Key Technology of Space Exploration (8)
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PLANETARY ROVER VISION PROCESSING AND VISUALIZATION: PROVIP AND PRO3D

Abstract

Three dimensional (3D) vision data processing is an essential component of planetary rover mission planning and scientific data analysis. Such processing is currently developed for the PanCam instrument of ESA's ExoMars Rover mission by the PanCam 3D Vision Team, with the following main goals:

- **Instrument design support & geometric calibration**
- Development **of 3D vision processing** functionality
- Development of a **3D visualization tool** for scientific data analysis
- **3D reconstructions** from stereo image data sets **during the mission**
- Support for **3D scientific exploitation** to characterize the overall terrain geomorphology and to characterize and quantify the geometry of rock outcrops using the reconstructed 3D models.

The developed processing framework PRoViP establishes a modular toolchain for 3D vision processing in planetary robotic missions. Examples of processing products and capabilities are: Digital Terrain Models, Ortho images, 3D meshes, occlusion-, solar illumination-, slope-, roughness-, hazard- and accuracy-maps. Another important processing capability is the fusion of rover and orbiter based images with the support of multiple missions and sensors (e.g. MSL Mastcam stereo processing).
For 3D visualization a tool called PRo3D has been developed to analyze and directly interpret digital outcrop models. Stereo image products derived from Mars rover data can be rendered in PRo3D, enabling the user to zoom, rotate and translate the generated 3D outcrop models. Interpretations can be digitized directly onto the 3D surface, and simple measurements of the outcrop and sedimentary features' dimensions can be taken. Dip and strike is calculated within PRo3D from mapped bedding contacts and fracture traces. Measurements and annotations can be organized according to their geological context in a hierarchical way. Furthermore, PRo3D offers a View Planner to interactively find ideal capturing parameters for rover instruments. The instrument's field of view is visualized on the DTM surface and its simulated view is shown in a separate window.
After ExoMars' landing in 2021 the software tools and the processing products will be used by geologists, exobiologists and mission engineers to decide upon experiments, select scientifically interesting sites

for the rover, and determine risks, resource costs and a priori success probability of vehicle operations: PanCam 3D vision is a key element of ExoMars mission success.