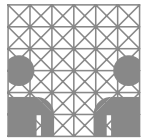


Immersive Teleoperation and Simulation with ROS & Unity3D

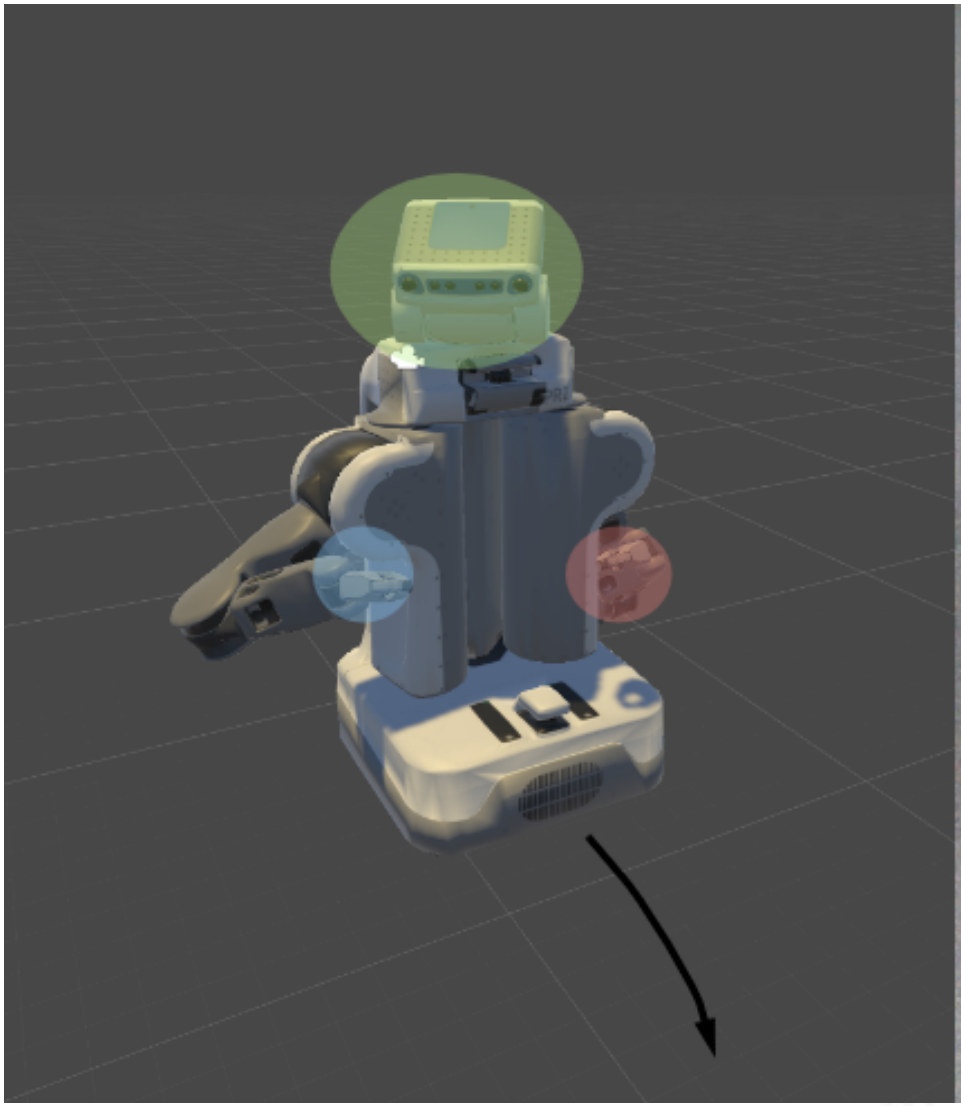
Current Status and Progress

Dennis Krupke

University of Hamburg
Faculty of Mathematics, Informatics and Natural Sciences
Department of Informatics

