Progress Report

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April 11, 2022

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1 Specific Research Goals

- VPQEKF (RAL - April 1st): Work on the paper.
- DLO Manipulation Dataset (ICRA - September)

2 To Do

- QEKF Paper - 30% extension (April 1st):
  - Edit VEst section and add updates.
- QEKF/QuEst+VEst Implementation (Feb. 28th):
  - Implement QuEst 5-point: Done, debugging.
  - Feature point extraction: implement semantic segmentation
  - Implement VEst
  - 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)
  - Experiments
  - Noise issue: noise cannot be modeled
- DLO Manipulation:
  - Related work literature review
  - Real dataset + paper (September 2022 - ICRA):
    - Design, discuss and build a data collection and test rig.
  - Unity dataset
    - Recreate virtual duplicates of physical test material
    - Model dynamics and deformity

3 Progress

The following items are listed in the order of priority:

- VPQEKF (RAL - April 1st, 2022): This week, I finished working on the RANSAC QuEst module. Initially, I was following Kaveh's RANSAC implementation and I found that very confusing to follow. I read on RANSAC for a day, it turns out there are many published works available to researchers. For example, in [1] the authors propose a RANSAC method that works with semi-degenerate data. Data degeneracy in RANSAC is referred to a situation where the given dataset does not contain enough constraints for a unique solution to be obtained via linear models. Quaternions are generally more robust to rounding noise and for now, we assume degeneracy is impossible. But in our implementation, we deal with a similar problem where we have to guess and pick the quaternion solution among all possible solutions and I believe the degeneracy test could help us with that. Moreover, [2] introduces a method for SIFT feature point matching with an improved RANSAC algorithm. In their work, they add a feedback loop to the random selection feature to improve the selection process and shorten the overall execution time. Moreover, I ported in SIFT matched features from Matlab to Python and I am in the process of comparing outputs line by line. We often forget that some of the mathematical formulas we use are not exact and are mere approximations. More often than not, where are multiple approximation functions are available for mathematical operation. For example, a matrix left division has multiple Python implementation and only some match the operation native to Matlab. Additionally, I noticed the mean rotation error decreased to half after I ported in SIFT matched feature points from Matlab. This points to SIFT's higher accuracy in either feature extraction, matching or both.

- DLO Manipulation Milestones: pose estimation and tracking, object detection (semantic segmentation), grasping, assembly and disassembly, and DLO manipulation.

- Pose Estimation (DLO-01): On-going under VPQEKF.

- 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] J.-M. Frahm and M. Pollefeys, "Ransac for (quasi-) degenerate data (qdegsac)," in *2006 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'06)*, vol. 1, pp. 453–460, IEEE, 2006.

[2] G. Shi, X. Xu, and Y. Dai, "Sift feature point matching based on improved ransac algorithm," in *2013 5th International Conference on Intelligent Human-Machine Systems and Cybernetics*, vol. 1, pp. 474–477, IEEE, 2013.