

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