Modular 6D Pose Estimation for Real-Time Rover Manipulation

Administrative Info

Semester:	Fall 2025
Project:	Modular 6D Pose Estimation for Real-Time Rover Manipulation
Responsibles:	Arno Laurie (Soft System Enginner) & Giovanni Ranieri (Vice-President Research)
Contact:	arno.laurie.@epfl-xplore.ch & giovanni.ranieri@epfl-xplore.ch

Motivation

EPFL Xplore is a student-led swiss robotics association, part of the MAKE Initiative at EPFL. It primary builds a Martian-like Rover each year to compete in the European Rover Challenge (ERC) in Krakow, against other universities. The team is composed of around 50 students (management & engineering). In its rank, the software team of EPFL Xplore is composed of navigation, robotic arm and control station teams, each one developing efficient solutions to bring the Rover alive.

The ERC imposes autonomous manipulation of different objects, for example cables and rocks. This autonomous processes always incorporate a 6D pose estimation to be able to first locate the object in a reference frame, and then move our manipulator to grab it. The manipulator is a gripper located at the end of a 6-DoF custom robotic arm.

EPFL Xplore has successfully been able to identify and grab rocks, switches, probes, but lacks of modularity. We are actually using YoloV8 for enhacing our models. The computations that are done after to compute the 6D pose estimation is redundant in many systems. In addition, we are not sure our method is the best, and improvements in terms of pose accuracy would not be a plus, but a huge help to increase the speed of detection and selection by our gripper.

Objectives

The goal of this project is to design, implement and validate a modular 6D pose estimation pipeline that improves both the accuracy and speed of object localization for our 6DOF robotic arm. This will enable faster, more reliable autonomous manipulation during the ERC. To achieve this, the student will:

1. Analyze the current YOLOv8-based detection and downstream 6D pose estimation workflow to identify the improvements that could be made.
2. Refactor the pipeline into modular components, separating the detection, feature extraction and pose solver, so that each stage can be independently optimized or replaced.
3. Research and integrate at least one alternative 6D pose estimation method (e.g. ZebraPose) alongside the existing approach.
4. Implement benchmark scripts to compare accuracy (pose error) across different methods on a representative dataset.
5. Deliver a concise report summarizing the benchmarking results, optimizations applied, and recommended default pipeline for integration into the Rover's software stack.

Requirements

EPFL Xplore is looking for a motivated student that wants to tackle real software challenges in a well-established association, all working with the goal of learning new things. For this project, we are particularly interested in someone with the following qualifications:

- Enrollment in a Bachelor's or Master's program in Engineering, Computer Science, Robotics or a related field.
- Basic programming skills in Python (and/or C++) with an eagerness to write clean, modular code.
- Good knowledge with computer vision concepts (e.g. image filtering, feature detection) and deep-learning frameworks (e.g. PyTorch, TensorFlow) for pose estimation.
- Comfortable using Linux and common command-line tools (e.g. `bash`, `ssh`, `git`).
- Interest in basic data analysis (e.g. using Python libraries like NumPy or pandas).
- Good problem-solving attitude, attention to detail, and ability to iterate on experimental setups.
- Strong attention to detail, good organizational skills and a hands-on mindset for running experiments.
- Ability to work both independently and collaboratively within a student team.

Resources

- ZebraPose, Coarse to Fine Surface Encoding for 6DoF Object Pose Estimation: `https://arxiv.org/abs/2203.09418`