Technical Aspects of Multimodal Systems

29. November 2016



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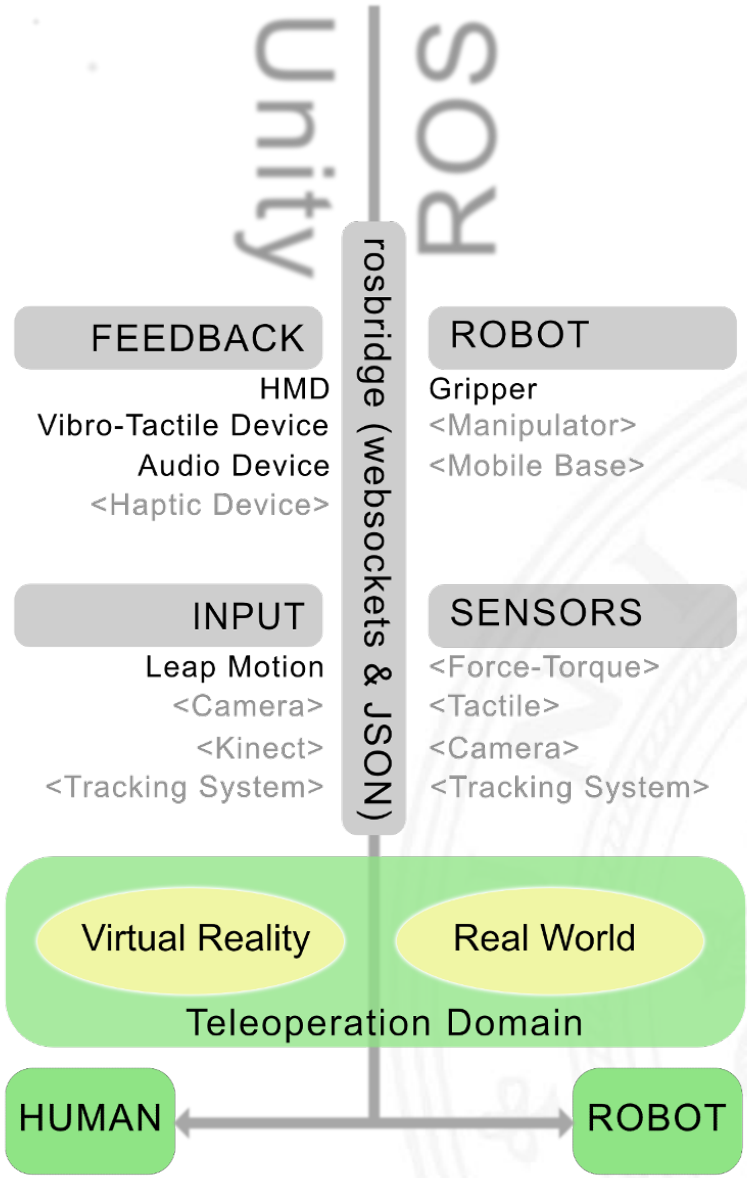
Why?

- usage of ROS is obvious for robotics
- Unity3D is state-of-the-art in interactive 3D computer graphics and virtual reality (VR)

