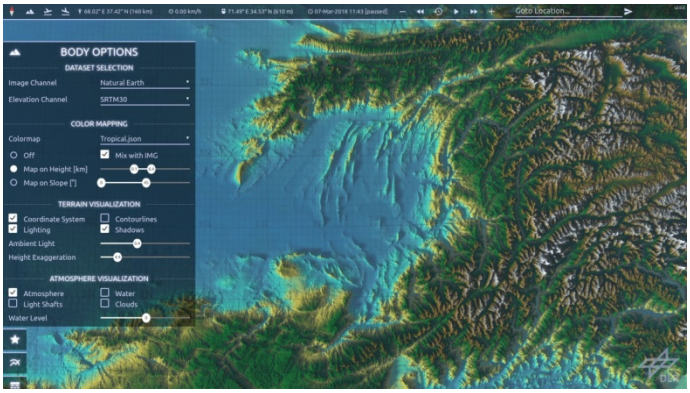
Screen-space soft shadows for high-resolution terrain rendering

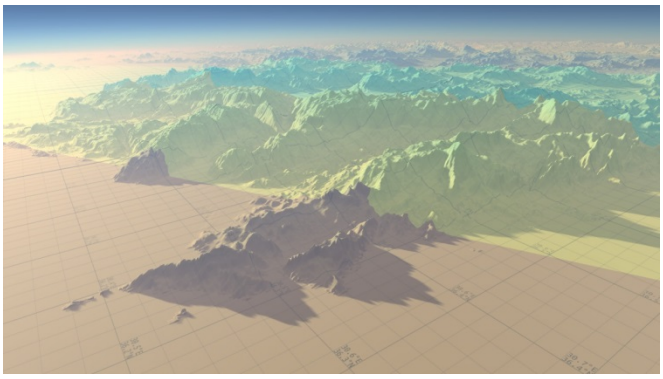


Goal of this thesis is to compare and implement various screen-space shadowing techniques for 2.5D elevation data.

In DLR's department for Simulation and Software Technology, a virtual-reality simulation of our solar system is being developed. With sophisticated level-of-detail-algorithms, high resolution digital elevation models and satellite imagery, entire planets and space missions can be explored in real-time. Light and shadow play an important role in realistic space simulations. However, conventional approaches such as cascaded shadow maps are not suitable for many scenarios. This is especially true for scenes like in the screenshot above with a narrow sun angle, many small details, short shadows and a small depth range. In these cases, other approaches such as screen-space shadows are very promising.

In the scope of this thesis, a survey on existing screen-space soft shadow (SSSS) algorithms shall be performed, taking into ccount the specially demands optimization opportunities of 2.5D terrain rendering. The most promising algorithm(s) will be implemented and optimized for this special use-case. Finally, tests and benchmarks shall prove the efficiency of the implementation and the limitations of the approach shall be discussed in detail.

Automatic parametrization of cascaded shadow maps for terrain visualizations at planetary scale

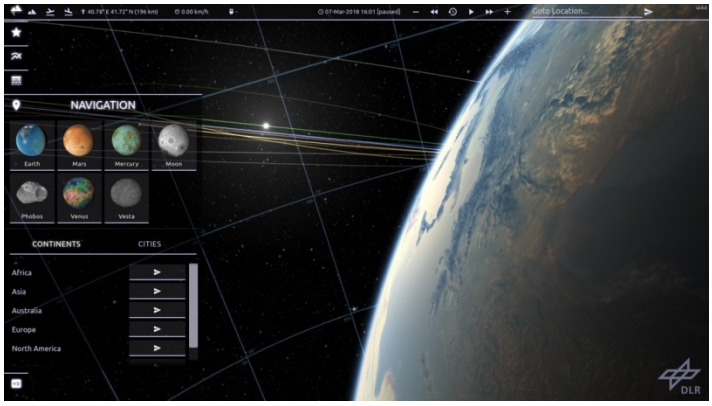


Goal of this thesis is to develop heuristics for optimal parametrization of cascaded shadow maps for very huge outdoor scenes.

In DLR's department for Simulation and Software Technology, a virtual-reality simulation of our solar system is being developed. With sophisticated level-of-detail-algorithms, high resolution digital elevation models and satellite imagery, entire planets and space missions can be explored in real-time. Light and shadow play an important role in realistic space simulations. However, there are a lot of parameters which can be used to tweak the quality and efficiency of the shadow calculation.

