Progress Report

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June 20, 2022

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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):
  - Read and summarize recent VO and QEKF papers.
- QEKF/QuEst+VEst Implementation (May 30th):
  - Point-feature extraction: tracking issue
  - Address scale factor (depth-scale) issues: DL solutions?
  - Noise issue: noise cannot be modeled - revisit
  - Adding plots - On-going
  - Add semantic segmentation for detecting moving object pixels and rejecting matched features in those regions
- DLO Manipulation: ICRA - Sept. 1st
  - Find other ICRA dataset papers and summarize the structure. — On-going.
  - Dynamic Dataset Collection System with Reinforcement Learning:
    - 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-based approach for known-objects

  - 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 found a series of papers on visual inertial odometry (VIO) and line feature tracking. In the VIO papers, the authors used inertial information from an IMU sensor to estimate depth. Per my conversation with Dr. Gans, we are not interested in methods that use inertial information collected from an IMU as it would dilute our work on vision-based approaches. Moreover, line-feature tracking has been used in visual-SLAM applications and is shown to perform more robustly than line features. I have not found a working implementation yet. At this moment, I am redoing a part data log visualization for QEKF module.

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

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

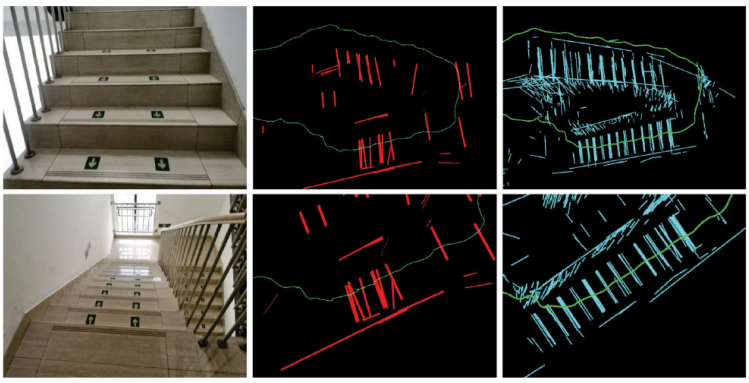

Figure 3: Line-features from an image sequence.

