Progress Report

Bardia Mojra

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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 worked on the RealSense module (rsDevice) for the most part. It turned out more complex than I expected, but I have a much better understanding of the RealSense system. RealSense has an internal save-to-file operation that is efficient in terms of memory usage and execution time. This method is sufficient for data collection. However, due to its distributed systems architecture, it is appropriate to use ROS for real-time operations where the data is processed online. I have integrated online data extraction without logging for visualization purposes. This will affect the frame rate at which we can collect data, and I will measure the execution times. Initially, I integrated Open3D for visualization, but its integrated RealSense API has known bugs. I am using OpenCV for now, but I will make a separate visualization module. I will be ready to collect data soon, but learning the API is essential.

- Maicol:

- DLO Manipulation (IROS): [1].

- XEst (RAL —): No update.

https://www.youtube.com/watch?v=WK5gUedQpK8

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 it 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 extend 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 it against the existing Koopman-based MPC control schemes for VTOL-DIP method and introducing a method for controlling VTOL-TIP in simulation. This method will become the backbone of my Koopman-based MPC control research effort.

- DLO-02 (TBD): This method will 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.