In the scope of this thesis, a system shall be developed which takes several factors (such as user's view direction, distance to the planet's surface or the distance to the horizon) into account in order to automatically create an optimal parametrization of the algorithm. The impact of each parameter on the shadow quality and algorithm performance shall be discussed. Finally, tests and benchmarks shall prove the efficiency of the implementation.

Automatic camera path planning through time and space in virtual reality

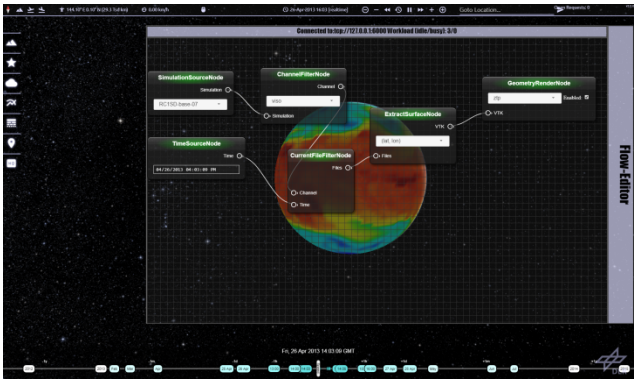


Goal of this thesis is to develop algorithms for automatic camera path animations when traveling through a virtual solarsytem in time and space.

In DLR's department for Simulation and Software Technology, a virtual-reality simulation of our solar system is being developed. With sophisticated level-of-detail-algorithms, high resolution digital elevation models and satellite imagery, entire planets and space missions can be explored in real-time. This is not only a simulation of space, but also of time since all celestial bodies are constantly moving on their orbits. When the user decides to use the "auto-pilot" to quickly fly to another location in space (this could be a region on the same planet, on another planet, a moon or a spacecraft) a camera path has to be calculated. On the one hand, this path should avoid intersecting other celestial objects and on the other, rotations and movements should be limited to an absolute minimum in order reduce motion sickness of the user.

In the scope of this thesis, this system shall be taken to another level: the travel target may not only be at another location in space, but also in time. That means, while being on Earth in 2018, the user may decide to witness the landing of Curiosity in the Gale Crater of Mars in 2012. Ultimately, this system will allow for the implementation of a “Space Mission Player” where users can seamlessly overserve the different stages of various space missions in time and space. A small user study will be required in order to evaluate the efficiency of different routing algorithms.

Exploration and analysis of high resolution climate data



The goal of this thesis is to develop and integrate analysis algorithms and graphical user interfaces to explore the high temporal resolution atmospheric simulation datasets of the ESCIMo project.

In DLR’s department for Simulation and Software Technology, a scientific visualization framework is being developed. This framework consists of e.g. CosmoScout VR, a rendering toolkit for large planetary datasets, and Viracocha, a middleware to develop parallel client/server applications. To achieve data analysis in near real-time, Viracocha is exploiting high performance computing (HPC) resources.

The tasks of the thesis include the development and integration of parallel algorithms into our framework. These need to generate timely averaged results. Since the input data consists of multiple simulations (ensembles), a visual comparison method for the presentation of different averaged results is also foreseen. Students interested in this position should have knowledge in C++ and OpenGL software development. An asset would be basic knowledge in the development of parallel algorithms using the message passing interface (MPI), but this is not a must.

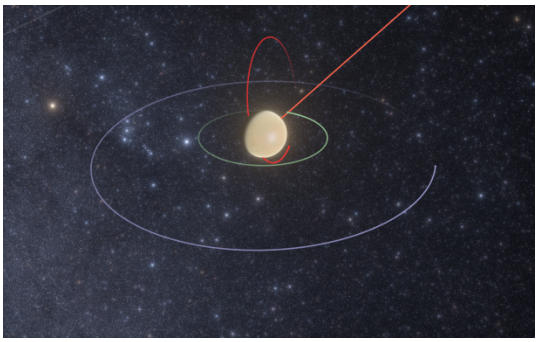
Network Communication for AR based Interaction Design for Satellite Assembly Tasks

In DLR’s department for Simulation and Software Technology, a team is working on developing augmented reality (AR) applications for aerospace industry. Hand controllers with external tracking systems are being used to facilitate hand manipulation of 3D virtual objects visualized through the AR glasses. Therefore, low latency network communication between the controller system and the AR glasses is needed.

