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Scientific Visualization for Atmospheric Data Analysis in Collaborative Virtual Environments

Wito Engelke (1), Markus Flatken (1), Arturo S. Garcia (2), Christian Bar (3), and Andreas Gerndt (1)

(1) German Aerospace Center (DLR), Simulation and Software Technology, Baunschweig, Germany, (2) The University of Salford, UK, (3) Thales Alenia Space, Italy

1 INTRODUCTION

The three year European research project CROSS DRIVE (Collaborative Rover Operations and Planetary Science Analysis System based on Distributed Remote and Interactive Virtual Environments) started in January 2014. The research and development within this project is motivated by three use case studies: landing site characterization, atmospheric science and rover target selection [1].

Currently the implementation for the second use case is in its final phase [2]. Here, the requirements were generated based on the domain experts input and lead to development and integration of appropriate methods for visualization and analysis of atmospheric data. The methods range from volume rendering, interactive slicing, iso-surface techniques to interactive probing. All visualization methods are integrated in DLR's Terrain Rendering application. With this, the high resolution surface data visualization can be enriched with additional methods appropriate for atmospheric data sets. This results in an integrated virtual environment where the scientist has the possibility to interactively explore his data sets directly within the correct context. The data sets include volumetric data of the martian atmosphere, precomputed two dimensional maps and vertical profiles. In most cases the surface data as well as the atmospheric data has global coverage and is of time dependent nature. Furthermore, all interaction is synchronized between different connected application instances, allowing for collaborative sessions between distant experts.

2 VISUALIZATION TECHNIQUES

Also the application is currently used for visualization of data sets related to Mars the techniques can be used for other data sets as well. Currently the prototype is capable of handling 2 and 2.5D surface data as well as 4D atmospheric data. Specifically, the surface data is presented using an LoD approach which is based on the HEALPix tessellation of a sphere [3, 4, 5] and can handle data sets in the order of terabytes. The combination of different data sources (e.g., MOLA, HRSC, HiRISE) and selection of presented data (e.g., infrared, spectral, imagery) is also supported. Furthermore, the data is presented unchanged and with the highest possible resolution for the target setup (e.g., power-wall, workstation, laptop) and view distance.

The visualization techniques for the volumetric data sets can handle VTK [6] based data sets and also support different grid types as well as a time component. In detail, the integrated volume rendering uses a GPU based ray casting algorithm which was adapted to work in spherical coordinate systems. This approach results in interactive frame-rates without compromising visual fidelity. Besides direct visualization via volume rendering the prototype supports interactive slicing, extraction of iso-surfaces and probing.

The latter can also be used for side-by-side comparison and on-the-fly diagram generation within the application. Similarily to the surface data a combination of different data sources is supported as well. For example, the extracted iso-surface of a scalar pressure field can be used for the visualization of the temperature.

The software development is supported by the ViSTA VR-toolkit [7] and supports different target systems as well as a wide range of VR-devices. Furthermore, the prototype is scalable to run on laptops, workstations and cluster setups.

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