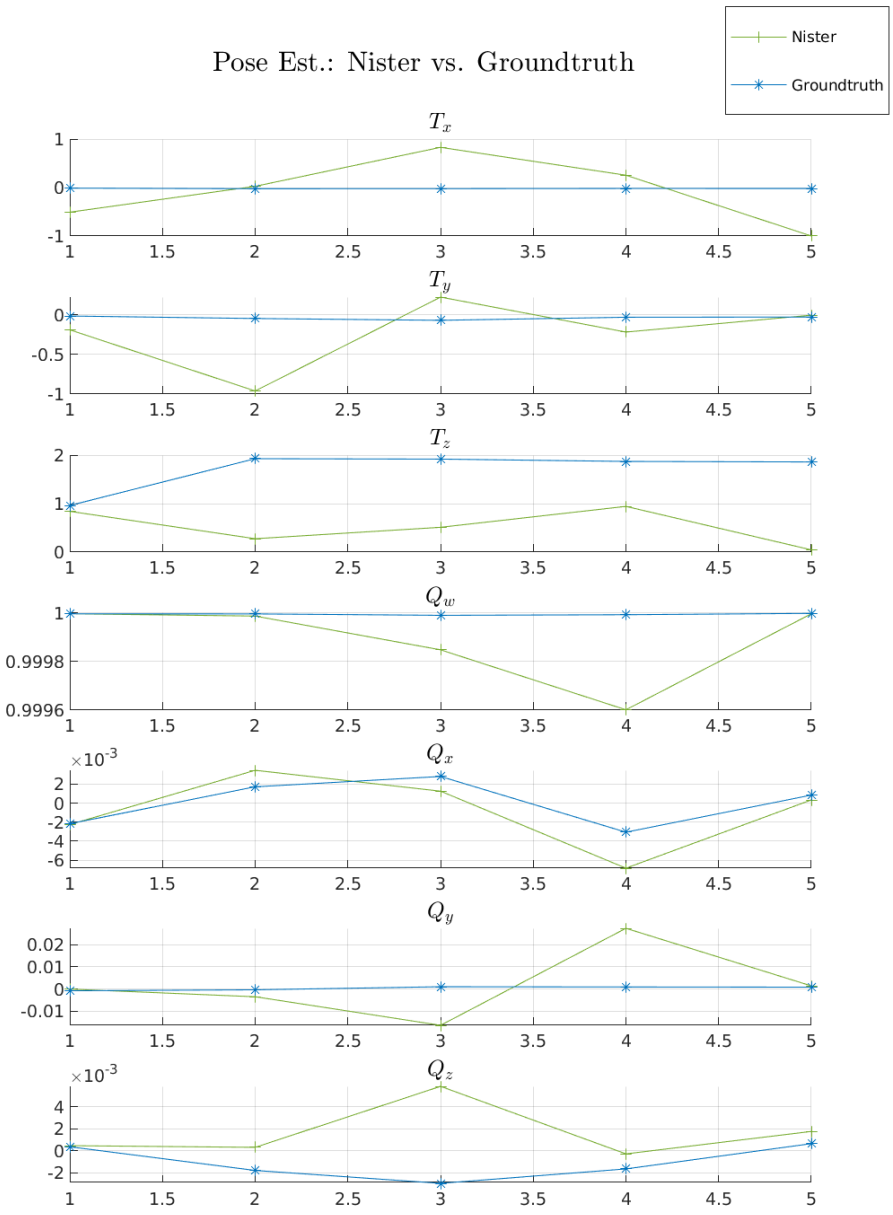

Figure 4: Pose estimation log: Nister vs. Groundtruth.

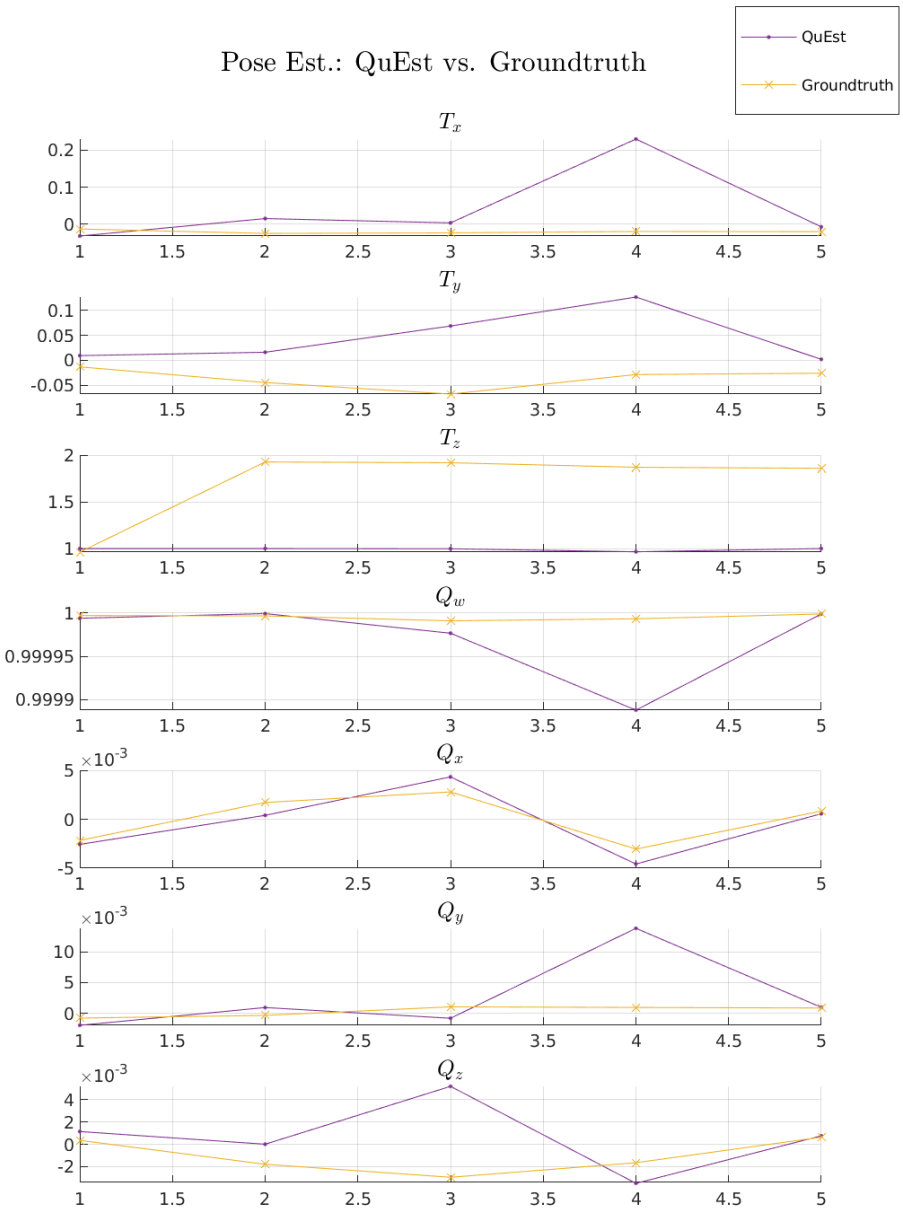

Figure 5: Pose estimation log: QuEst vs. Groundtruth.

- 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.