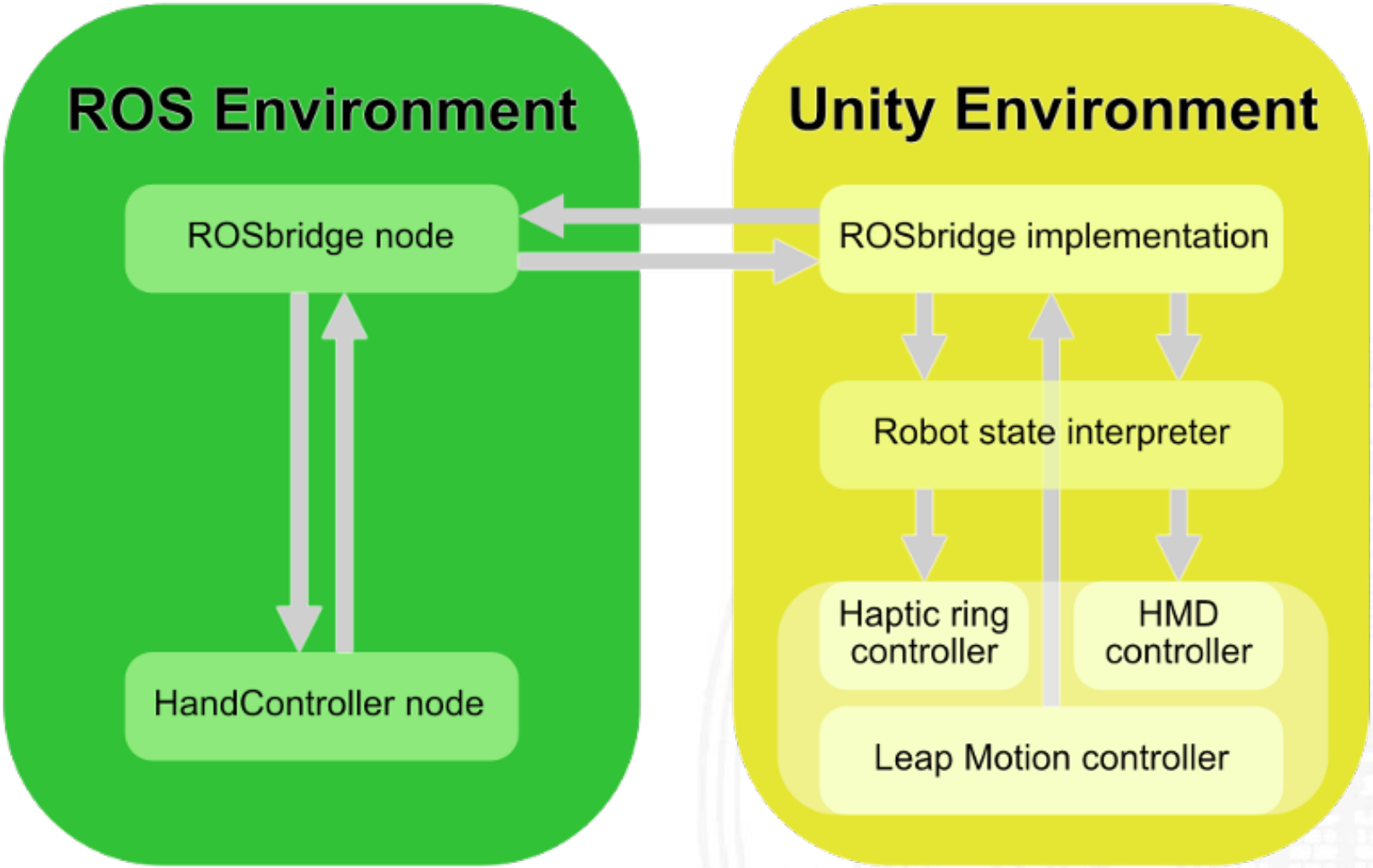
Benefits

- Fast prototyping of HRI scenarios with high quality graphical representations and support of various input and output devices.
- Separating details of robot control in ROS from interaction design

Structure


Unity
ROS
rosbridge (websockets & JSON)
FEEDBACK
HMD
Vibro-Tactile Device
Audio Device
<Haptic Device>
ROBOT
Gripper
<Manipulator>
<Mobile Base>
INPUT
Leap Motion
<Camera>
<Kinect>
<Tracking System>
SENSORS
<Force-Torque>
<Tactile>
<Camera>
<Tracking System>
Virtual Reality
Real World
Teleoperation Domain
HUMAN
ROBOT

Communication Example



ROS-messages and JSON


```
{
    "msg":{
        "rACT":1,
        "rMOD":0,
        "rGTO":1,
        "rATR":0,
        "rGLV":0,
        "rICF":0,
        "rICS":0,
        "rPRA":0,
        "rSPA":255,
        "rFRA":150,
        "rPRB":0,
        "rSPB":0,
        "rFRB":0,
        "rPRC":0,
        "rSPC":0,
        "rFRC":0,
        "rPRS":0,
        "rSPS":0,
        "rFRS":0
    },
    "latch":false,
    "op":"publish",
    "id":"publish:/SModelRobotOutput:3",
    "topic":"/SModelRobotOutput",
    "type":null}
```


- implemented messages are (de)serializable to JSON strings
- serialized JSON strings are transmitted

