Progress Report

Bardia Mojra

May 29, 2022

Robotic Vision Lab

The University of Texas at Arlington

1 Specific Research Goals

- VPQEKF (May 30th): Work on the paper.
- DLO Manipulation Dataset (ICRA - Sept. 1st)

2 To Do

- QEKF Paper - 30% extension (May 30th):
  - Edit VEst section and add updates.
- QEKF/QuEst+VEst Implementation (May 30th):
  - OOP Integration: QEKF - Done.
  - Feature point extraction: implement semantic segmentation
  - Address scale factor (depth-scale) issues: DL solutions?
  - Address "hand off" issue when objects enter or leave field of view
  - Real-time streaming images for real-time operation (optional) - Done
  - Experiments - Done
  - Noise issue: noise cannot be modeled - revisit
- DLO Manipulation: Sept. 1st
  - Find other ICRA dataset papers and summarize the structure. — On-going.
  - Dataset (ICRA - Sept. 1st):
    * Finalize MoCap design, design digital twin work cell. — Done.
    * Build work cell.
    * Collect data and create a dataset.
    * Create object dynamics ground-truth method, format, and evaluation metrics.
  - Control and Tracking
    * Create UR5+DLO simulation in Matlab and begin work on H-Infinity control before Reza leaves for Indiana State.
    * Model dynamics and deformity

- Real-Time Preception
  - PVNet approach for known objects
  - Rope Manipulation dataset
  - Time model inference, using auto-encoders generate the lowest dimensional representation for each object.
  - Use another GAN model for object deformity for each object.
  - Evaluate encoded representation for accuracy.
  - Used another GAN to explore other abstraced representations from individual encoded representation. In theory, we can create a low dimensionsal representation for multiple similar objects, given all individual low-dimensional representations. This is inspired by "fundamental principles first" approach which has universal applicability.
-

3 Progress

The following items are listed in the order of priority:

- VPQEKF (RAL - April 1st, 2022): I finished working on VPQEKF code and shared results with Dr. Gans. He provided feedback and updated the code to better represent the output. But there seem to remain some confusion on what the output represent. In short, the system runs 4 QEKF's at the same time, one for each pose estimation method. The run-time Kalman filters are stored and managed as different instances of the same object, where each instance receives pose and velocity estimates corresponding to its assigned pose method. For each keyframe, inputs, outputs, and some state variables (e.g. QEKF state residual) are stored in a frame buffer. At the end of each frame iteration, the frame buffer is passed to the data logger module which stores each variable in its corresponding instacne of the log object. Any variable could be logged with minimal changes to the code. Dr. Gans and I will discuss the code and its output next week. The outputs are attached to this report for your attention.
- DLO Dataset: Jerry and Joe seem very busy so I just went with their design. It is probably the best design since it take minimal time to build. I researched ICRA DLO manipulation papers, made a list and

began dissecting them systematically. I also started a mind-map for related work section. The paper review document and the mind-map are attached for your attention. It turns out, I have been over-thinking (as always) the DLO manipulation task. It seems that even RGB only dataset could be sufficient to teach an agent to manipulation DLOs in real time. The authors in [1] created a state estimation and predition framework very similar to what I have thinking. Of course, I did not see it as clearly them but I think it provides a good base-line for my paper. Moreover, I can follow their method and create a similar dataset with our added contributions such as additional objects or sensors (and sensor fusion model).

- DLO Control: No update.
- DLO Perception: No update. – might not be needed.
- Semantic segmentation (DLO-02): Per my discussion with Dr. Gans, I will explore DL methods for the depth or scale problem.
- Grasping Project (DLO-03): I am making this a part of the DLO project.
- PyTorch Tutorials: Transfer learning.

4 Intermediate Goals - Fall 2021:

- QEKF: Finish paper.
- UR5e: Do the tutorials.

References

[1] W. Zhang, K. Schmeckpeper, P. Chaudhari, and K. Daniilidis, "Deformable linear object prediction using locally linear latent dynamics," in *2021 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 13503–13509, IEEE, 2021.