

Vorbesprechung Praktika & Projekte

Dr. Hugo Brument

E193-03 Virtual & Augmented Reality Research Group
Institute of Visual Computing & Human-Centered Technology
TU Wien, Austria

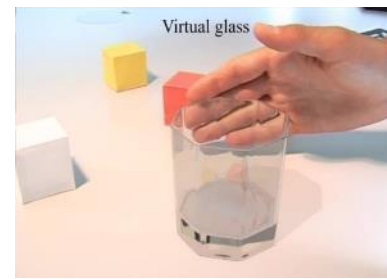
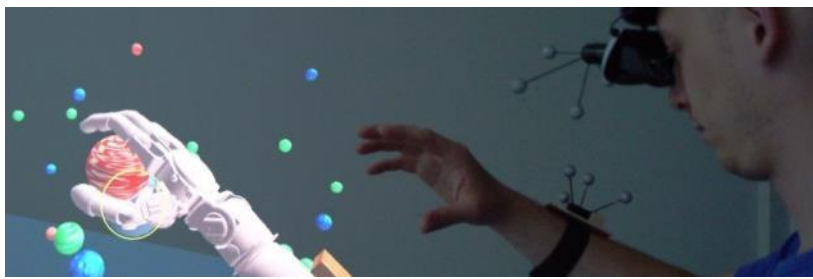


Courses

- Summer Semester 2024
 - 193.021 Project Media and Human-Centered Computing 1
 - 193.022 Project Media and Human-Centered Computing 2
 - 193.023 Project in Visual Computing 1
 - 193.024 Project in Visual Computing 2
 - 193.118 Project in Computer Science 2
- Bachelorarbeit für Informatik und Wirtschaftsinformatik; 10 ECTS
- Master Thesis, 30ECTS

Project Courses: General Info

- **Supervision:** regular meetings with supervisor (e.g., bi-weekly)
- **Hardware:** Suitable lab equipment is provided
- **Process:** literature research, iterative design and development of solution, evaluation and presentation
- **Strong practical component:** independently implement a prototype (hardware and/or software)
- Option to work in a small group (2 people)
- All topics available at
 - <https://www.vr.tuwien.ac.at/topics/>
 - http://www.vreeclimber.at/student_projects/
 - TISS course pages
 - Slides available on our website: https://www.vr.tuwien.ac.at/wp-content/uploads/2024/03/Praktika_Vorbesprechung_2024SS.pdf



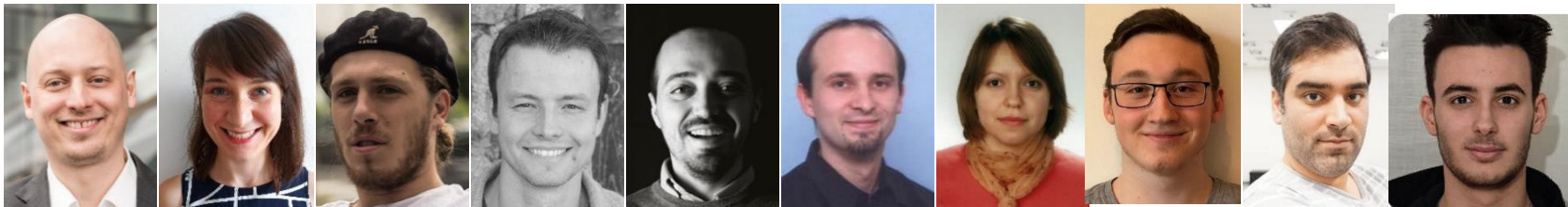
VIRTUAL & AUGMENTED REALITY



Univ.Prof. Mag. Dr.
Hannes Kaufmann



Research Staff



Postdocs: Christian Schönauer, Iana Podkosova, Peter Kán, Hugo Brument, Francesco De Pace

PhDs: Emanuel Vonach, Khrystyna Vasylevska, Soroosh Mortezaipoor, Matteo Bosco + 3 external PhDs

