Progress Report

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1 Specific Research Goals

- VPQEKF: Combine QuEst and Vest with QEKF paper.
- Pose estimation survey.
- NBV-Grasping.
- Universal pose estimation.

2 To Do

- Catch up on my reading list.
- PVQEKF:
  - Replace data input to QEKF, remore IMU data with QuEst and Vest data. – On going.
  - Update state definition and measurement matrices.
  - Get ROS environment up and running. – On going.
- Pose Estimation Survey:
  - Categorize pose estimation research and create a mind map. – On going.
  - Implement key point feature extraction: ORB, SIFT, SURF.
  - Survey: I need start working on this. – On going.
  - Survey implementation: Classical, 2-stage, and end-to-end methods. PnP, QuEst, PVNet and else.
- NBV-Grasping:
  - Update URDF and Xacro files for UR5e to include sensor, sensor mount (with offset), and the gripper.
  - 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 had some issue setting up ROS environment, where I did not properly uninstall OpenCV-3.2 and it was causing dependency conflict with OpenCV-3.4.9 installation. Next, I will purge all ROS related packages and install the barebone version. Then, I should be able to build the package without any problems.

  Moreover, I worked on QEKF implementation that I received from Asif. I cleaned up the code and I am currently trying to run it with existing dataset to make sure it runs as intended. Next, I will take out IMU state data and add in state data from QuEst and VEst.

  I am not sure how it will work since without acceleration data we will lose the second order approximation term.
- NASA MSI Fellowship: Need to read more NASA papers.
- PyTorch Tutorials: Transfer learning.
- NBV Grasping Project: I did not get to work on this project this week.
- PE Survey: I started a mind map of pose estimation research. I am currently listing papers and categorizing them as well as attaching a short brief to each. It is still early in the work.

- 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).