

VR-based Human Motion Data Collection for Humanoid Robots

Ausgangslage

Humanoid robots are advancing rapidly, driven by learning-based control methods. The main bottleneck is no longer hardware but data: learned policies need large amounts of high-quality demonstrations of human movement, which are costly and slow to collect. Teleoperation, where a human operator directly controls the robot, is currently the most common way to generate such data. Among the available approaches, commercial virtual and mixed reality devices are especially promising. They are affordable, quick to set up, independent of a specific robot, and give the operator an immersive view from the robot's perspective. Open questions remain about data quality, operator fatigue, precision, latency, and how well the collected data transfers to robot control. The Institute of Interactive Technologies (IIT) brings together expertise in extended reality and human-robot interaction to address this problem.

Zielsetzung / Methodik / Vorgehen

The goal of the project is to design, implement, and evaluate a VR-based pipeline that collects human motion data and applies it to training and controlling humanoid robots. It covers three aspects:

1. *Data collection using VR.* Based on a review of the state of the art, the student selects a suitable hardware configuration and develops an application that records synchronized head, hand, and body motion while giving the operator visual feedback from the robot.
2. *Data processing.* The raw motion data is cleaned and mapped onto the robot's kinematic structure, addressing typical problems such as physically infeasible poses and differences between human and robot hands. The result is a structured dataset suitable for robot learning.
3. *Application to robot control.* The processed data is used to control a humanoid robot, first in simulation and then, where possible, on a real platform. In a later stage, this can include training a learning-based control policy from the collected demonstrations.

Verlangte Skills: Interest in robotics, virtual reality and machine learning; good programming skills (Python and C#); experience with Unity or a comparable engine is an advantage; basic knowledge of kinematics and linear algebra; enjoyment of both software development and hands-on experiments with hardware.

Teilaufgaben

The project can be carried out in 2 to 3 stages: consecutive projects P7 (state-of-the-art analysis and VR data collection prototype), P8 (data processing pipeline, motion retargeting, real-time teleoperation in simulation) and P9 (transfer to a real robot and/or policy learning from collected data, systematic evaluation including user study).

Studienart: [x] Vollzeitstudium
[x] Teilzeitstudium 50%

Projektorganisation: Einzelarbeit (im Umfeld eines Projektteams)

Projektfinanzierung: TBD

Arbeitsort: Windisch

Advisor: Prof. Dr. Kevin Kim