Msc students: Victor Mittermair + 15 others

Virtual & Augmented Reality Themenbereiche



Total:
138,9
FPS



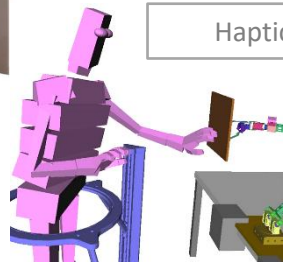
High Quality Rendering in AR

Real Time Ray Tracing in VR

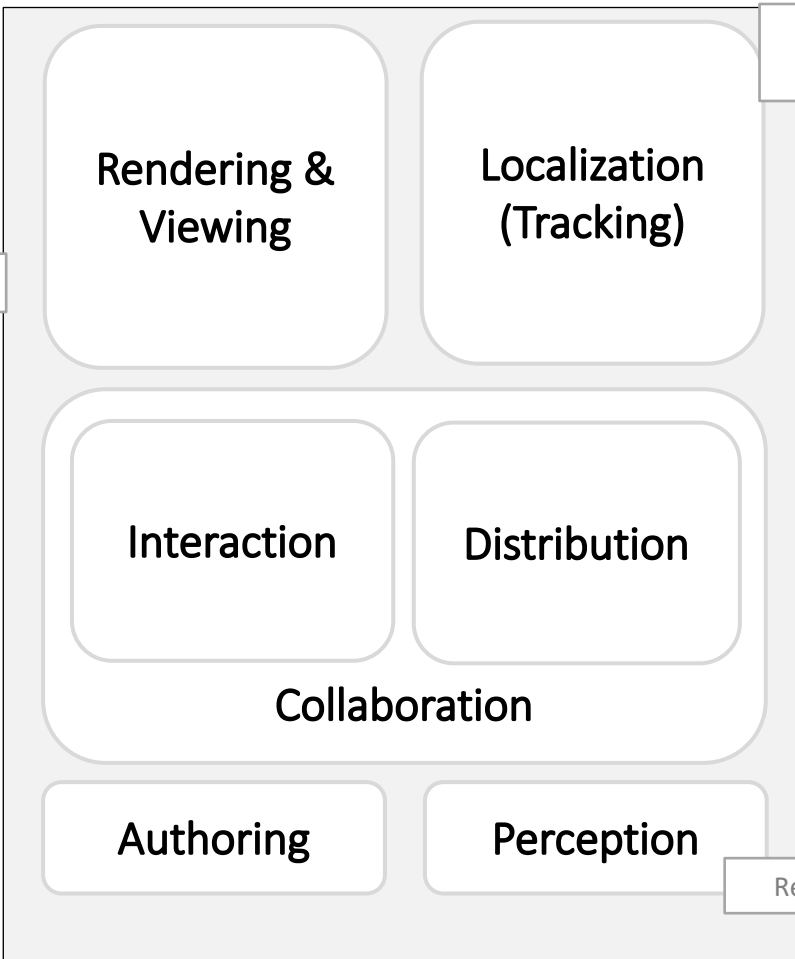


Firefighter Training with Virtualizer

Input



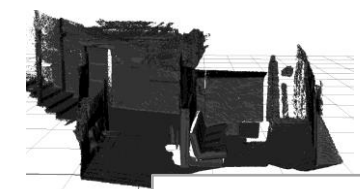
Haptic Feedback



Wide Area Multi-User Optical Localization

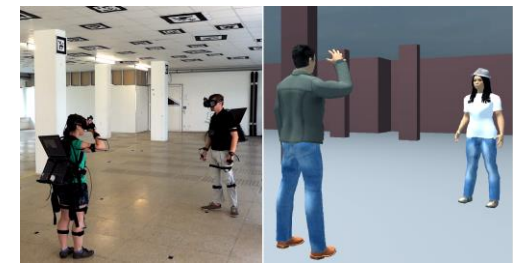


ioTracker



Live 3D Reconstruction for First Responders

Shared Collaborative Virtual Spaces Navigation



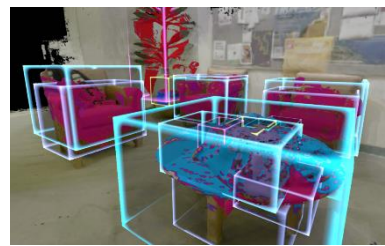
Redirected Walking



Automated 3D Model Generation



Object Detection and Segmentation in Live 3D Reconstruction



Next Steps...

Send us an email with the following information:

- Which course you require credits for
- The idea/topic you wish to pursue
- Your name and Matrikelnummer

To: *<topic supervisor>*

CC: *hannes.kaufmann@tuwien.ac.at*

We will make individual agreements about

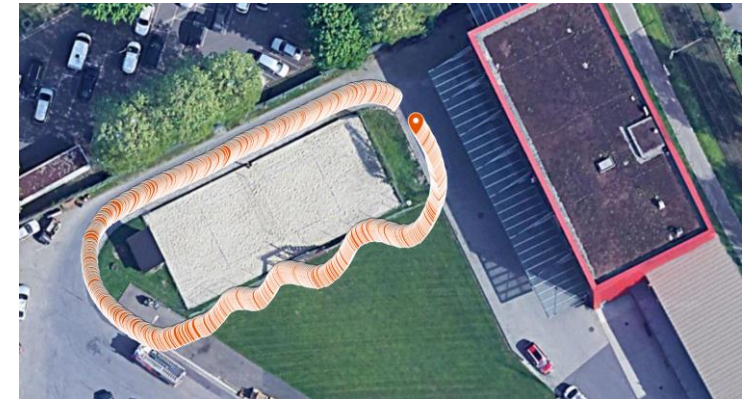
- supervision
- hardware pickup
- specific tasks

List of topics

AUGMENTED REALITY

Outdoor Augmented Reality (AR) Tracking System

- AR tracking solutions are not usually suitable for large outdoor areas
- **Task:** development of an outdoor GPS-based tracking system for wearable AR devices (e.g., Magic Leap, Microsoft HoloLens)
 - Verify accuracy of a GPS system (REDCatch):
 - Comparison with the wearable AR device tracking system
 - How to use GPS positional data to improve tracking
 - User tests to assess the effectiveness of proposed solution from a human-centered perspective
- **Setup/IDE:**
 - Many possible solutions (to be discussed)
 - Windows (Unity3D)
 - Android (for GPS)
 - C#, Java/Android, C++
 - ROS
- **Scope:** Master Thesis
- **Supervisor:** francesco.pace@tuwien.ac.at



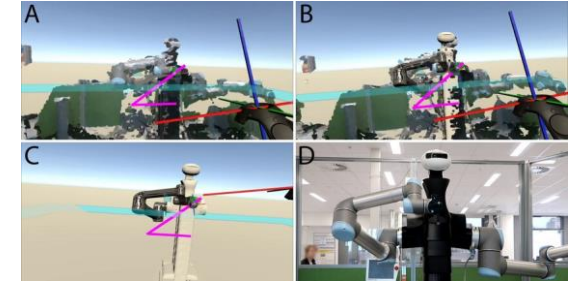
Virtual Interfaces for Human-Robot teams

- **Task:** In the context of Human-robot Interaction, research and develop VR/AR interfaces for interacting with a mobile robot. Specifically, the main goal of the thesis is to develop and evaluate virtual interfaces for human-robot teams during the exploration of unknown environments.
- **Possible steps (to be discussed):**
 - generation of a common map, shared between the robot and the users
 - Development of AR/VR interfaces to interact with the common map
 - Development of AR/VR interfaces to interact with the robot
- We provide the Spot Boston Dynamics robot and VR/AR devices
- **Thesis start date:** around April 2024
- **Setup/Skills:**
 - Unity3D/C#
 - C++/Python
 - ROS
- **Scope:** Master thesis
- **Supervisor:** francesco.pace@tuwien.ac.at



Long-Distance Virtual Reality Robot Teleoperation

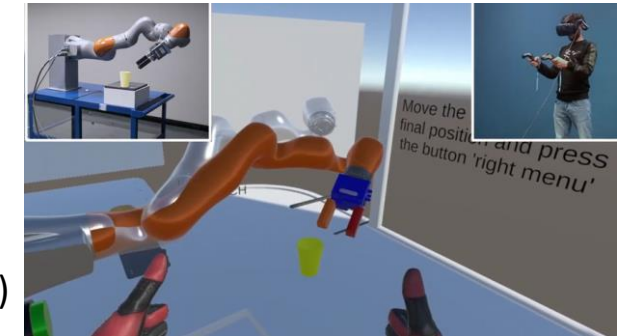
- **Task:** In the context of Human-robot Interaction, Virtual Reality (VR) interfaces are usually used to control industrial robotic arms for short-distance interaction (e.g., same LAN). In real world scenarios, VR teleoperations should be also employed over long distances (e.g., world wide) that present additional challenges (e.g., delay, jitter, etc.). Moreover, the robotic environment is normally reconstructed using point cloud-like data which suffers under high-delay conditions. This thesis will explore long-distance VR teleoperation systems using RGB-D cameras, VR immersive headsets, and a real industrial robotic arm.



