Learning objectives offline (IRL)**
- **Learning objectives online (shared autonomy)**

Challenges

- **Intent Detection**
- **Arbitration**
- **Feedback**



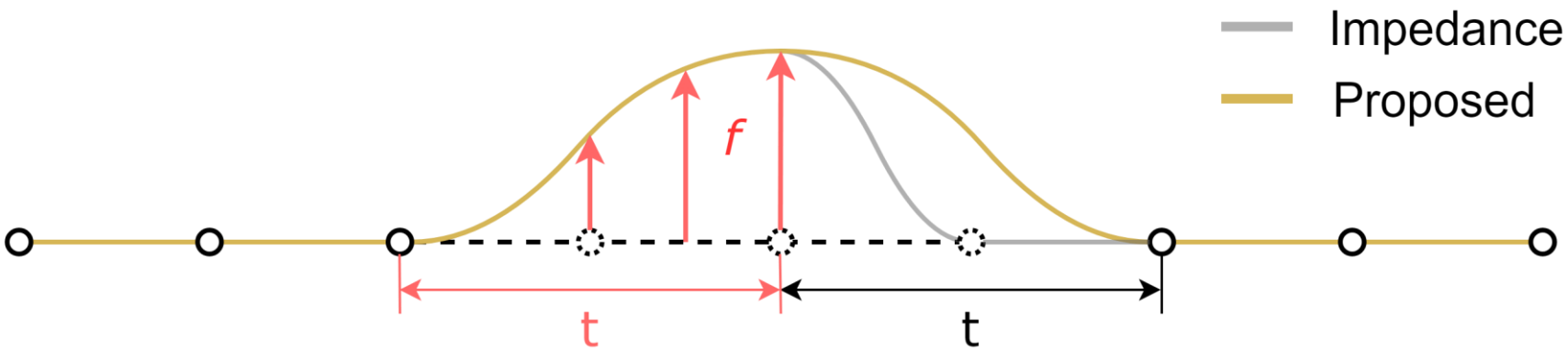
Losey, Dylan P., Craig G. Mcdonald, Edoardo Battaglia and Marcia Kilchenman O'Malley. “A Review of Intent Detection, Arbitration, and Communication Aspects of Shared Control for Physical Human-Robot Interaction.” *Applied Mechanics Reviews* 70 (2018)

Goal

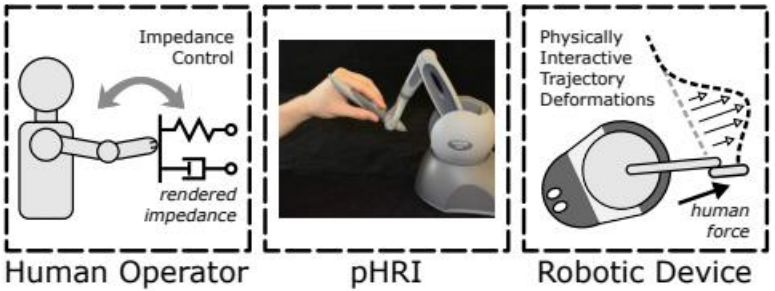
Investigate and develop methods to enable robots to dynamically and interactively adjust their trajectories based on real-time human inputs

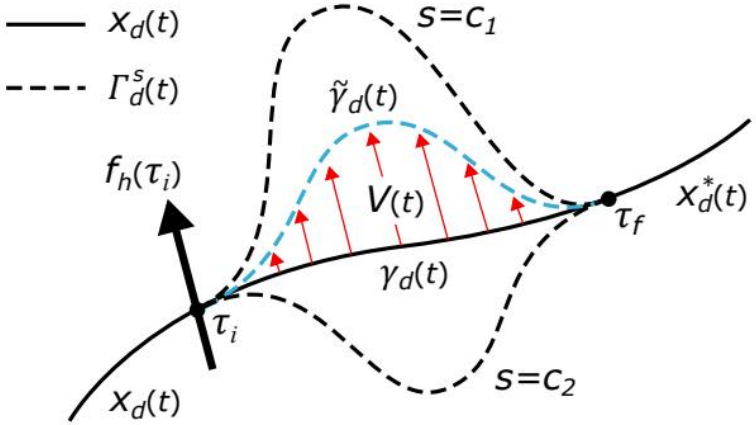
First approach

- **Record time *t* when external force moving average exceeds a threshold**
- **Skip to the goal *t* timestamps forward when interaction ends**



