Lehrstuhl für Robotik und Systemintelligenz
TUM School of Computation, Information and Technology
Technische Universität München

KI.FABRIK

Internship/Forschungspraxis (possible to be extended as Master Thesis)

Visuo-Tactile Robot Manipulation for Tight Clearance Assembly

Background

Insertion, also widely known as *Peg-in-Hole*, is one of the most essential skills for robots in both modern manufacturing and services robotics. Recent advances in flexible manufacturing and trending shift from Industry 4.0 to Industry 5.0 highlights the needs of learning machines, i.e., robots enabled by *embodied intelligence*, which can acquire manipulation skills more efficiently in unstructured or dynamic environment. In our previous studies [2][3], we proposed a novel framework to formulate manipulation skills for robotic assembly, leveraging modern torque-controlled robots and featuring reactive real-time Behavior Tree for robust real-world execution and sample-efficient transfer learning. To further enhance the versatility and adaptability of this method, we aim to leverage state-of-the-art computer vision techniques for pose estimation, such as [1], and integrate the relevant information into our existing *robot control and learning* framework and software architecture [4] for contact-rich robotic assembly. Although the robotics community has seen a myriad of research efforts into visuo-tactile robot manipulation, most works lack robustness in physical execution in real-world industry relevant challenging tasks. Our goal is to build a reliable visuo-tactile robot control, planning and learning architecture to lay a solid foundation for various ongoing research topics in our lab.

Your Tasks

In this work, your research topic will be in 6D pose estimation algorithms and contact-rich manipulation. More specifically:

- Evaluating the performance of the some latest 6D pose estimation algorithms in various scenarios;
- Integrating visual perception into our original tactile insertion skill framework and software architecture;
- Verifying your algorithm with real robot experiments;
- Assist the research activities including experiments, and publications;
- Possible to extend internship period to master thesis and **aim at publishing papers in top-tier robotics conference**.

Requirement

- Highly self-motivated;
- Experiences or knowledge from related courses;
- C++ and python programming experiences;
- knowledge and experience of Git, Linux is a plus.

Supervisor: Prof. Sami Haddadin

Advisor: Yansong Wu, Dr. Fan Wu

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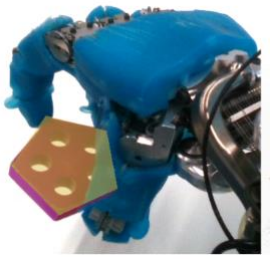

Figure 1 Overview of the experiment setup.

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[1] Stoiber, Manuel, Martin Sundermeyer, and Rudolph Triebel. "Iterative corresponding geometry: Fusing region and depth for highly efficient 3d tracking of textureless objects.", Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR). 2022.
[2] Johannsmeier L, Gerchow M, Haddadin S. “A framework for robot manipulation: Skill formalism, meta learning and adaptive control”, 2019 IEEE International Conference on Robotics and Automation (ICRA), 2019.
[3] Yansong, Fan, Lingyun, et al. “1 kHz Behavior Tree for Self-adaptable Tactile Insertion”. (under review)
[4] Yansong Wu et al., “Learning dynamic robot-to-robot object handover”, 22nd IFAC World Congress, 2023.