- **Possible steps (to be discussed):**

- How to simulate different network conditions (in terms of delay, jitter, bandwidth)
- How to 3D reconstruct the robotic environment
- How to effectively transfer the data to the user side

- Possible collaboration with the [New Dexterity](#) group (New Zealand-based, **to be verified**)

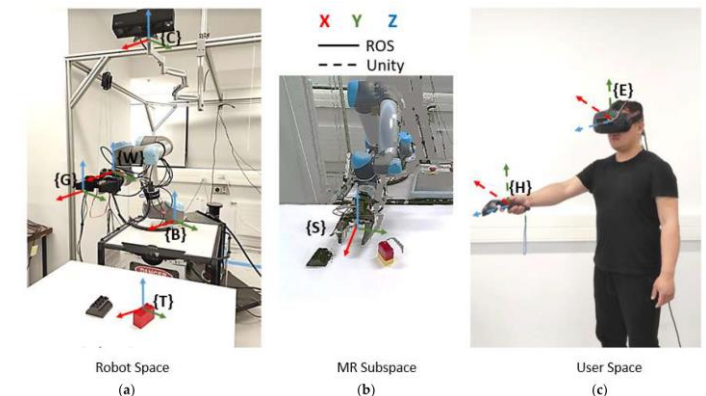


- **Setup/Skills (not mandatory but recommended):**

- Unity3D/C#
- C++/Python
- ROS

- **Scope:** Master thesis

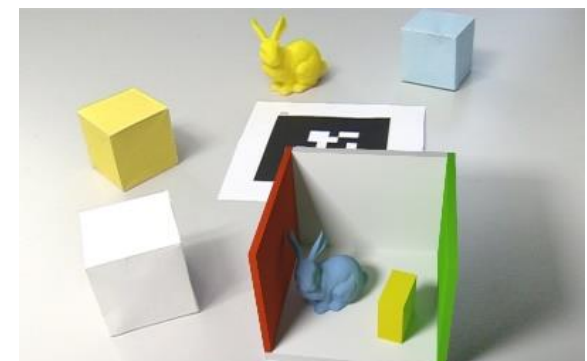
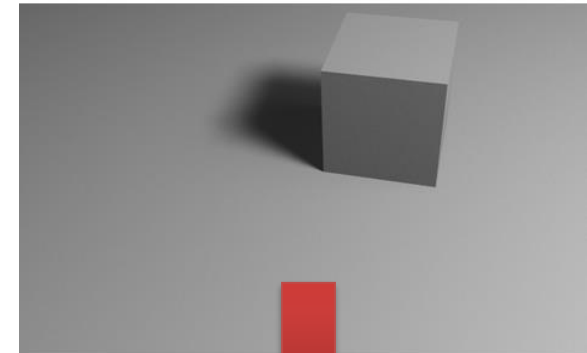
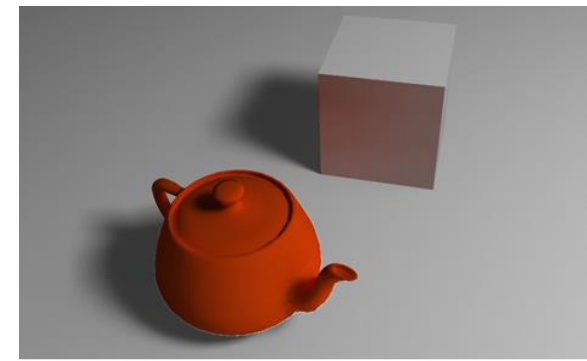
- **Supervisor:** francesco.pace@tuwien.ac.at



RENDERING IN VR/AR

Differential Gaussian Splatting for Realistic Augmented Reality

- Capture two image sequences:
 - Without target 3D object
 - With target 3D object
- Reconstruct differential gaussian splatting representation
 - Render in AR



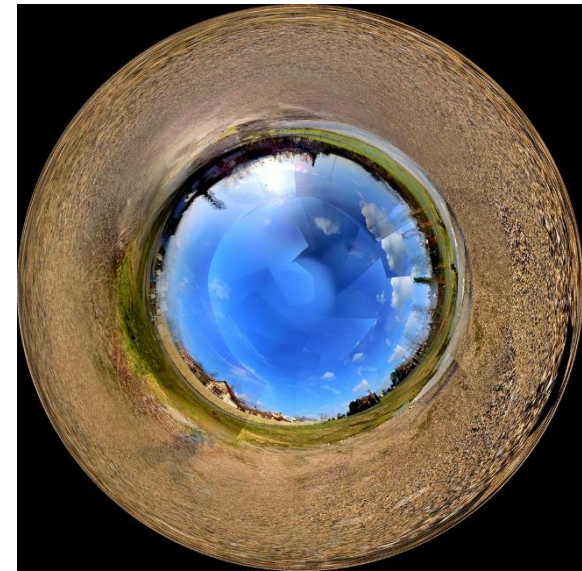
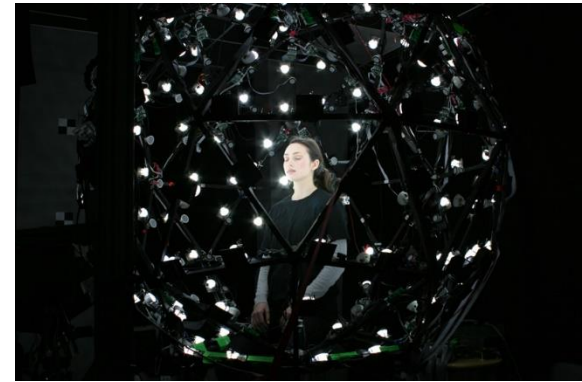
Master thesis

Supervisors: Peter Kán, Hannes Kaufmann

peter.kan@tuwien.ac.at

Many-Dimensional Gaussian Splatting for Scene Relighting

- Create Gaussian Splatting representation that contains data for each possible light direction
- Render synthetic dataset
- Relighting implementation by linear combination of multidimensional data



