

Impedance Control for Safe and Robust Cobot Contact Task Execution

Level: Bachelor/Master (1-2 students possible)

Duration: 3 months

Start: By agreement

Mentors: Nikola Knežević, Branko Lukić

Institution: ETF Robotics

Overview and Technology: This project develops and validates an **end-effector-level impedance controller** for the **Franka Emika Panda** using a **ROS1 software stack**. The goal is to make the robot behave like a **programmable spring-damper system** in task space, so that the end-effector can interact safely and robustly with the environment (contact, sliding, insertion, human guidance), rather than only following stiff position trajectories. Instead of commanding only position/velocity, the controller shapes the dynamic relationship between **pose error** and **interaction forces**, allowing the robot to remain compliant in selected directions while staying stiff and accurate in others. The work includes controller design, ROS integration, safety constraints, and application-level demonstrations where controlled compliance improves performance under uncertainty (part tolerances, unknown surface normals, slight misalignments, or human contact).

Platforms / hardware <ul style="list-style-type: none"> • Franka Emika Panda 7DoF Cobot • PC Workstation 	Software & tools <ul style="list-style-type: none"> • Linux + ROS • Python, C++ • Gazebo/MuJoCo
Project options (projects can be modified based on student interests) <ul style="list-style-type: none"> • Peg-in-hole / Connector insertion • Surface following: polishing, sanding, or wiping with constant contact force • Hand-guiding / Kinesthetic teaching 	
Expected outcomes <ul style="list-style-type: none"> • Literature review • Project code and documentation/video • Final report in IEEE research paper form 	Recommended background <ul style="list-style-type: none"> • Basics of robot programming and control • ROS basics + MoveIT • Impedance Control
Literature <ul style="list-style-type: none"> • Impedance Control course materials • ROS Basics • Franka ROS + ros_control 	