Thanks to Sebastian

Useful packages

Robot Importer (URDF) for Unity

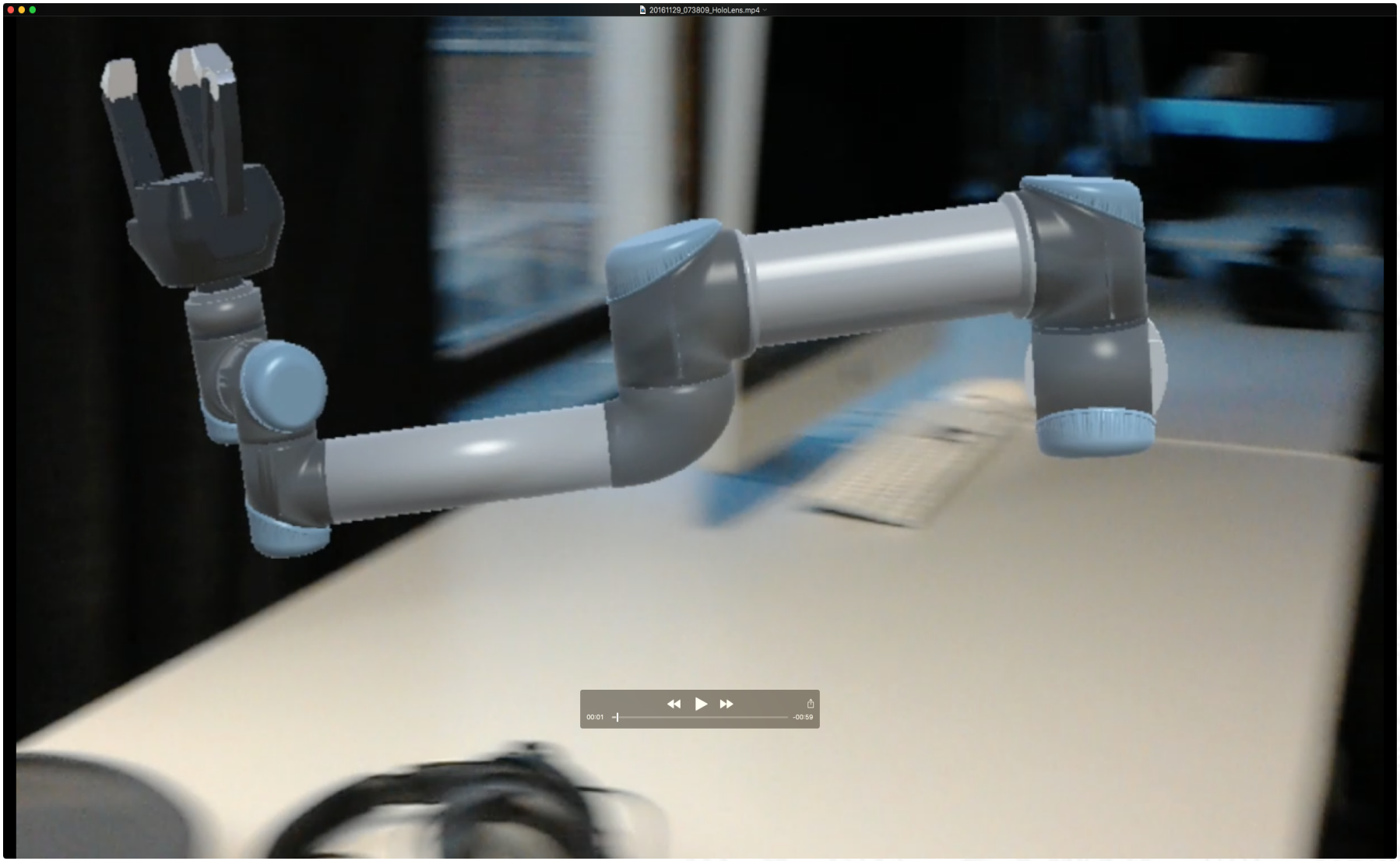
- parses URDF and creates hierarchical structure of the robot in Unity3D using the 3D meshes from the ROS repositories
- adds joints, which are controllable from scripts
- converts between different coordinate systems

Inverse Kinematics in Unity3D

- bio-inspired inverse kinematics for 6-DOF poses
- highly scalable
- supports branching chains
- supports multi targets

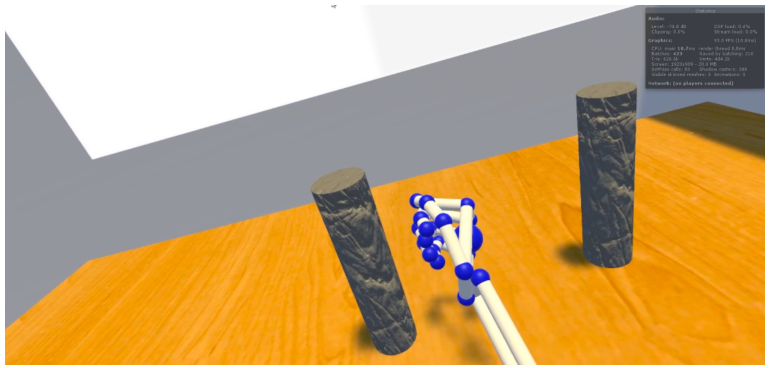
$\Rightarrow$ In combination with the communication component via ROSbridge, Websockets and JSON it provides a powerful toolkit.