Master thesis

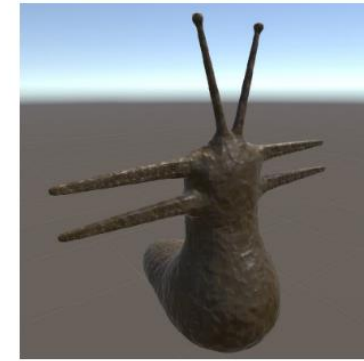
Supervisors: Peter Kán, Hannes Kaufmann

peter.kan@tuwien.ac.at

AVATARS AND MULTIUSERS APPLICATIONS

Co-Embodiment: Non-Human Avatar

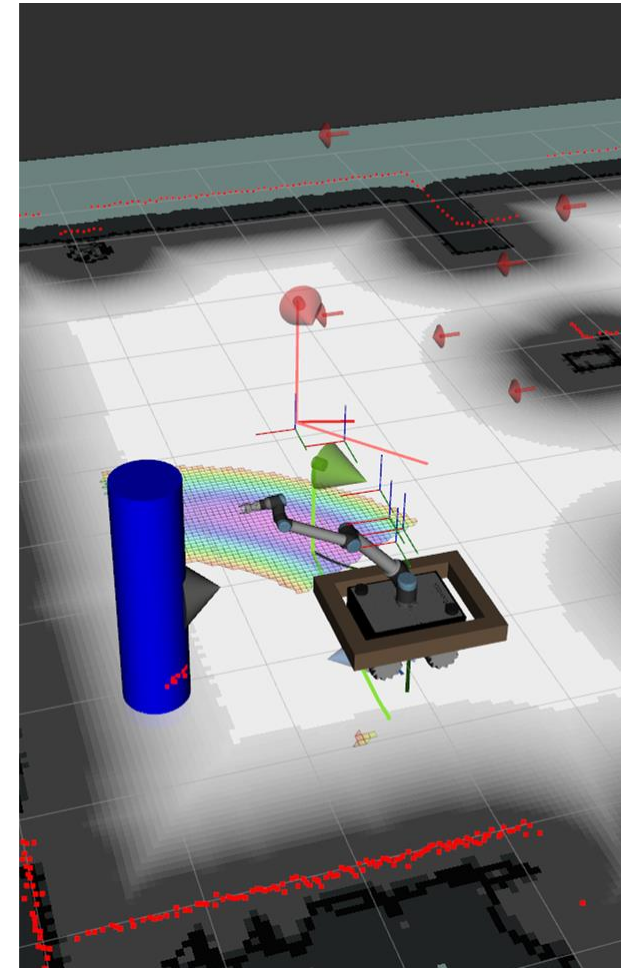
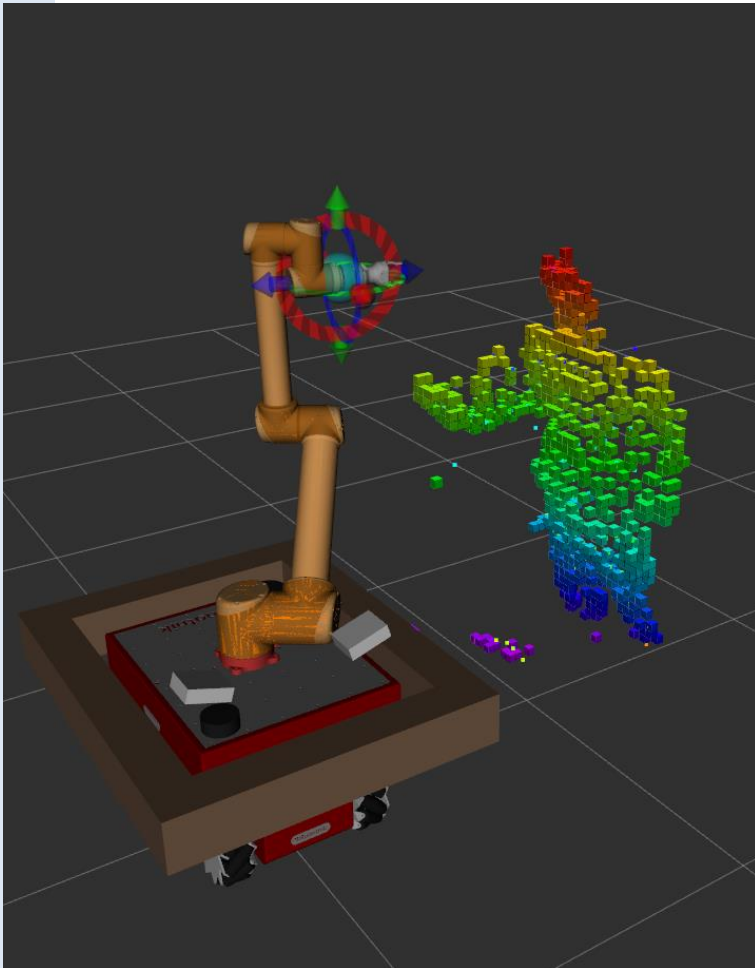
- Suitable for: PR, Master Thesis
- Goal: Design and implement an existing networked non human avatar that can be embodied and controlled by two users
- Tasks
 - Develop the networking of the non human avatar
 - Develop experimental tasks to demonstrate and test co-embodiment of non human avatar
 - Run an experiment to evaluate the avatar
- Environment, hardware etc.: Unity3D, Oculus Quest or HTC Vive, potentially hand tracking and inverse kinematics
- Contact: Hugo Brument hugo.brument@tuwien.ac.at, Iana Podkosova yana.podkosova@tuwien.ac.at



