Progress Report

Bardia Mojra

January 23, 2023

Robotic Vision Lab

The University of Texas at Arlington

1 Progress

The following items are listed in the order of priority:

- DLO Dataset (IROS - March 1st.): Last week, I wrote two separate programs; one for collecting RealSense RGBD frames and generating the corresponding point cloud for each frame, and another for connecting to UR5e over IP and commanding it via a TCP-based ASCII API. The robot runs a custom program (URP file) that anticipates commands while in Realtime Data Exchange (RTDE) mode. I had some issues rerunning the program on Friday, which I need to figure out why. Moreover, I need to set boundaries and movement constraints to prevent self-collusion. Additionally, I need to investigate how we can configure the elbow to stay up or down while the arm is in motion. The point clouds and robot state data look good, and I need to combine the two programs to collect and store data in sync. Lastly, Dr. Gans and I explored methods for automatically segmenting and annotating the point cloud frames. Dr. Gans suggested we use high-contrast colors for the DLO and its background (table) and convert the point cloud colors to HSV color mapping for automated annotation. I think it is simple and effective, I will implement it. We can also use K-nearest neighbors and random forest algorithms to filter out noise and reconstruct the DLO from a point cloud frame where a section of the DLO is missing or is occluded.

- Maicol:

- 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.