Existing communication techniques are often helpful but they do not guarantee low latency data transfer. The

purpose of this thesis is to find out the serialization and data transfer techniques that would communicate the controller interaction information from a PC to/from the AR glasses with minimum latency. In the end, the communication techniques and the benchmark performance results have to be reported in the written thesis.

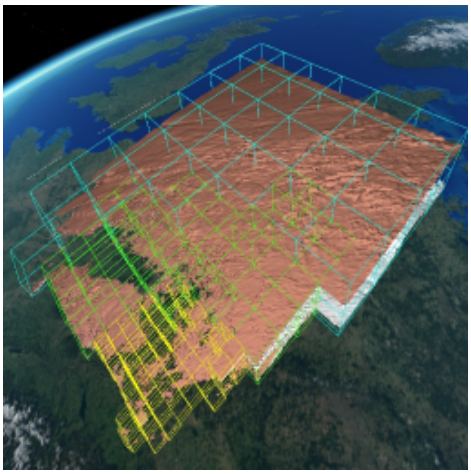
Motion Sickness Reduction for Solar System Exploration in VR



The successful candidate will work on visualization approaches to reduce motion sickness while exploring planets and the entire solar system. The work will based on a multi-scale solar system visualization system offering high-resolution data from street view to planet perspective to solar system navigation in virtual environments. Right now, the user can navigate freely though space which creates motion sickness for the users and even more for attending colleagues. The goal of the internship is to investigate methods to reduce motion sickness in virtual environments. Additionally, useful approaches for navigation on different scales should be evaluated. This might include restriction of degrees of freedom as well as autonomous flight trajectories from A to B. The next task is to implement visual means to reduce the motion sickness e.g. by adding visual anchors.

Requirements: Computer Science background, proficient C++ experiences, good OpenGL / Computer Graphics knowledge, some Linux knowledge, Virtual Reality skills would be an asset.

Multi-Resolution Atmospheric Data Visualization



The successful candidate will work on algorithms for atmospheric simulation and measurement datasets. The main topic will be on global time-dependent simulation datasets for weather forecasts and climate informatics. The goal is to process data for interactive visualization approaches. The required Level-of-Detail model has to support view-dependent refinement and streaming from remote high-performance clusters. Topology-based techniques need to be developed to allow analysis and visualization at different levels of detail of multi-field datasets. Besides mapping data on a 3D planet, extracted features from data products are to be processed in a view-dependent manner as well.

Requirements: Computer Science background, proficient C++ experiences, good OpenGL / Computer Graphics knowledge, some Linux knowledge, Scientific Visualization skills would be an asset.

Position Tracking for Augmented Reality Scenarios

The goal of this project is the design and development of a framework to allow for a stable position tracking in Augmented Reality (AR). The framework shall combine external tracking techniques with sensor information from the Microsoft HoloLens in real-time.

In DLR's department for Simulation and Software Technology, an AR framework for the visualization and interaction of huge city data models is being developed. The visualization of such data in AR using state-of-the-art technics, as in the Microsoft HoloLens, has diverse limitations in tough environment conditions as outdoor/sunny scenes, moving vehicles or highly reflective materials. The combination of external tracking techniques with internal sensor data can help to overcome such limitations.

The main tasks of this project include the investigation of tracking methods that can be used in AR scenarios. Furthermore, an AR framework to connect external tracking systems with the HoloLens needs to be developed. Students interested in this project should have knowledge in computer graphics, and programing skills in C++ / C# or have experience on game engines as Unity 3D and Unreal.

Augmented Reality in City Simulators

The goal of this project is the development of a framework to augment a virtual scene in a city simulator with dynamic holograms using the HoloLens. An exemplary application to visualize drone holograms shall be implemented as a use case for the framework.

At DLR, a project is being developed to investigate how humans deal with air drone traffic in all-day situations. The developed framework will contribute to create virtual stimuli that can be used in such perceptual studies.

The main tasks of this project include the investigation of existing Augmented Reality applications for simulators and the development of a framework to connect dynamic holograms, exploiting the HoloLens, to a simulation scene in a city simulator. Students interested in this project should have knowledge in computer graphics and programing skills in C++ / C#. An asset is to have experience on game engines such as Unity 3D or Unreal.