

# 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:
  - Keep improving and debugging the QEKF code.
  - Get ROS environment up and running. – Next: test header include bug theory.
- RVL profile material.
- Real-time pose estimation demo.
- 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 got QEKF code working and tested different datasets i received from Dr. Gans and Cody. We have had various results, and we still suspect computational errors. I developed a handler for KITTI IMU dataset and it too indicates there are some issues with QEKF. Figure 1 shows some issue translation data which I had to generate using IMU data. I believe instead of using translation with respect to previous frame( $X_t^{t-1}$ ), I need to use translation with respect to initial frame of reference ( $g(t)X_t^0$ ). Furthermore, figures 2 and 3 allude to additional issues with QEKF estimations.

Figure 1 shows translation in 3D. Figure 3 shows measurement ( $z$ ) vs estimate ( $x-post$ ) translation in 3D. Figure 3 shows measurement ( $z$ ) vs estimate ( $x-post$ ) over 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.

## Quest Translation in 3D

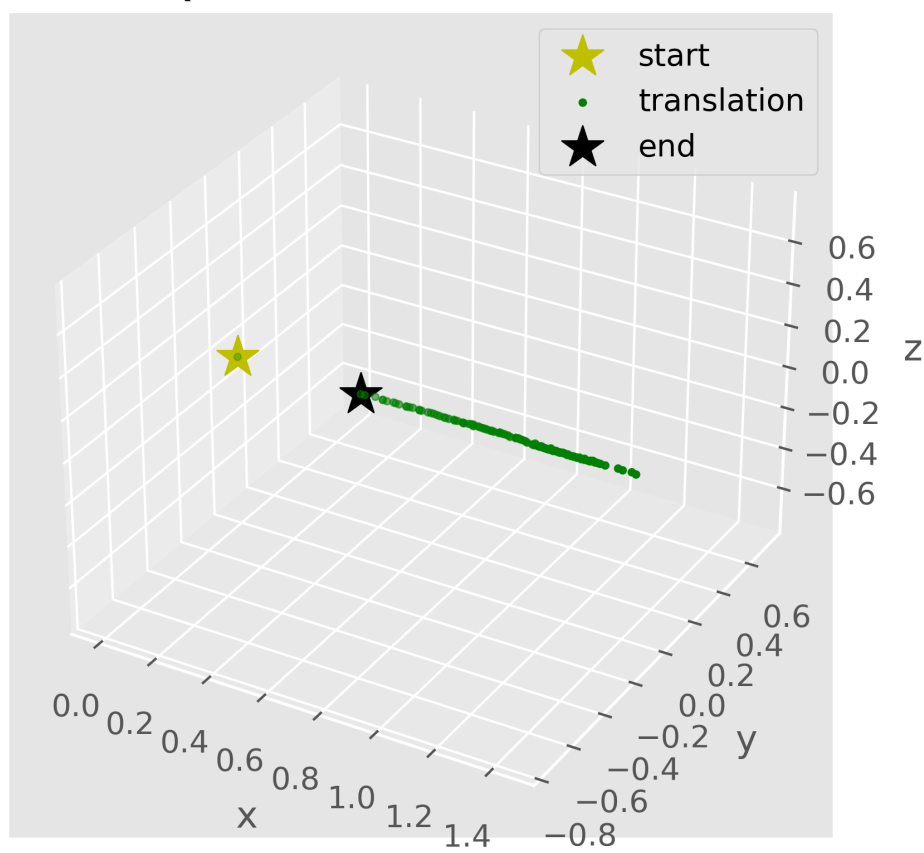


Figure 1: KITTI 001 - Translation ( $v$ ).

