Progress Report

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1 Specific Research Goals

- VPQEKF (May 30th): Work on the paper.

- DLO Manipulation Dataset (ICRA - Sept. 1st)

2 To Do

- QEKF Paper - 30% extension (June 30th):

- Implementation (May 30th):

  - Point-feature extraction: tracking issue – resolved
  - Address scale factor (depth-scale) issues: – resolved
  - Noise issue: noise cannot be modeled - revisit
  - Adding plots – done
  - Rewrite RQuEst (RANSAC-QuEst) to use triangulation
  - Replace the relative pose estimation routine in SfM example with RQuEst

- DLO Manipulation: ICRA - Sept. 1st

  - Work on the paper everyday – up-coming
  - Find other ICRA dataset papers and summarize the structure. – Done.
  - Setup Omniverse on TACC – Next
  - Setup digital twin reinforcement learing setup:
    * Design dynamic DLO data collection system.
    * Build work cell.
    * Collect data and create a dataset.
    * Define evaluation metrics.
    * Create a high frequency RGBD dataset with UV-frames and open-loop input control actions as the ground truth.
  - Real-Time Preception
    * Deep learning methods for keypoint pose estimation in real-time.
    * Use UV dye dataset

* Use PVNet-like approach for known-object pose estimation.
  - Learning DLO Dynamics and System Identification
    * List feasible approached for learing DLO dynamics
    * Model dynamics and deformity in a latent space
  - Real-Time Control
    * 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:

- XEst (RAL - April 30st, 2022): I finished working on the plotting module for QEKF and was able to generate log plots for each of the pose estimation algorithms. Although, there is an issue with the quaternion estimation output where it does not update properly. It seems to be a tuning issue, I looked into it but the issue presisted and I am working Bundle Adjustment so I shelved QEKF for now.

Figure 1: Acceptable point-feature matches between two frames.

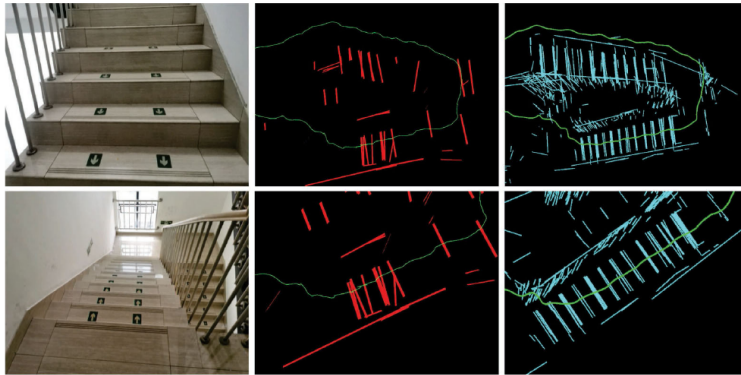Figure 2: Noisy point-feature matches between two frames.

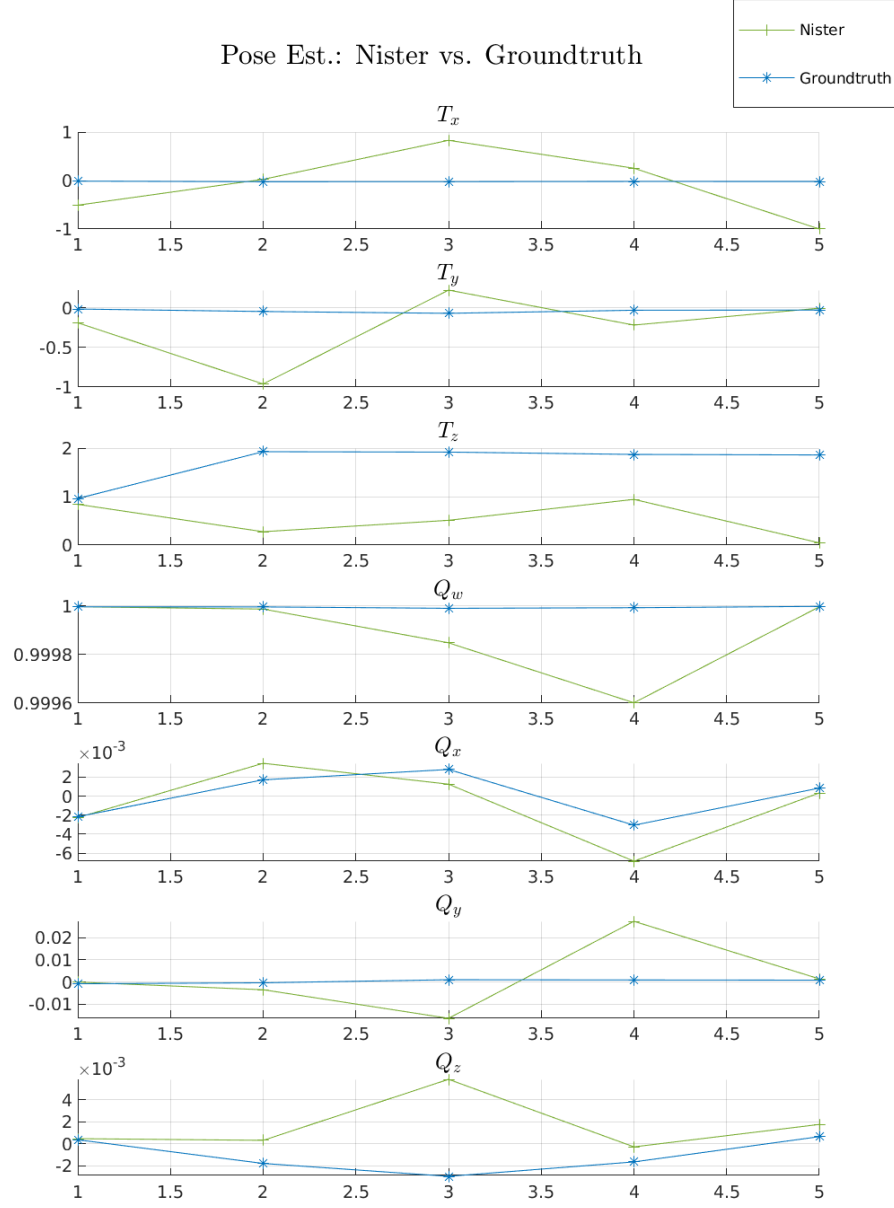Figure 3: Line-features from an image sequence.

