Progress Report

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1 Progress

The following items are listed in the order of priority:

- DLO Dataset (IROS - March 1st.): Last week, I finished reviewing the RealSense documentation and code examples. I worked through UR5e tutorials and I am currently setting up the gripper. I take responsibility for originally installing the gripper and not setting it up in software. Per UR documentation, the robot touch center point (TCP), payload weight, and payload center of gravity (CoG) should be updated according to the application. This is besides the URCaps driver that is required for UR5e to interface with the gripper. Improper payload configuration could explain the drift issue noted by Joe. In the tutorial, they instruct updating the payload configuration per objects in an object pick and placement application. I am setting up UR5e and the gripper per documentation; I will try to save and document everything as much as possible. Perhaps sometime today, I will record a trajectory with UR5e over Ethernet connection. In the next step, I will record the input, robot state, RGB images, point cloud frames, and depth map frames.

- Maicol: He has been assisting with updating the design and printing the DLO mount.

- DLO Manipulation (IROS): [1].

- XEst (RAL —): No update.

2 Research Plan

This section outlines my current research plan for the next 3 months, 6 months, and 1 year. Moreover, I have included open projects and ideas to keep track of them.
Target conferences: ICRA, IROS (March), CASE (Late Feb.), NIPS.
Target Journals: RAL, CVPR, CORAL.

2.1 Research Plan:

- **3 months:** The primary objective will be to publish the DLO dataset paper, (DLO-1), finished my classes, and to meet my next Ph.D. milestone, comprehensive exam. My goal is to submit the DLO dataset paper to IROS by March 1st.

- **6 months:** Next, I want to explore using DMD as a method to retrieve the correct Quaternion solution for the QuEst method, (QuEst-01). I believe this testing this is fairly fast and I should be able to publish that paper fairly quickly. I believe the RAL would be an appropriate journal to target; we can discuss this further with Dr. Gans to get his input.

- **1 year:** Next, I want to focus on (PIKO-01) as a method for fast online system identification. My aim is to confirm this method by comparing against existing Koopman-based methods. In the following work I will extend this method to control DLOs in real time (DLO-02).

2.2 Research Pipeline:

- DLO-01 (IROS - March 1st, 2023): DLO manipulation dataset with DLO configuration and gripper pose, as well as the gripper control input. Ideally, UR5 back-EMF current and bus voltage should be recorded. A DLO mount is introduced. A method for configuration estimation is introduced. Perhaps, a method for learning DLO dynamic can be trained and introduced.

- QuEst-01 (IROS): Optimal transform solution for QuEst based on dominant mode decomposition (DMD).

- PIKO-01 (TBD): This work leverages DMD and Physics-Informed machine learning to extract low-dimensional coherent modal structures from dynamic data. This method will extends DMD-based approaches to include mixed basis functions. Moreover, this method will automatically try to find the best fit at a specified range of ranks. This method will be validated by comparing against the existing Koopman-based MPC control schemes for VTOL-DIP method and introducing a method for controlling VTOL-TIP in simulation. This methods will become the backbone of my Koopman-based MPC control research effort.

- DLO-02 (TBD): This methods extend PIKO-01 to a control method for the DLO-01 dataset.

References

[1] I. Abraham, G. De La Torre, and T. D. Murphey, "Model-based control using koopman operators," *arXiv preprint arXiv:1709.01568*, 2017.