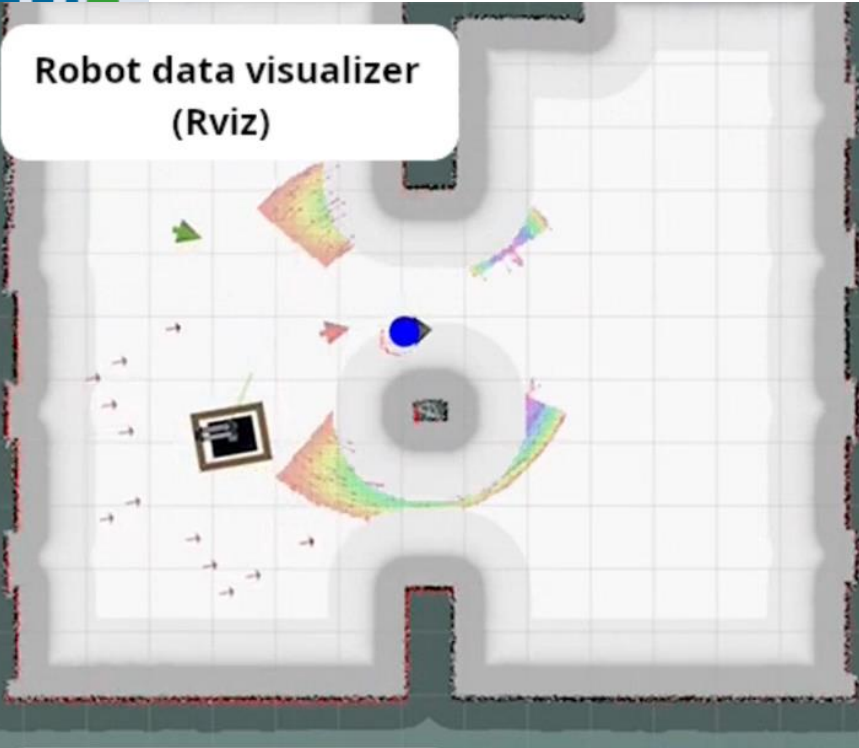
ROBOTICS AND VR

CoboDeck

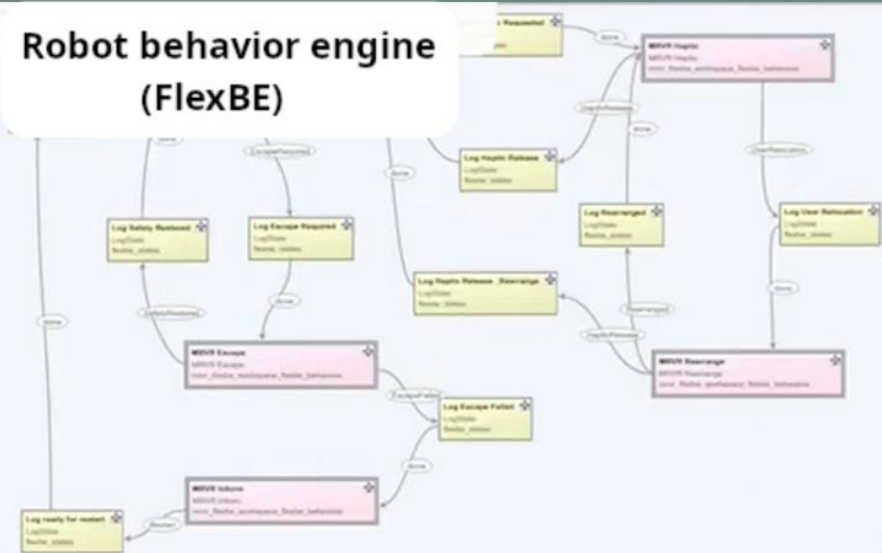
A Large-Scale Haptic VR Interactive System Using a Collaborative Mobile Robot



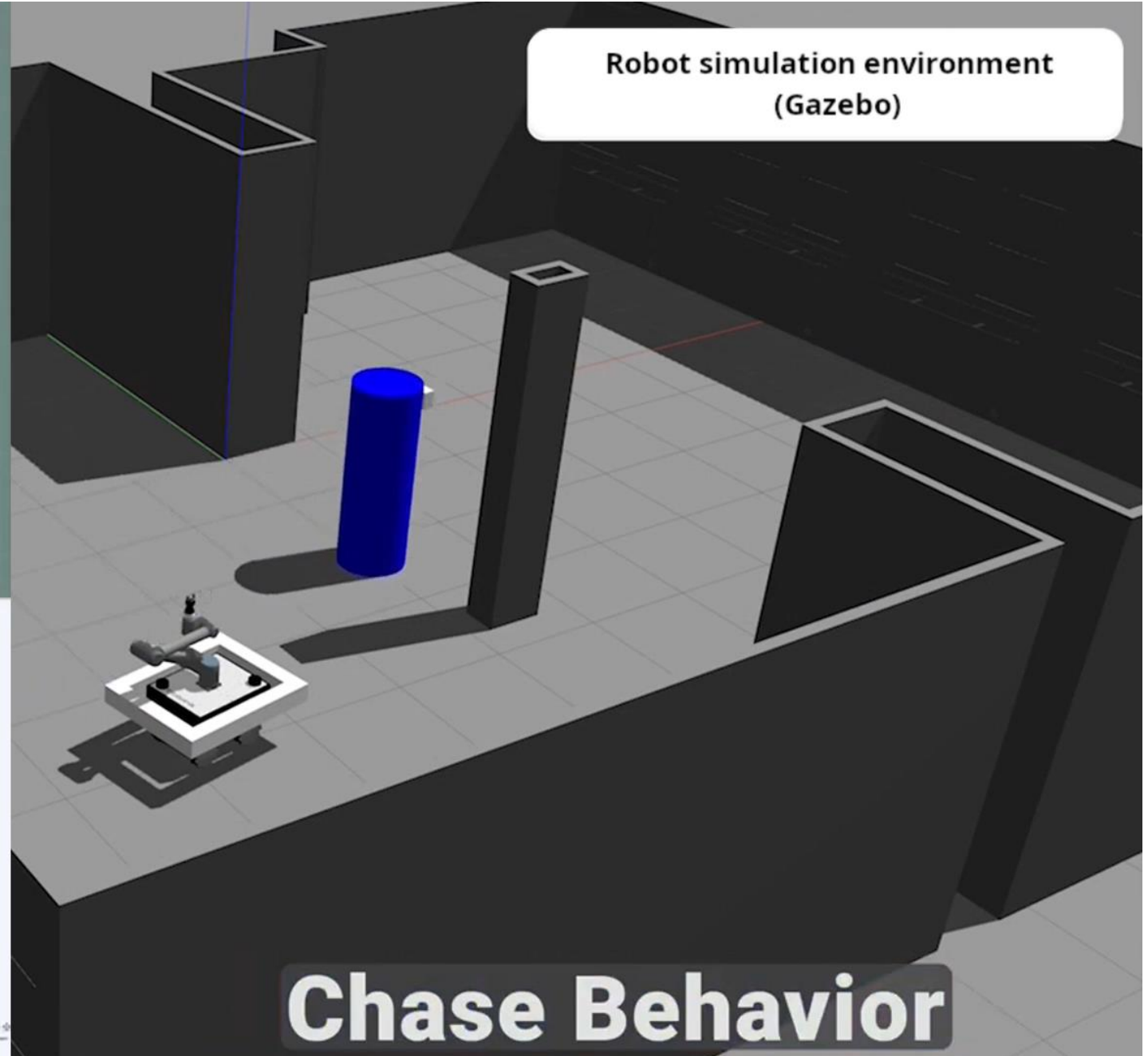
Robot data visualizer
(Rviz)