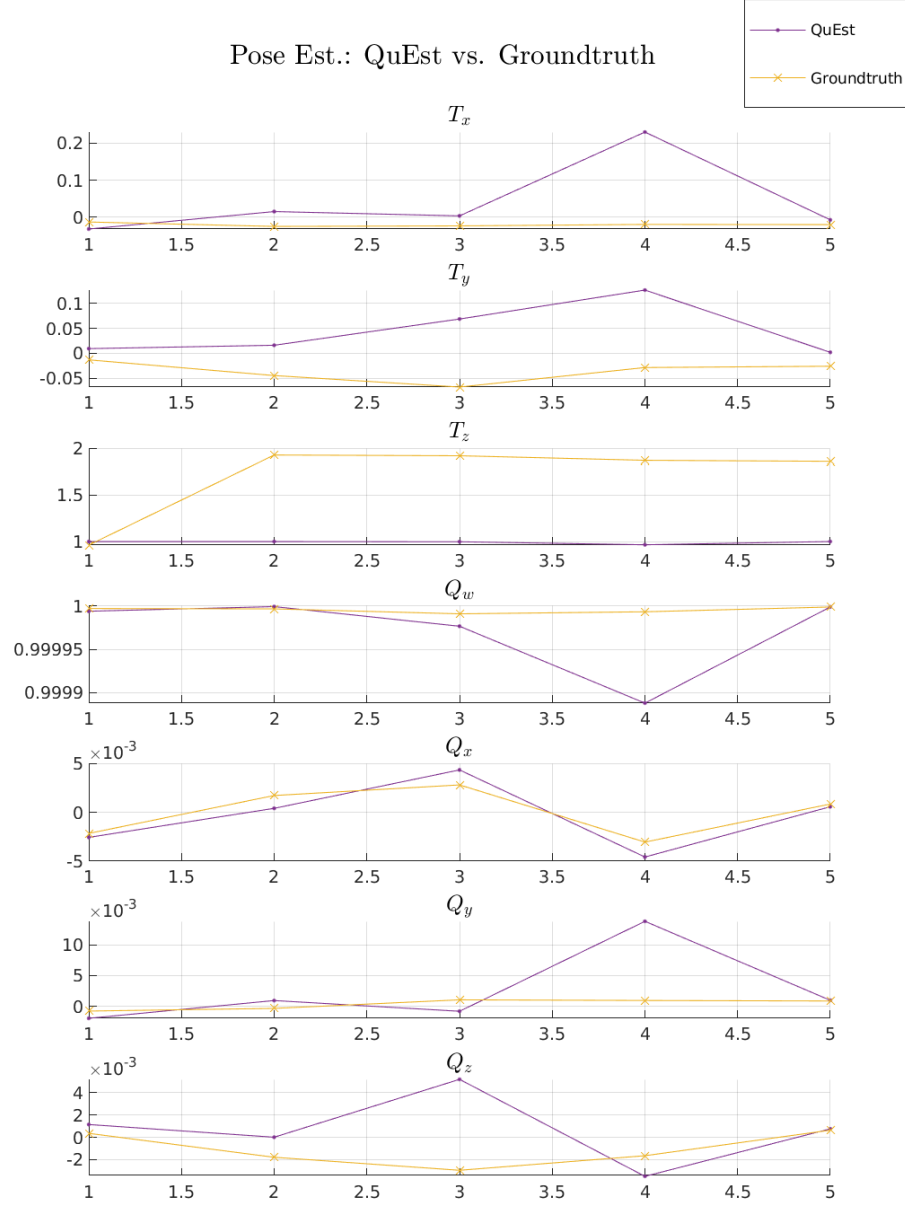Figure 4: Pose estimation log: Nister vs. Groundtruth.

Figure 5: Pose estimation log: QuEst vs. Groundtruth.

- XEst - Semantic segmentation (RAL - April 30st, 2022): No update on implementing [1].

- DLO Dataset: I installed Unity and soon will begin working on tutorials.

- Linus (REU): He is working on Unity tutorials, recreating RVL workcell, and importing UR5 model into Unity.

- Maicol (REU): He is working on ROS2 tutorials, MoveIt tutorials, and way-point navigation of UR5 in Unity.

- Myself (with REU): I will start on MuJuCo tutorials as well.

- DLO Control (MuJuCo): No update.

- Grasping Project (DLO-03): I am making this a part of the DLO project.

- PyTorch Tutorials: Transfer learning.

- Manifold learning: Marcus emailed me some papers, I will read them and reply to him. I am not particularly interested in the project but his ideas are interesting and I would like to help him if I can. He is very knowledgeable on mathematics and I cherish that.

4 Intermediate Goals - Fall 2021:

- QEKF: Finish paper.

- UR5e: Do the tutorials.

References

[1] I. Ballester, A. Fontan, J. Civera, K. H. Strobl, and R. Triebel, "Dot: dynamic object tracking for visual slam," in *2021 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 11705–11711, IEEE, 2021.