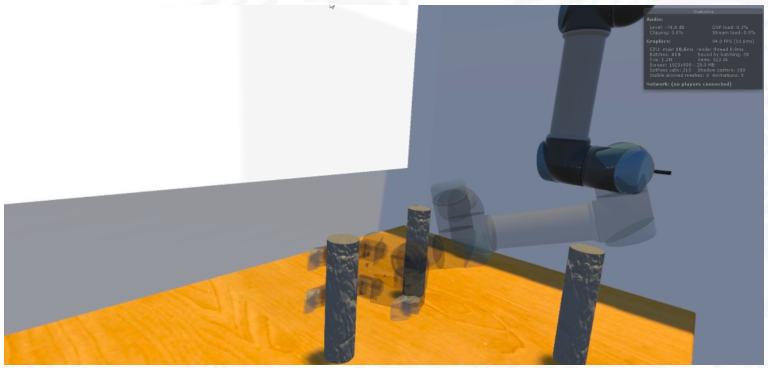
Excursion: Microsoft HoloLens



Simulation

- training for non-experts in robotics
- safe testing of algorithms
- prototyping of HRI scenarios
- psychological experiments

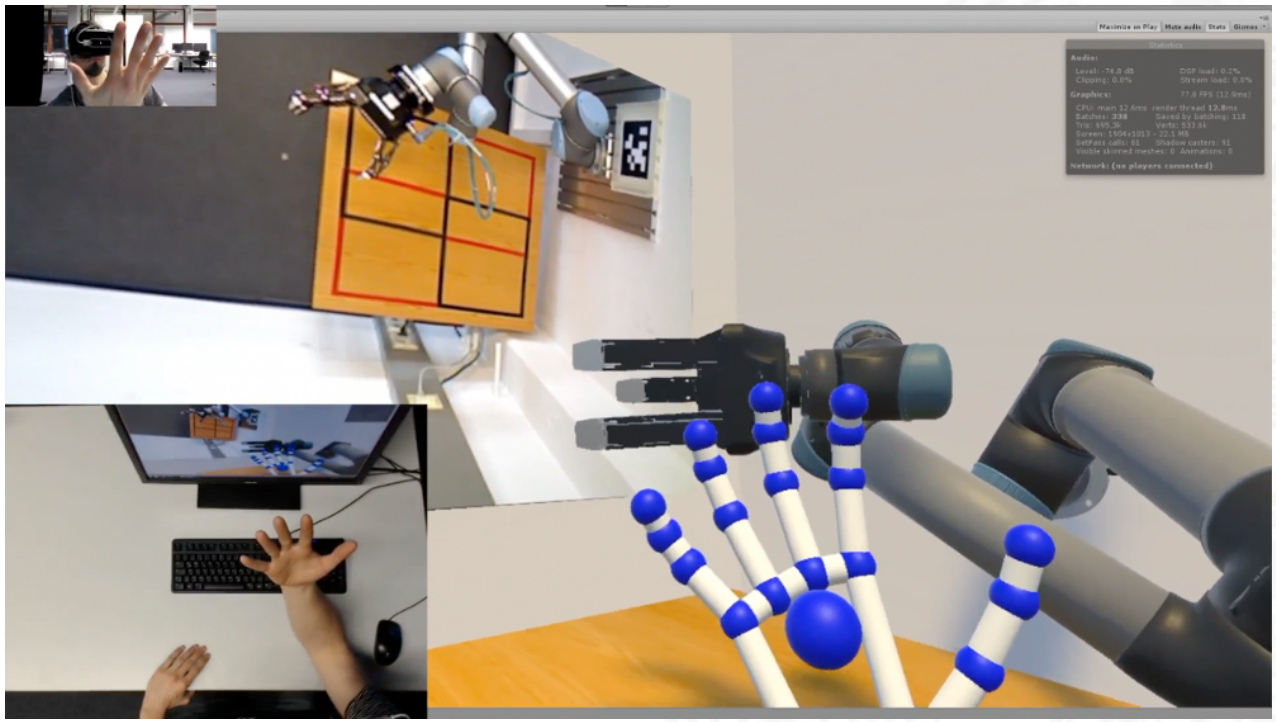




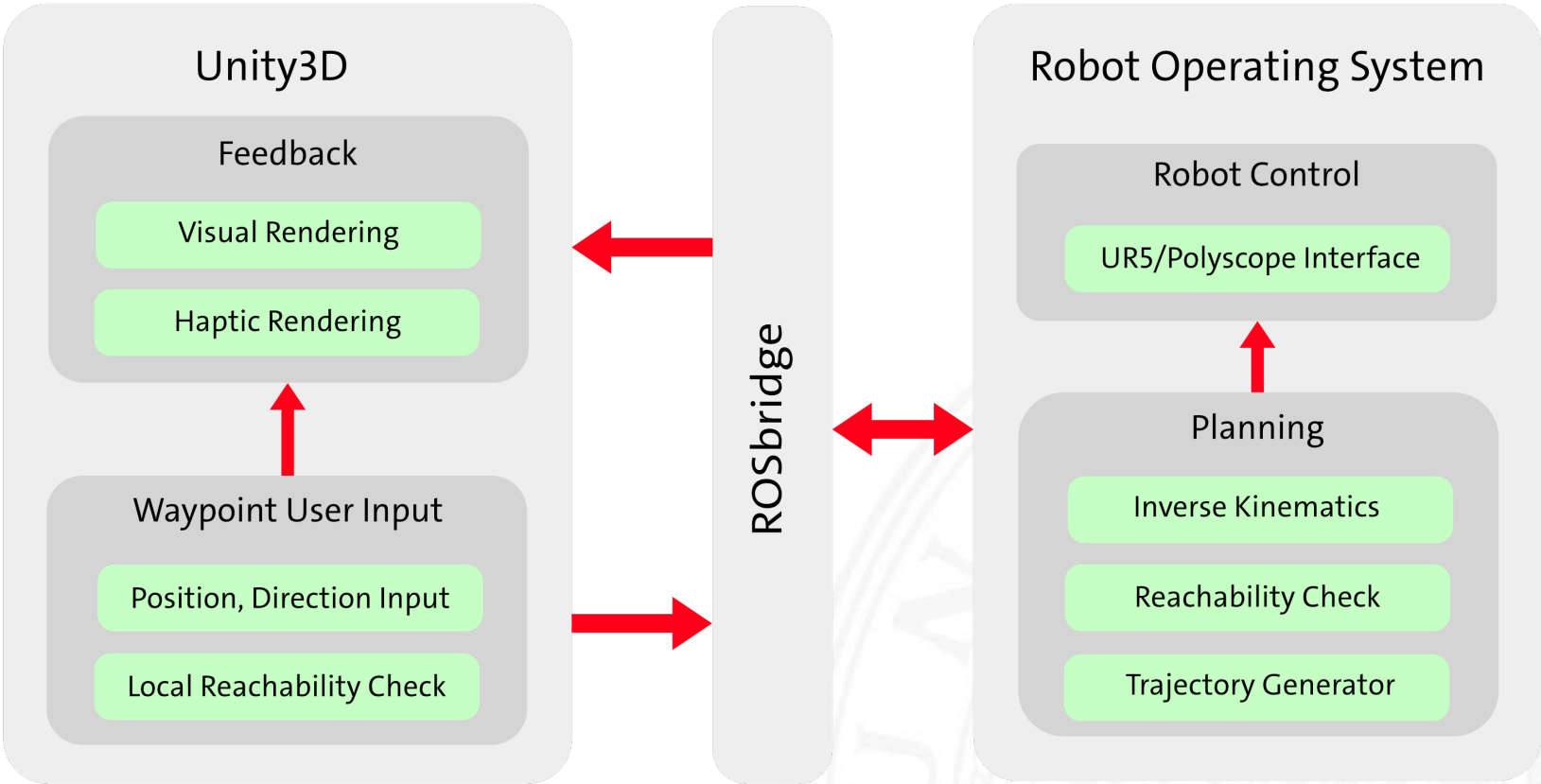
Teleoperation

Topics of interest:

- simulated latencies
- embodiment techniques
- methods for assigning different DOF of user and robot



Example: Cartesian Path Planning



Ongoing Work
High-level VR-based teleoperation

Currently under development:

Live-pointcloud view in 3D/VR.

Near future work:

Integration of eye-tracking inside the HMD.

Final goal:

Using eye- and hand-tracking for endpoint prediction of reach-to-grasp gestures for reachable objects in a pick-and-place scenario.