

Progress Report

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Robotic Vision Lab

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1 Specific Research Goals

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

2 To Do

- QEKF Paper (April 1st):
 - Related work
 - Introduction
 - QuEst + VEst description
 - QEKF description
 - Experiments
 - Conclusion
- QEKF/DR Implementation (Feb. 2st):
 - Finish updating QEKF code - done
 - Add Vicon data as ground truth - overdue
 - Test on multiple datasets
- QEKF/QuEst+VEst Implementation (Feb. 11th):
 - Integrate and confirm update QEKF works
 - Address scale factor (depth-scale) issues
 - Address "hand off" issue when objects enter or leave field of view
 - Real-time streaming images for real-time operation (optional)
 - Experiments
 - Feature point extraction
 - 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 (on-going)
- * Define DLO classes and specs
- * Purchase DLO samples for data collection
- 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:

- Dead Reckoning (Feb. 2nd, 2022): I debugged the DR code and was able to get some initial results. State estimate which is orientation in Quaternion seems to be noisy and highly inaccurate, see figure 1. With a closer examination, we suspect low observation noise on angular velocity might be a cause, see figure [2]. Angular velocity is measured but in EKF formulation, it is considered input and is a part vector u . Dr. Gans and I suspect input signal noise u_{wrpy} and computational errors may be the root causes for these issues. Thus, I am working on importing Vicon data to be used as ground truth. Moreover, I will try to apply a smoothing function or a moving-average filter to angular velocity signal u_{wrpy} since it is considered input and is not expected to have noise.
- VPQEKF (April 1st, 2022): I need to start working on feature points extraction done by Quest+Vest code [1].
- DLO Manipulation: I looked into getting a wiring harness assembly 'formboard', figures 3 and 4. The boards are custom and are made-to-order, so we either have to get an old one or build one ourselves. I explained the situation to Dr. Gans and he said he know some senior people at GM and he is gonna talk to them. Additionally, I looked into a formboard stand and it costs about \$2,500, I will look for cheaper alternatives.
- NBV-Grasping Project: No update.
- PyTorch Tutorials: Transfer learning.
- Pose Estimation: I will need it for DLO segment localization.

4 Intermediate Goals - Fall 2021:

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

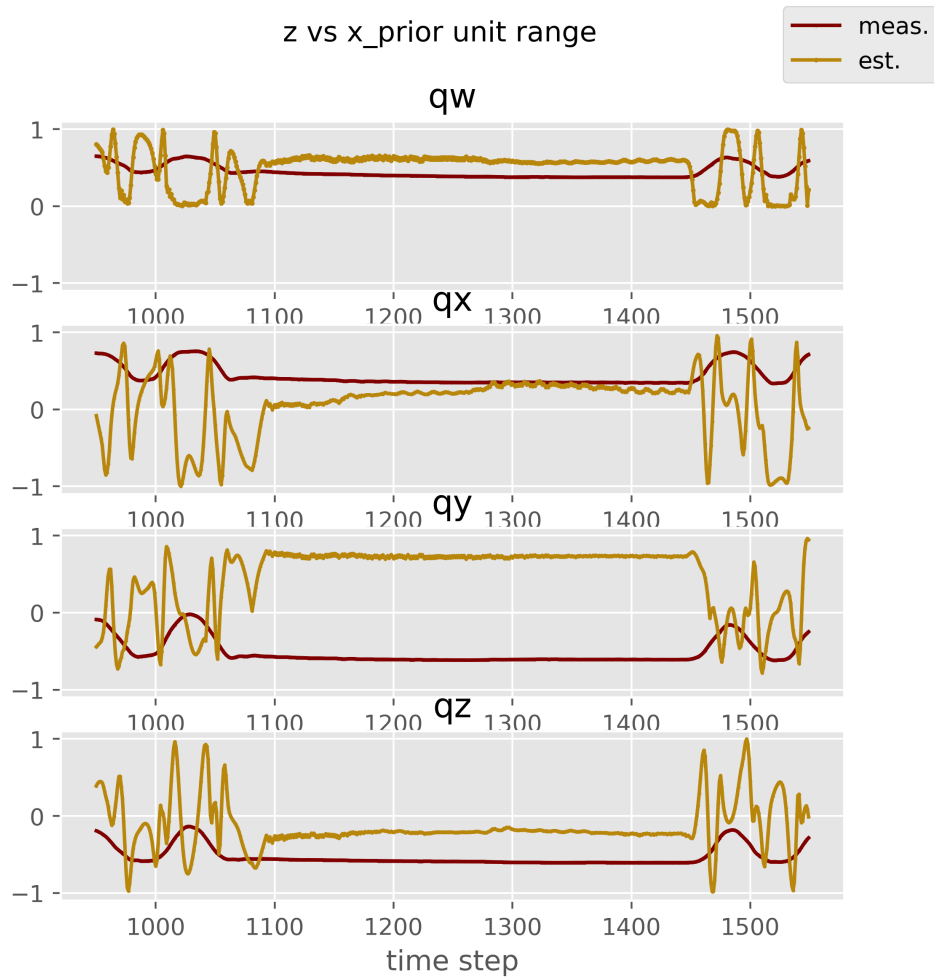


Figure 1: Measured and state estimate of orientation in Quaternion.

