

# VR-Enabled Digital Twin Workflow for UR5e Robot Operation

This project was developed for Robotic Campus as part of RoboCo. project and was conducted at the HAMK robotics research facility. The main purpose was to prototype a future remote robotics laboratory for students, where robot operation could first be tested safely in simulation before being extended to the real robot.

The prototype was built around a UR5e collaborative robot with a Robotiq gripper. It connected Unreal Engine, NVIDIA Isaac Sim, ROS 2, and MoveIt 2 to support robot interaction in simulation and, when enabled, execution on the physical robot.

Using a VR headset and controller, the operator could interact with the robot workflow, test movement through the simulation environment, and demonstrate real UR5e motion and gripper actuation through a wireless local-network setup. The system could also be used to create robot programs, test them first in simulation, and then send them to the real robot for execution.

## What was demonstrated

- VR-based robot interaction
- UR5e simulation in Isaac Sim
- ROS 2 communication between system layers
- real UR5e movement through a wireless test connection
- Robotiq gripper actuation
- waypoint recording and robot program export
- simulation-tested programs transferable to the real robot

## Project outcome

The project demonstrated how a simulation-first digital twin workflow can support safer and more flexible access to collaborative robot systems. It created a practical foundation for future work in student remote laboratories, digital twins, VR-assisted robot operation, robotics education, and supervised remote robot access.

The wireless test setup also showed a possible path toward future fully remote robot control over Wi-Fi, with further development needed for safety, monitoring, user access, and stable remote operation.

Status: Completed laboratory prototype and demonstration.