Robot behavior engine
(FlexBE)



Robot simulation environment
(Gazebo)

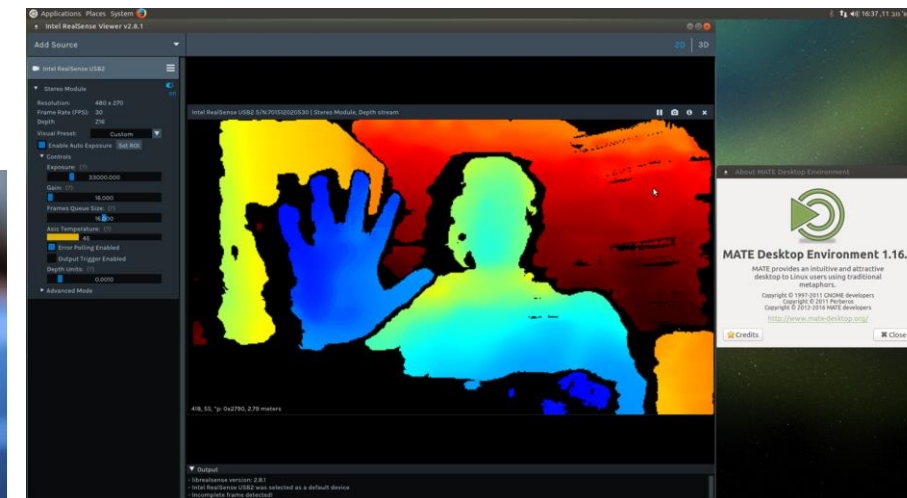
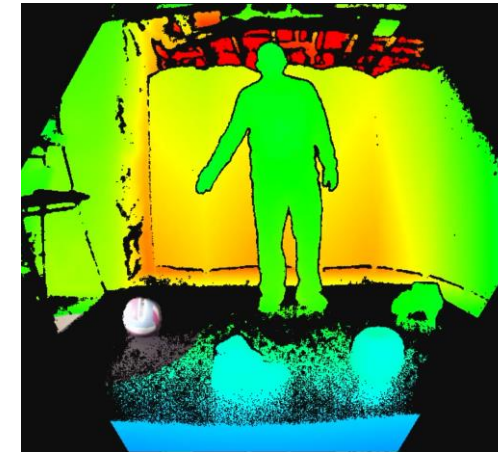


Chase Behavior

Vision for Robot: Detect the VR User

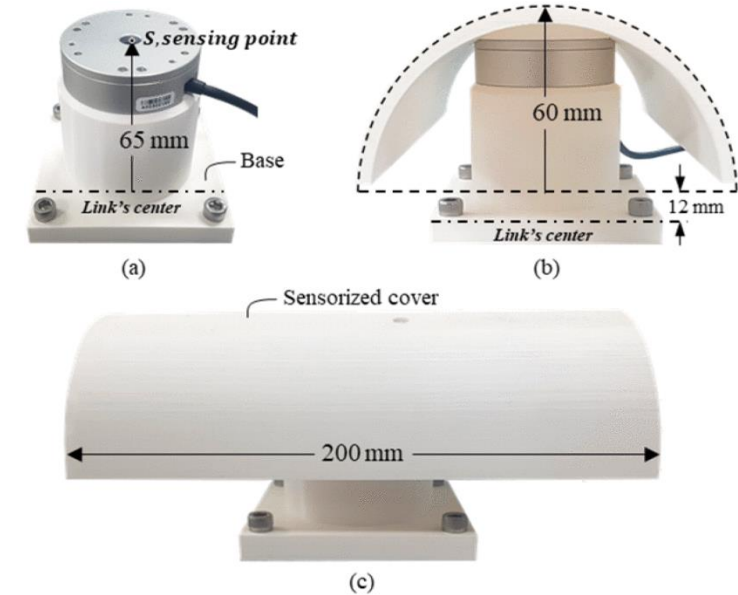
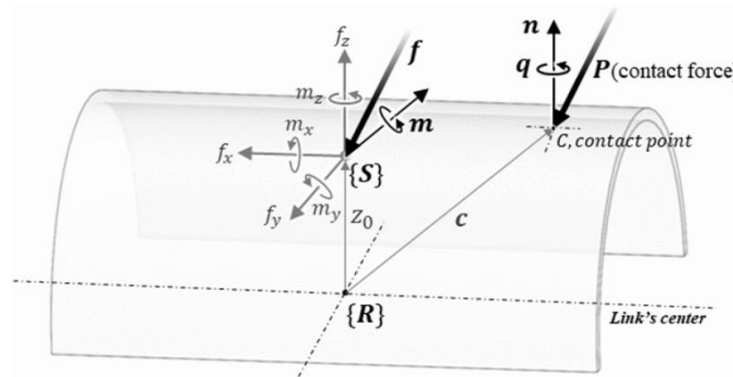
- **Task:** Enable fast user detection on the robot for safety and interaction
 - Implement a solution for user detection:
 - Whole body or only hands/legs
 - Tell apart user from a static obstacle
 - Test for optimal recovery (collision avoidance) behavior
 - For thesis:
 - Explore options for time-optimization
 - Prepare and help running a user study

- **Setup/IDE:** Ubuntu, ROS (Robot Operating System), Azure Kinect
Prerequisites: Basic Linux command, Python 2.7 & C++
Scope: PR, Master thesis



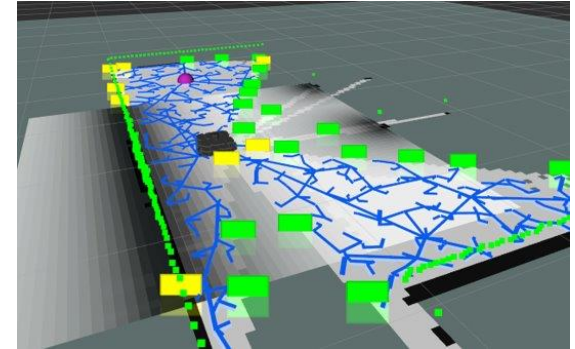
Contact Point Sensing with Force Torque Sensor