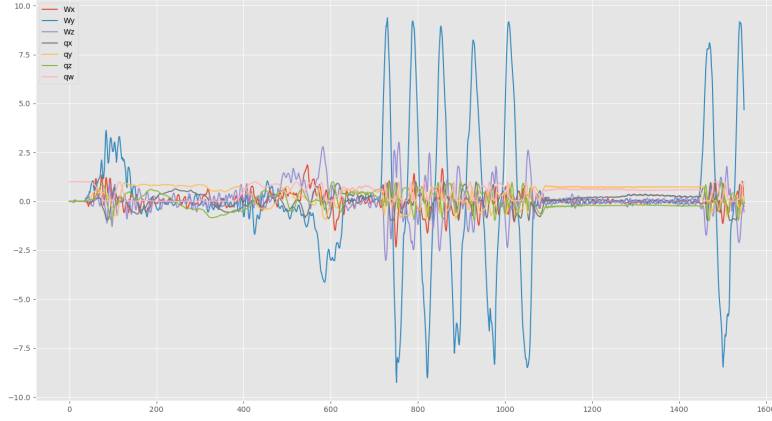


Figure 2: Input angular velocity signal and orientation state estimate in Quaternion.

References

- [1] K. Fathian, J. P. Ramirez-Paredes, E. A. Doucette, J. W. Curtis, and N. R. Gans, “Quest: A quaternion-based approach for camera motion estimation from minimal feature points,” *IEEE Robotics and Automation Letters*, vol. 3, no. 2, pp. 857–864, 2018.

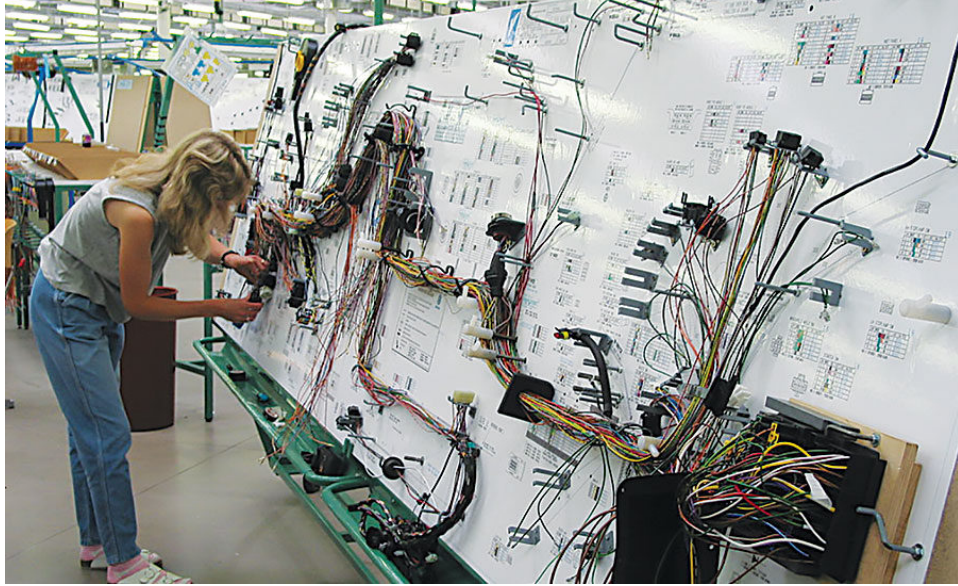


Figure 3: Wiring harness assembly on a designated formboard.

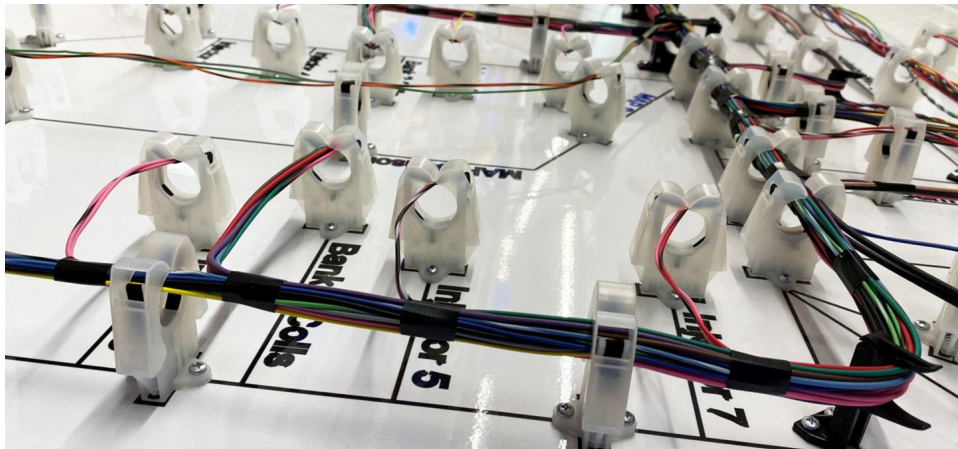


Figure 4: A formboard close up.