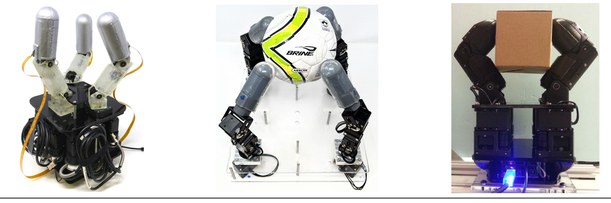
Scalable Multimodal Tactile Sensing for Robotic Manipulators in Manufacturing

Matei Ciocarlie[1] , John Kymissis[2] and Peter Allen[3]
[1]Dept. of Mechanical Engineering, [2]Dept. of Electrical Engineering, [3]Dept. of Computer Science, Columbia University

- Development of tactile sensors and their use to enable reliable grasping and dexterous manipulation
- Integration into robot hands: both off-the-shelf models and custom-built models integrating proprioception
- Integrated low-level control and high-level planning, combining model-based and model-free approaches
- Application to grasping in dense clutter, such as bin picking and kitting in automotive manufacturing



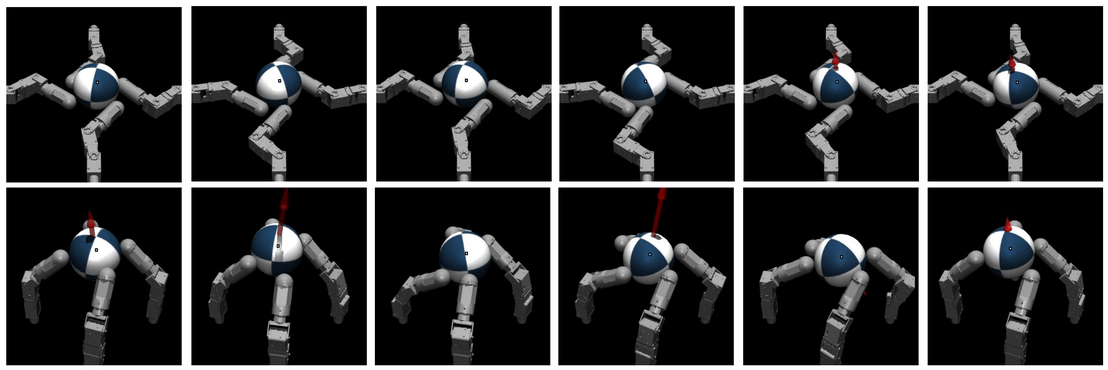
In-Hand Manipulation Using Tactile Data: Finger Gaiting

(Ciocarlie and Kymissis labs)

We are working towards dexterous skills like in-hand manipulation with a multi-fingered hand equipped with the tactile fingers developed in this project and described in [Piacenza et al., T-MECH 2020]. To achieve this, we are combining model-free RL with model-based stability analysis metrics using tactile data.

Figure shows a 12-dof four-finger hand using our optics-based multi-curved tactile fingers shown on the right.

Example: using proximal policy optimization (PPO), we can learn robust and stable policies that produce repeatable for rotating objects about an axis in both 2D and 3D.

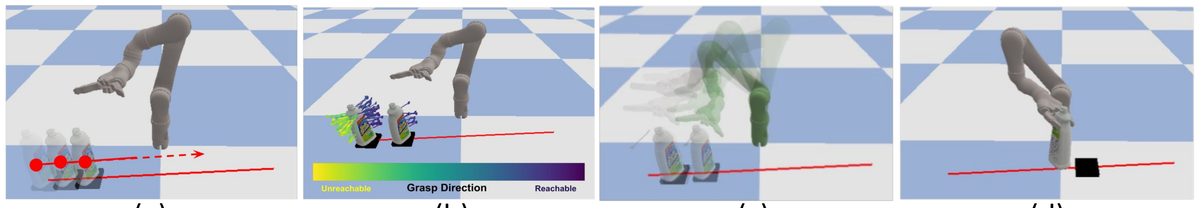


(a) through **(f)** show a cycle of the learnt gait where the hand alternates between rotating the object and switching contacts from one set of fingers to the next. **(a)** and **(f)** are equivalent states, showing the gaits are repeatable. We are working on transferring such gaits to the real robot hand shown above [submission in preparation].

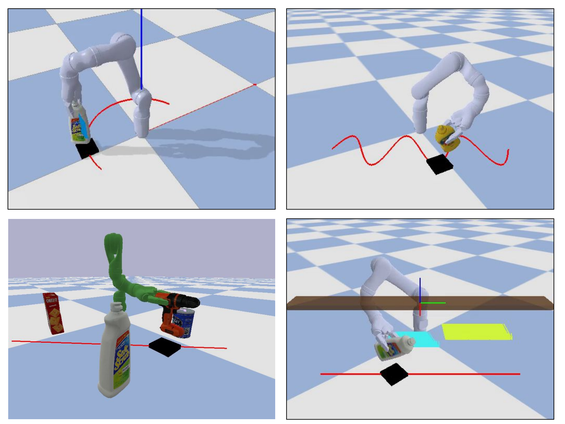
Motion-Aware Reaching/Grasping of Moving Objects in Cluttered Environments

(Allen lab)

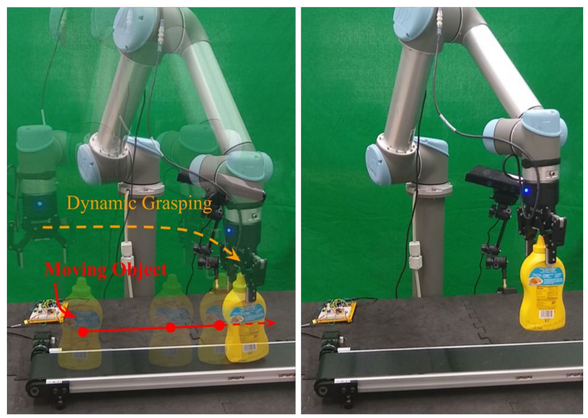
- We present a framework that improves grasping in dynamic settings.



- a) Object motion modeling with pose-estimation neural network and Kalman filter.
- b) Grasp generation and switching using reachability and object motion awareness.
- c) Arm trajectory generation using solution from previous time-step as seed.
- d) New trajectories are updated and executed until object is picked up.



Simulation experiments demonstrate our method in picking fast moving targets with randomized linear, nonlinear motion with different velocities and within static obstacles



Real: A UR5 robot arm is able to track, reach and pick a moving object off a conveyor belt before it escapes the robot's workspace. [Work in submission at IROS 2021]

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