

Progress Report

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November 7, 2022

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1 DLO Dataset Tests

- Clamped end low, DLO on table and flat, change gripper pose, no twist on DLO: omega shape, s shape, u shape, circle shape, ellipse shape, spiral.
- Clamped end low, DLO on table and 3D, with twist: same shapes.
- Clamped end low, DLO angles at 30 degrees and 3D, without twist.
- Clamped end low, DLO angles at 45 degrees and 3D, without twist.
- Clamped end low, DLO angles at 60 degrees and 3D, without twist.
- Clamped end low, DLO angles at 75 degrees and 3D, without twist.
- Clamped end low, DLO angles at 90 degrees and 3D, without twist.
- Clamped end low, DLO angles at 30 degrees and 3D, with twist.
- Clamped end low, DLO angles at 45 degrees and 3D, with twist.
- Clamped end low, DLO angles at 60 degrees and 3D, with twist.
- Clamped end low, DLO angles at 75 degrees and 3D, with twist.
- Clamped end low, DLO angles at 90 degrees and 3D, with twist.

2 Progress

The following items are listed in the order of priority:

- DoD SMART (**Dec 1st.**): I am currently working on this.
- DLO Dataset (**Dec 1st.**): I finished designing the test. This week, I will finish the test setup design and BOM. I will send out the BOM by the end of this week. Moreover, I am installing Unity, Fusion360, and setting up Intel Realsense for data collection. We will use a Realsense D455 and I borrowed one from the lab.
- DLO Manipulation (**IROS**): [1].

- Maicol (REU): He is working with me on DLO dataset.
- XEst (**RAL** —): No update.

References

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

3 Research Plan - Out of date

This section outlines my current research plan where the main ideas, target conference/journal, and expected date of completion for each paper are provided. Target conferences: ICRA, IROS (March), CASE (Late Feb.), NIPS. Target Journals: RAL, CVPR, CORAL.

- Koopman-01 (**IROS - Dec. 1st - active**): Koopman-based MPC control of VTOL-DIP and VTOL-TIP in simulation, DLO pose estimation in simulation, experiments on choice of basis function and lifting dimensions, and performance comparison with optimal, robust, and/or adaptive control schemes.
- Koopman-02 (**ACC - Sep 30th - active**): A review on Koopman-based control schemes. **Not enough, make it part of another paper.** Read papers and write literature reviews.
- Koopman-03 (RAL - Mar. 1st - status): Extension to Koopman-01, Koopman-based dynamic estimation of DLO, collect dynamic DLO dataset, prediction of DLO configuration.
- Quest-01 (**IROS - Mar. 1st - next**): Optimal transform solution for QuEst based on dominant mode decomposition (DMD).
- Quest-02 (IROS/RAL - date - status): QuEst-based EKF, structure from motion, and VSLAM, compare performance with existing methods.
- Koopman-04 (IROS/RAL - date - status): Physics Informed (PI) Koopman-based control of a DLO, show obtained is persistent, compare to other non-PI methods, offline-online learning.
- Koopman-05 (IROS/RAL - date - status): PI Koopman operator (PIKO) based persistent model for DLOs, low dimensional, compare performance, offline-online learning/adapting, fast transfer learning.

- Koopman-06 (IROS/RAL - date - status): PIKO-based unit segment model for DLOs, more generalized, should yield better performance if number segments are selected online in order to obtain optimal representation in real-time given available hardware, compare results.
- Koopman-07 (IROS/RAL - date - status): DLO dataset, PIKO-based reinforcement learning of real DLO dynamics in a digital twin (DT) setting, experiments of model persistence, compare learning rate with neural network based methods, compare performance with available methods, and experiments on learning limitations.
- Koopman-08 (IROS/RAL - date - status): Koopman-based real-time control of DLO on GPU.
- Koopman-09 (IROS/RAL - date - status): PIKO-based real-time control of DLO on GPU.
- Koopman-10 (IROS/RAL - date - status): PIKO-based real-time control of deformable planar objects (DPO).
- Koopman-11 (IROS/RAL - date - status): PIKO-based real-time control of deformable volume objects (DVO).
- Koopman-12 (IROS/RAL - date - status): PIKO-based unit segment for DPOs, on GPU.
- Koopman-13 (IROS/RAL - date - status): PIKO-based unit segment for DVOs, on GPU.