Trajectory deformation





$$\tilde{\gamma}_d = \gamma_d + s\delta H f_h(\tau_i)$$

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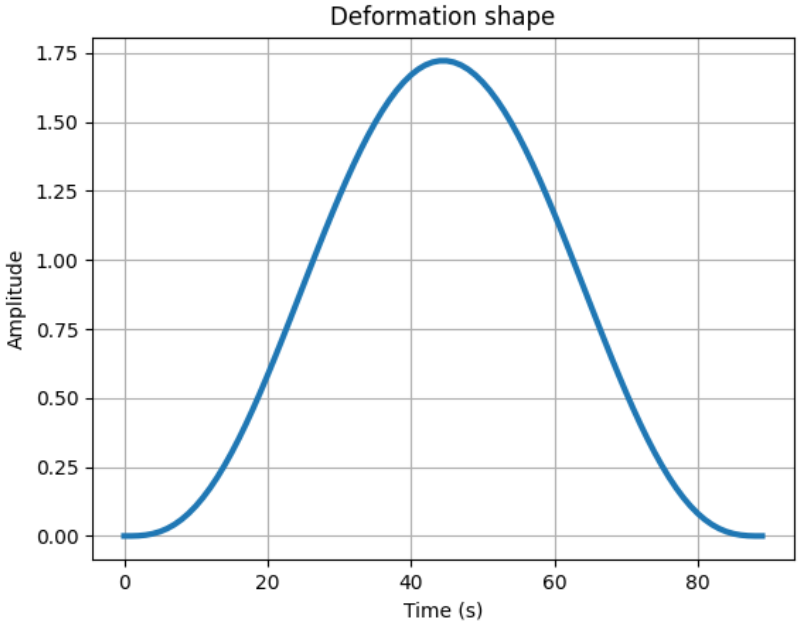
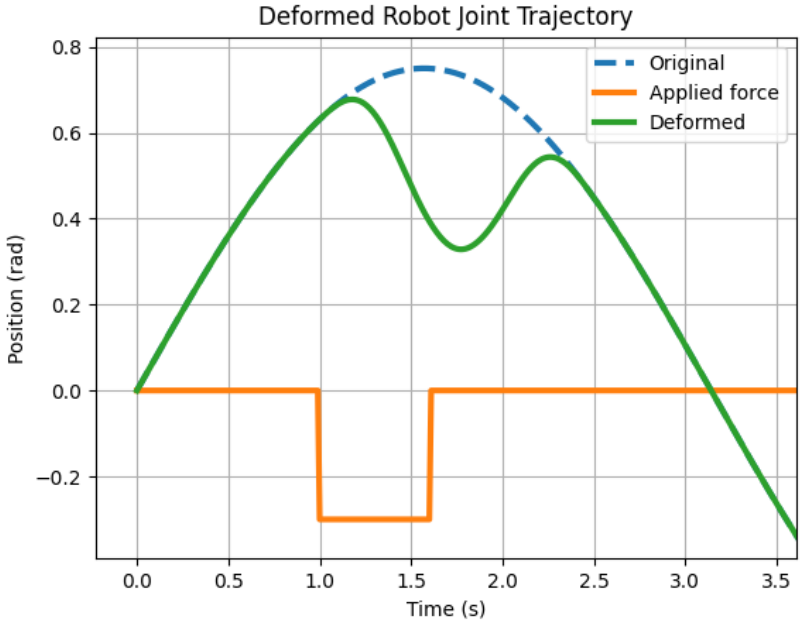
Losey, Dylan P., and Marcia K. O'Malley. "Trajectory deformations from physical human–robot interaction." *IEEE Transactions on Robotics* 34.1 (2017).