- Sensing the contact point on a surface with a Force Torque Sensor in the center
- **Task:** Reimplementing a mathematically elegant approach, described in an existing paper. <https://ieeexplore.ieee.org/document/9429923/media#media>
- **Setup/IDE:** C++ and/or Python, ROS (Robot Operating System), if helpful Matlab/Octave
- **Prerequisites:** Programming with Python and/or C++, interested in mathematical problems
- **Scope:** PR, thesis

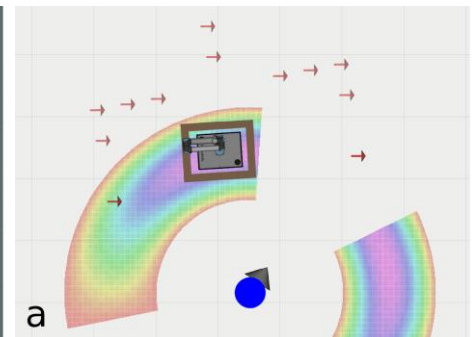
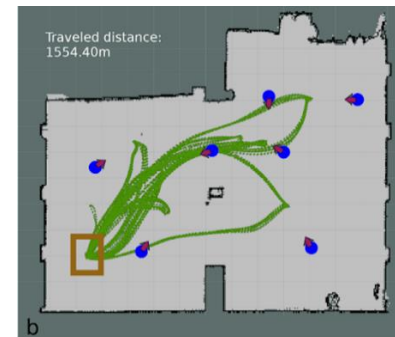
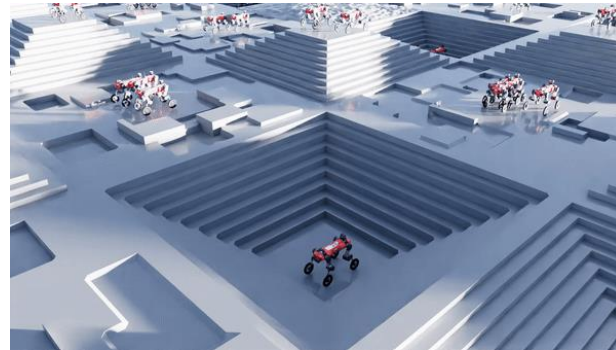


Optimize Mobile Robot Positioning with Reinforcement Learning

- **Objective:** Develop a Reinforcement Learning algorithm for optimal positioning of a mobile robot in proximity of VR user:
 - Safety
 - Collision probability minimization
 - Response time optimization
- **Tasks:**
 - Research Task: Exploration, analysis, and documentation of the current state-of-the-art
 - Development Task:
 - Implementation of test/training rig in either Unity 3d or Nvidia Isaac Gym
- **Requirements for development task:**
 - Basic Knowledge of programming with Python/C++
 - Basic knowledge of ML and/or RL
 - Knowledge of Nvidia Omniverse is +

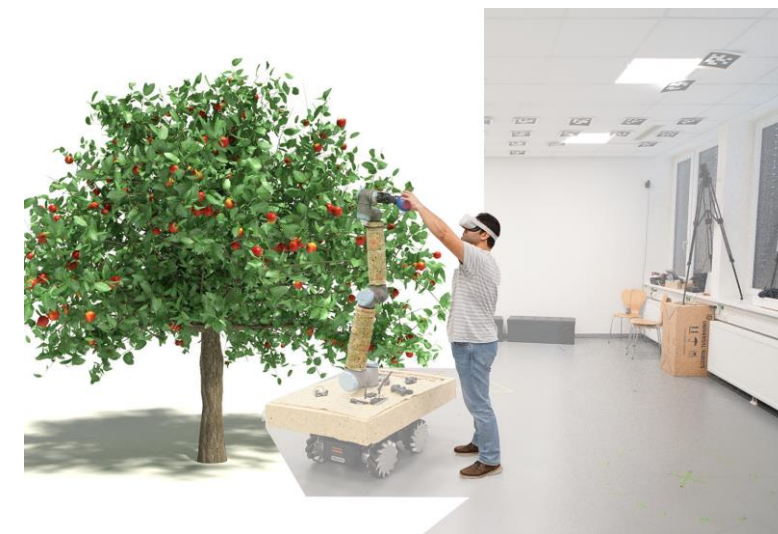
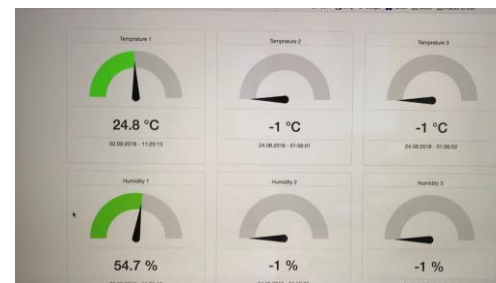


Scope: PR, SE, Thesis



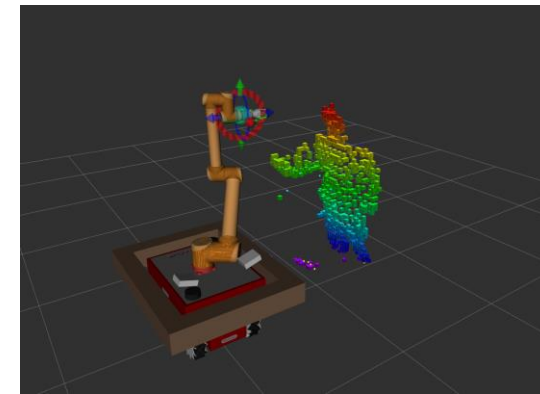
Cobodeck safety monitoring using AR

- **Setup:**
 - Cobodeck – Safety monitoring for an Observer using AR
 - Windows + Unity, Ubuntu + ROS, AR (MS HoloLens, Quest 3, ...)
- **Various Tasks available:**
 - ROS (Linux):
 - Implementation of safety parameters measurements
 - Windows:
 - Connection to AR glasses for visualizations
- **Scope:** VR: AT, PR, SE, thesis



New robot sync with test user

- **Setup:**
 - Scout Mini
 - Windows + Unity / Ubuntu + ROS2 on docker
- **Various Tasks available:**
 - Localization stack setup (Marker tracking)
 - Navigation stack sync with simulated user in Unity
 - Adjust physical parameters to imitate human user
- **Scope:** VR: AT, PR, SE, thesis



Safe Planning & Control of a Robot Arm for VR Use

- Moving a robotic arm close to an unaware immersed VR user can be dangerous.
- A robotic arm can alter the order of moving its different joints (finding and selecting different solutions for an inverse kinematic problem) to create a safer path for its joints to reach a certain goal by making changes in the arm path planning algorithm.
- **Task:** Employ and configure arm path planning algorithms and inverse kinematic solvers.
- **Setup/IDE:** Ubuntu, ROS, Gazebo
- **Prerequisites:** Basic Linux commands, basic understanding of spatial transformations, maybe basic python.
- **Scope:** PR, thesis



Interested in CoboDeck?