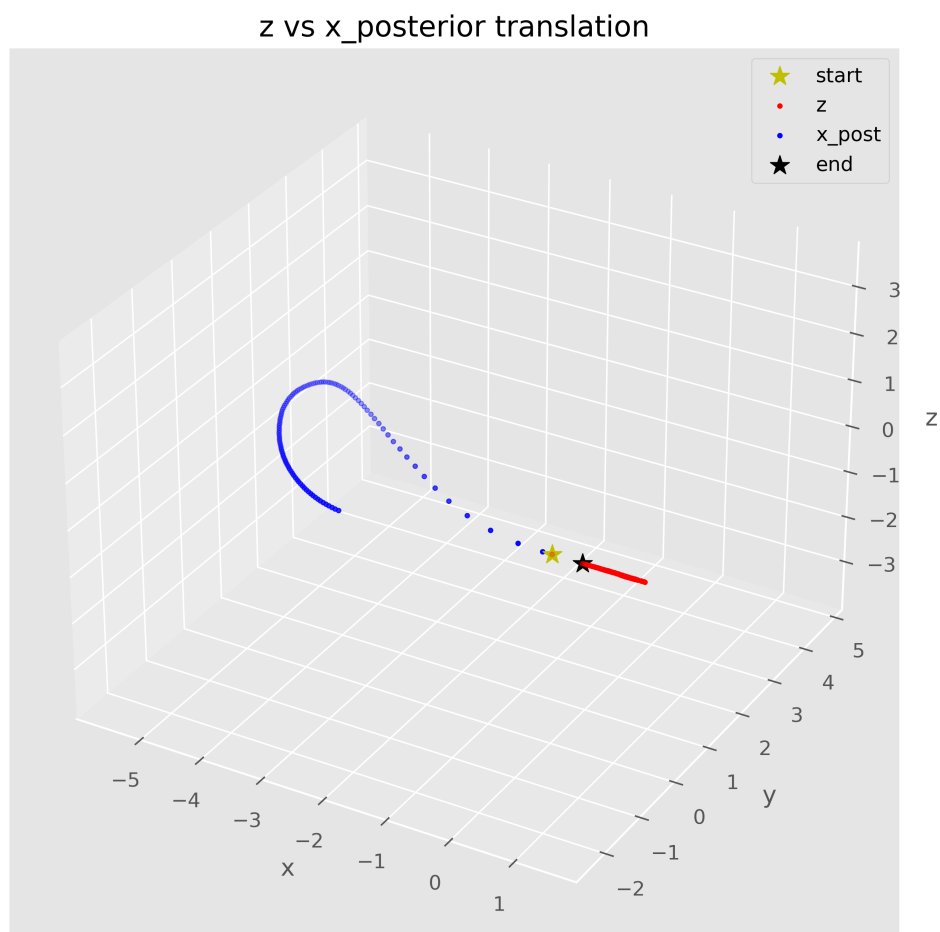
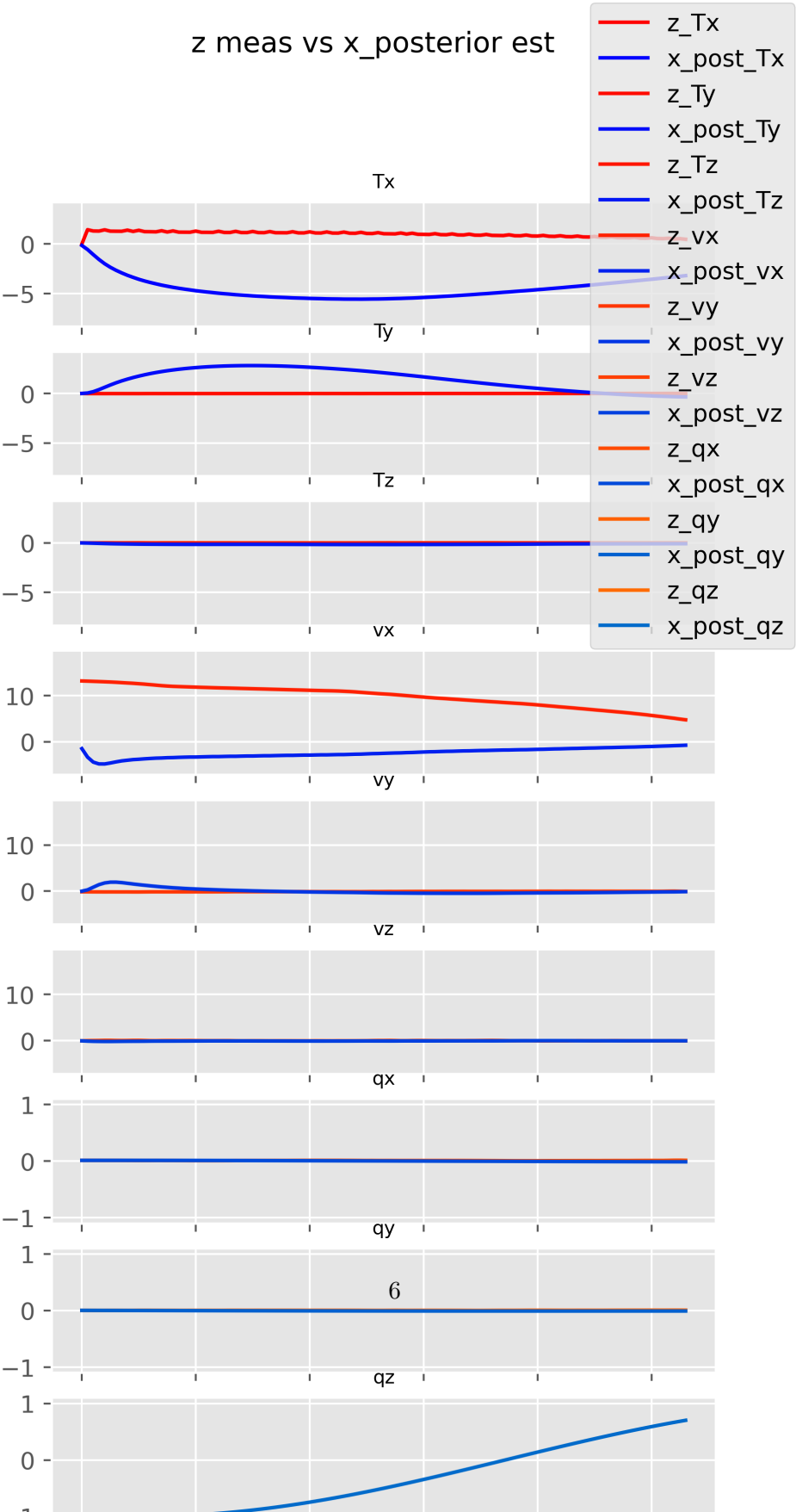


Figure 2: KITTI 001 - Measurement vs Posterior Est. Translation ( $v$ ).

z meas vs x\_posterior est



## **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).