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An Interactive Virtual 3D Tool for Scientific Exploration of Planetary Surfaces

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In this paper we present an interactive 3D visualization tool for scientific analysis and planning of planetary missions. At the moment scientists have to look at individual camera images separately. There is no tool to combine them in three dimensions and look at them seamlessly as a geologist would do (by walking backwards and forwards resulting in different scales). For this reason a virtual 3D reconstruction of the terrain that can be interactively explored is necessary. Such a reconstruction has to consider multiple scales ranging from orbital image data to close-up surface image data from rover cameras. The 3D viewer allows seamless zooming between these various scales, giving scientists the possibility to relate small surface features (e.g. rock outcrops) to larger geological contexts.

For a reliable geologic assessment a realistic surface rendering is important. Therefore the material properties of the rock surfaces will be considered for real-time rendering. This is achieved by an appropriate Bidirectional Reflectance Distribution Function (BRDF) estimated from the image data. The BRDF is implemented to run on the Graphical Processing Unit (GPU) to enable realistic real-time rendering, which allows a naturalistic perception for scientific analysis.

Another important aspect for realism is the consideration of natural lighting conditions, which means skylight to illuminate the reconstructed scene. In our case we provide skylights from Mars and Earth, which allows switching between these two modes of illumination. This gives geologists the opportunity to perceive rock outcrops from Mars as they would appear on Earth facilitating scientific assessment.

Besides viewing the virtual reconstruction on multiple scales, scientists can also perform various measurements, i.e. geo-coordinates of a selected point or distance between two surface points. Rover or other models can be placed into the scene and snapped onto certain location of the terrain. These are important features to support the planning of rover paths. In addition annotations can be placed directly into the 3D scene, which also serve as landmarks to aid navigation.

The presented visualization and planning tool is a valuable asset for scientific analysis of planetary mission data. It complements traditional methods by giving access to an interactive virtual 3D reconstruction, which is realistically rendered. Representative examples and further information about the interactive 3D visualization tool can be found on the FP7-SPACE Project PRoViDE web page http://www.provide-space.eu/interactive-virtual-3d-tool/.

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