Supervisor:

- Khrystyna Vasylevska
- Emanuel Vonach
- Soroosh Mortezaipoor
- Mohammad Ghazanfari



Send email for more information and discuss topics:

cobodeck@list.tuwien.ac.at

HARDWARE INTERFACES FOR VR INTERACTION

Hanger Reflex



- A force illusion that accompanies involuntary body rotation
- Task
 - Development of an interface that generates the Hanger Reflex on different body segments (head, waist, legs).
 - Development of a proof of concept in Unity3D to show how users could be redirected in VR experimental platform using Unity3D
- Knowledge of Arduino/ROS/Microcontrollers
- Contact: hugo.brument@tuwien.ac.at

BUILDING INFORMATION MODELLING (BIM)

Visualization of segmented point cloud data in Unity

Objective

Visualization of object detection pipeline results (i.e. detected objects and corresponding meta-data)

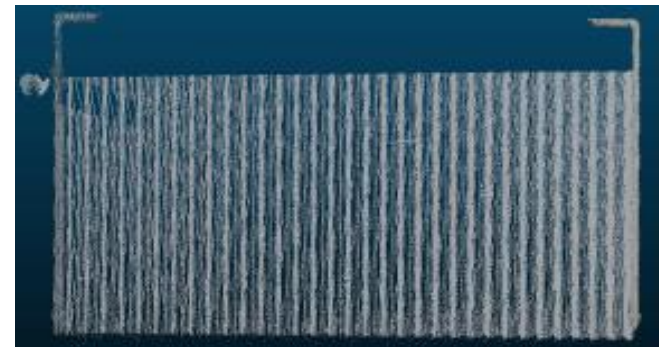
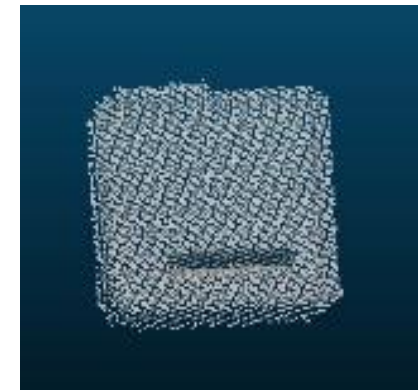
Tasks

- Read a JSON file describing objects segmented from a point cloud into Unity
- Visualize the read-in objects and their meta-information: bounding boxes, IDs, points belonging to each object etc.
- Implement basic interactions with the visualized objects: filtering of the displayed information

Topic for: PR

Financial bonus for positive and timely completion

Contact: christian.schoenauer@tuwien.ac.at and/or yana.podkosova@tuwien.ac.at



Visualization of differences between scanned point clouds and 3D models

Objective

Visualization (and calculation) of the difference between a building's 3D model and scanned point cloud

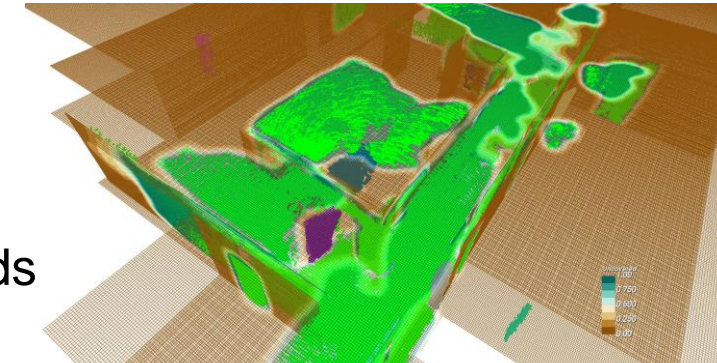
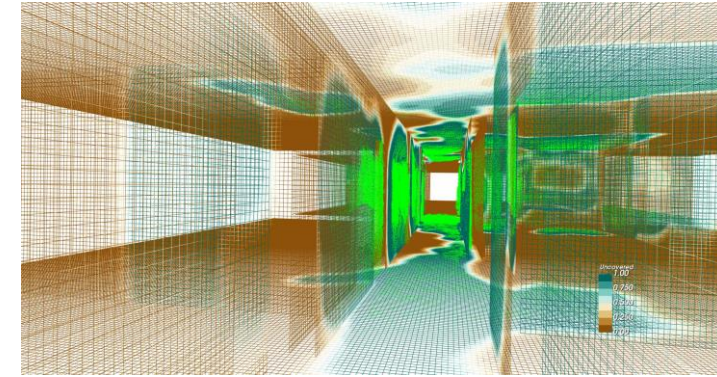
Tasks

- Implementation or improvement of algorithms to visualize (and calculate) the difference of scanned points and 3D models.
- Improvement of the processing pipeline and interfaces, i.e. the loading and processing of point clouds scanned by Lidar and/or Kinect. Alignment, matching and comparison of these point clouds with the model to create the data for the visualization.
- Implement basic interactions with the visualized environment

Topic for: PR – Tasks sufficient for 2-3 students

Financial bonus for positive and timely completion

Contact: christian.schoenauer@tuwien.ac.at and/or yana.podksova@tuwien.ac.at



Suggest Your Topic!

- Additional topics available and added every semester on:
 - <https://www.vr.tuwien.ac.at/topics/>
- Suggest your own topic
 - If you have a topic that you feel very passionate about
 - If you want to make your own piece of equipment
 - Your topic has something in common with AR/VR or any of the topics above
- Feel free to contact Prof. Kaufmann
[*hannes.kaufmann@tuwien.ac.at*](mailto:hannes.kaufmann@tuwien.ac.at)

Next Steps...

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To: *<topic supervisor>*

CC: *hannes.kaufmann@tuwien.ac.at*

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Questions?

