# Progress Report

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# 1 Specific Research Goals

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

# 2 To Do

- QEKF Paper - 30% extension (—):
- Implementation (—):
  - Noise issue: noise cannot be modeled - revisit
  - Rewrite RQuEst (RANSAC-QuEst) – Done
  - Replace the relative pose estimation routine in SfM example with RQuEst – Done
  - SfM: RQuEst cannot find solution – under investigation
- DLO Manipulation: (ICRA - Sept. 1st)
  - Work on the paper everyday – up-coming
  - ICRA 2022 RL workshops: gym, stable-baseline3, and RL zoo – on-going
  - Setup digital twin reinforcement learing setup:
    * Unity Robotics extension setup – on-going.
    * Design dynamic DLO data collection system.
    * Build work cell. – on-going
    * Collect data and create a dataset.
    * Define evaluation metrics.
    * Create a high frequency RGBD dataset with UV-frames and open-loop input control actions as the ground truth.
  - Real-Time Preception
    * Deep learning methods for keypoint pose estimation in real-time.
    * Use UV dye dataset
    * Use PVNet-like approach for known-object pose estimation.
  - Learning DLO Dynamics and System Identification

    * List feasible approached for learing DLO dynamics
    * Model dynamics and deformity in a latent space
  - Real-Time Control
    * Time model inference, using auto-encoders generate the lowest dimensional representation for each object.
    * Use another GAN model for object deformity for each object.
    * Evaluate encoded representation for accuracy.
    * Used another GAN to explore other abstraced representations from individual encoded representation. In theory, we can create a low dimensionsal representation for multiple similar objects, given all individual low-dimensional representations. This is inspired by "fundamental principles first" approach which has universal applicability.

# 3 Progress

The following items are listed in the order of priority:

- XEst (RAL —): I integrated Kaveh's QuEst algorithm into Matlab's Structure from Motion (SfM) example. The example is based on [1] and [2]; I have replaced Nister's 5-point algorithm with Kaveh's QuEst. I will Implement a new RANSAC method once I figure out why SfM-QuEst doesn't produce feasible results. It runs but current RANSAC [2] can not find a feasible solution in given number of trials. This can be due to noise on Quaternion solutions or possibly an implementation bug. I am currently investigating this by comparing results with existing Implementation. The new RANSAC methods with use Quaternion specific evaluation metrics as well as Sampson distance. The new approach will feature constraint satisfaction problem implementation by either using priorities, weights, or an algorithmic approach handle multiple static constraints. The new RANSAC will be a solid contribution on its own. This project might take a bit longer but at this point, I am aiming for setting new SOTA and getting top paper award.

- DLO Dataset (ICRA - Sept. 1st): I am starting on the paper this week. I begin with paper structure and related work and start with that everyday moving forward. Moreover, I am working on Unity-Robotics extension. Moreover, I am implementing [3] on my work station. We picked up the parts for MoCap system but there were no fastening parts with the shipment. Please advise on that. I am spending more time on this as I am worried about the progress too.

- Linus (REU): He is working on ROS2 tutorials. I have asked him to upload what he has on Unity to Github so I can finish the workcell.
- Maicol (REU): He is working on Unity tutorials. Soon, he will start on Unity-Robotics extention. Turtlebot tutorials are given lower priority.
- PyTorch Tutorials: Transfer learning.
- Omniverse: Apply for access. – To-Do

## References


[1] D. Nistér, "An efficient solution to the five-point relative pose problem," *IEEE transactions on pattern analysis and machine intelligence*, vol. 26, no. 6, pp. 756–770, 2004.

[2] P. H. Torr and A. Zisserman, "Mlesac: A new robust estimator with application to estimating image geometry," *Computer vision and image understanding*, vol. 78, no. 1, pp. 138–156, 2000.

[3] H. Zhang, J. Ichnowski, D. Seita, J. Wang, H. Huang, and K. Goldberg, "Robots of the lost arc: Self-supervised learning to dynamically manipulate fixed-endpoint cables," in *2021 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 4560–4567, IEEE, 2021.