Progress Report

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1 Specific Research Goals

- VPQEKF: Combine QuEst and Vest with QEKF paper.
- NBV-Grasping.
- Universal pose estimation or a novel and superior approach.

2 To Do

- Catch up on my reading list.
- PVQEKF:
  - Update state definition and measurement matrices. – Done.
  - Get ROS environment up and running. – Next: test header include bug theory.
- NBV-Grasping:
  - Update URDF and Xacro files for UR5e to include sensor, sensor mount (with offset), and the gripper. – Next
  - Add movement constraints for tables and scenes.
  - Write two IK functions for gripper and sensor, one for each. It should plug-in with MoveIt configurator.
  - Research and implement point-cloud data to training TensorFlow models.
  - Learn and implement GraspIt package.
- MSI Fellowship: On pause.

3 Reading List

- Vision-based robotic grasping from object localization, object pose estimation to grasp estimation for parallel grippers - a review [1] - On-going.
- Leveraging feature uncertainty in the pnp problem [2].
- Normalized objects [3].

- Berk Calli's YCB [4].
- NASA papers [5].
- Roadmap [6].

4 Progress

The following items are listed in the order of priority:

- VPQEKF: I finished updating state transition model and observation model matrices. I am currently debugging data handling and computation.

  EKF is a low dimensional joint probability distribution robust estimator. It essentially combines dynamically constrained robust estimator with i.i.d. random variable noise assumption to create a more accurate model the real world, a chaotic system. It makes *full state estimations* with tuned noise variance tolerances that allows for random noise conspensation. An observation is made and EKF update it's *belief* according to both *prior belief* and *current observation*. In a low dimensional context, the weights assigning proportionality to *prior belief* and *current observation* for every state (dimension) are called **the Kalman gain**.

  EKF's update step computes *the residual* – finished section at a later time.

- NBV Grasping Project: No update.
- NASA MSI Fellowship: Need to read more NASA papers. – On pause.
- PyTorch Tutorials: Transfer learning.
- Pose Estimation: On pause.
- SD Team: No update.
- EE Autonobots: No update.

5 Immediate Plans - Summer 2021:

The following items are listed in the order of priority:

- UTARI: Dr. Gans' pose and velocity estimation paper.
- NBV-Grasping:
- Pose estimation: Survey paper.

6 Intermediate Goals - Fall 2021:

- Pose estimation: I must be finished with implementation, perhaps make some improvements, and should be working on a paper for ICRA or CVPR.
- Scene understanding and active learning: After pose estimation, I want to expand my research into scene understanding and active learning in the context of advanced manufacturing.
- ARIAC: Once I am up to speed, I will do the ARIAC workshops/tutorials and will talk to Jerry about possible contributions.

References

[1] G. Du, K. Wang, S. Lian, and K. Zhao, "Vision-based robotic grasping from object localization, object pose estimation to grasp estimation for parallel grippers: a review," *Artificial Intelligence Review*, pp. 1–58, 2020.

[2] L. Ferraz Colomina, X. Binefa, and F. Moreno-Noguer, "Leveraging feature uncertainty in the pnp problem," in *Proceedings of the BMVC 2014 British Machine Vision Conference*, pp. 1–13, 2014.

[3] H. Wang, S. Sridhar, J. Huang, J. Valentin, S. Song, and L. J. Guibas, "Normalized object coordinate space for category-level 6d object pose and size estimation," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2019.

[4] B. Calli, A. Singh, A. Walsman, S. Srinivasa, P. Abbeel, and A. M. Dollar, "The ycb object and model set: Towards common benchmarks for manipulation research," in *2015 international conference on advanced robotics (ICAR)*, pp. 510–517, IEEE, 2015.

[5] NASA, "Nasa technical reports server (ntrs)." `https://ntrs.nasa.gov/`, 2020. (Accessed on 05/07/2021).

[6] USA-CRA, "roadmap-2020.pdf." `https://cra.org/ccc/wp-content/uploads/sites/2/2020/10/roadmap-2020.pdf`, 2020. (Accessed on 04/30/2021).