1-DoF example

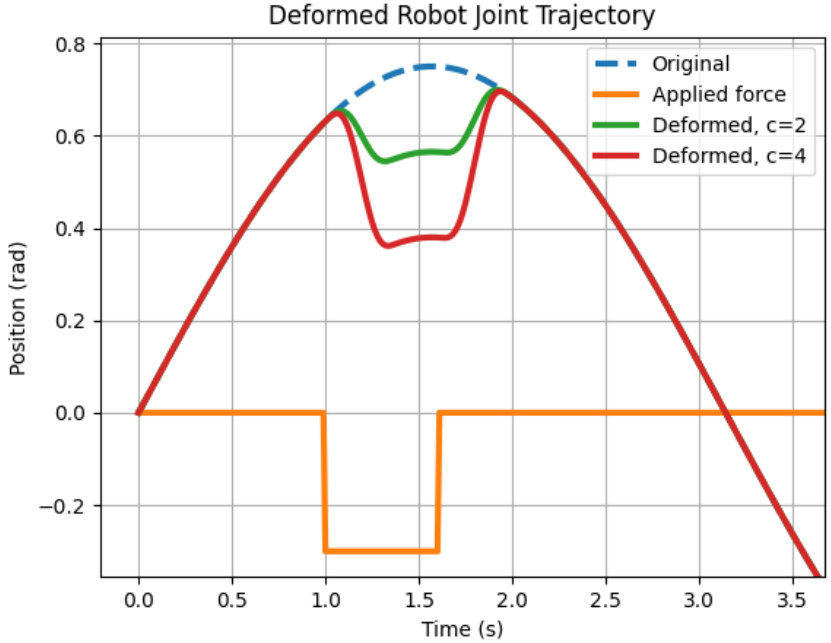


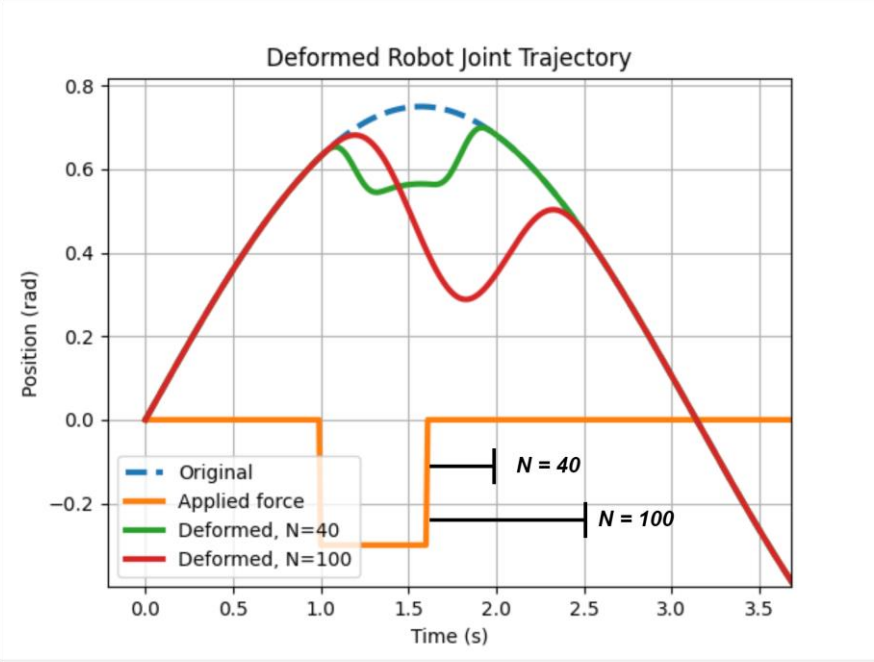


Demo

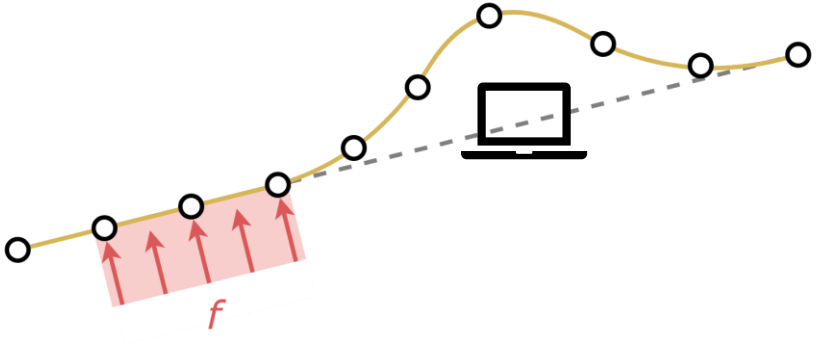
Impedance vs. Deformation

Parameters: Admittance & Deformation length

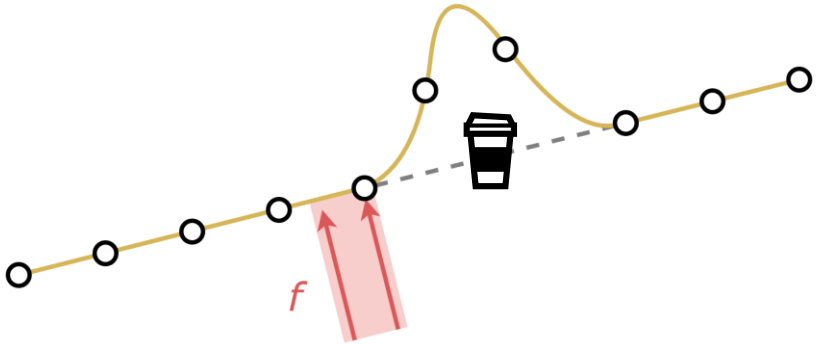




Dynamic parameter update



Long and gentle interaction



Quick but strong interaction

Demo

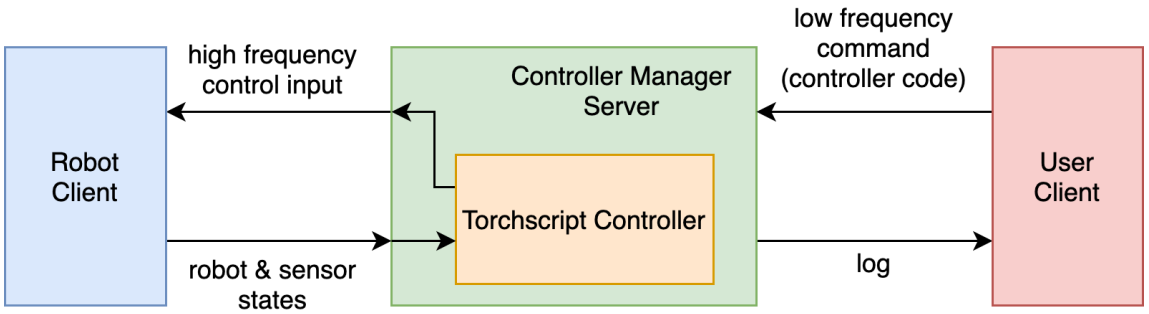
Dynamic parameter update

Future work

- **Apply this work for a real human-in-the-loop project where we can adaptively learn when an intervention is useful.**
- **Learn how to gradually adapt the deformations based on the interaction parameters**

A quick note on Polymetis

- **An alternative framework to write PyTorch controllers, test them in simulation, and seamlessly transfer to real-time hardware**
- **Unfortunately, still lacks some useful developer tools.**



Source code