Progress Report

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1 Specific Research Goals

- VPQEKF (IROS - Mar. 1st): Work on the paper.
- DLO Manipulation Proposal: Work on a personal statement.

2 To Do

- Fellowship:
  - Develop a well-written personal statement. — On-going.
  - Seek other graduate fellowship opportunities. — On-going.
  - Develop multiple versions of research and personal statements for submission to different opportunities.
- PVQEKF:
  - Go over code and write matrix equations. — On-going
  - Write daily. — On-going.
  - Double-check my data prep implementation. Use KITTI Python module.
  - Test with Hilti dataset.
  - Add L2-norm and L2 loss features. — Done.
  - I need to separate the state observation and control input vectors from the z matrix. — Task under review.
  - Develop object tracking and robust-to-truncation feature.
  - Get ROS environment up and running. I need to install Armadillo (C++) with a certain dependency configuration.

3 Progress

The following items are listed in the order of priority:

- Fellowship: Per Dr. Gans' recommendation, we should target [**?**]. It is a broad call for proposals by NSF, without a deadline, which may signify its necessity. Next, NDSEG [**?**] seems to be right fit for our proposal. After that, NASA's Robonaut program [?] seem to benefit greatly from the outcome of our proposal.

I have been going over my personal statement almost everyday now and each day I add a few lines. The following is the latest iteration of the introduction paragraph. I was five years old when I was introduced to electronics. I watched in fascination as my father examined and repaired my brother's remote-control car. That experience triggered me, I became curious how electronics work and decided to become an electrical engineer. At eight, I used available parts around the house to wire up a tent I made in my bedroom with lights, a fan and switches. In junior high, I kept to myself, perhaps because I stutter, so I decided to join an after-school robotics program. With help from my teacher, I built my first autonomous robot at thirteen. It was an analog firefighter robot with a differential drive system and a running water pump. One wheel turned at all times and the other was controlled by an IR sensor installed in front of the robot. The robot would turn until it faced fire, which dissipates some of its energy by emitting electromagnetic signals in the infra-red band, causing the other wheel to start to turn and the robot would move toward the fire.

- VPQEKF: I finished integrating L1 and L2 norm loss functions. Moreover, I have been writing up the equations corresponding to QEKF implementation for debugging purposes. The latest version is available on Overleaf.

  This is very interesting and useful. Usually, such details are dismissed because of the locality of linearization but differentiation and linearization may not directly apply to non-euclidean spaces. The authors in this paper introduce a linear model for estimating orientation parameter (quaternion) distribution in their true space (SO(3) with Quat representation), resulting in more accurate pose estimations. http://www.roboticsproceedings.org/rss13/p16.pdf

  I think this paper is pure genius. Instead of linearizing their estimation model, they used a particle filter to learn and estimate Bigham distributions for both translations and orientations (with dual quaternion representation - I'm still learning that part), hence estimating the pose for rigid body motion in SE(3) (I expected something like SO(6)) with better performance. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=arnumber=9125962

  and here is dual-quaternion representation.

Remember, Quaternion was invented by Hamilton to represent rotations in a computationally efficient manner. To do that, quaternions use i, j, and k unit vectors as unit scalars which allows for using higher multiples to keep coefficients numerically simpler while maintaining numerical accuracy (this is huge deal if you're used to solving dynamics equations by hand, even with a calculator sigfigs, error propagation and more.. - you generally want to avoid decimals). The fourth term, w, is added as a scalar constraint to keep the quaternion magnitude at 1, while preserving the ratio of i, j, k coefficients hence preserving the rotation and discarding the arbitrary magnitude/

- 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.
- Active Learning.
- UR5e: Do the tutorials.