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PRoViDE: Planetary Probes' Mass Vision Data Processing

G. Paar (1), J.-P. Muller, Y. Tao (2), T. Pajdla (3), Jeremy Morley (4), K. Willner (5), I. Karatchevtseva (6), C. Traxler, G. Hesina (7), L. Tyler, D.P. Barnes (8), S. Gupta (9)

(1) JOANNEUM RESEARCH, A (Gerhard.paar@joanneum.at); (2) University College London, UK; (3) Czech Technical University, CZ; (4) University of Nottingham, UK; (5) Technical University Berlin, D; (6) Moscow State University of Geodesy and Cartography, RUS; (7) VRVis Zentrum für Virtual Reality und Visualisierung Forschungs-GmbH, A; (8) Aberystwyth University, UK; (9) Imperial College of Science, Technology and Medicine, UK.

Abstract

The FP7-SPACE project PRoViDE will assemble a major portion of the imaging data gathered so far from vehicles and probes on planetary surfaces into a unique database, bringing them into a common planetary geospatial context and providing access to a complete set of 3D vision products. Processing and GIS web access is complemented by a multi-resolution visualisation engine that combines various levels of detail for a seamless and immersive real-time access to dynamically rendered 3D scene representations.

1. Introduction

The international community of planetary science and exploration has launched, landed and operated dozens of human and robotic missions to the planets and the Moon. They have collected various surface imagery that has only been partially exploited for further scientific application purposes. Few attempts have been made so far to bring the data into a unified geospatial context, to exploit spatial relationships between such images and with orbiter data.

The FP7-SPACE project PRoViDE (2013-2015; www.provide-space.eu) will assemble a major portion of the imaging data gathered so far from vehicles and probes on planetary surfaces into a unique database. It will process a complete set of 3D vision products, bringing them into a common planetary geospatial context and providing seamless and immersive real-time access to them through a multi-resolution visualisation engine with various levels of detail for a dynamically rendered 3D scene representation.

2. PRoViDE Objectives

A plethora of images from planetary surfaces have been acquired. A large number of these images remain unexploited in terms of 3D data extraction, particularly the comprehensive data sets from MER's, Apollo's and Lunokhod's especially with large baselines. We propose collecting them in a unique geospatial and temporal manner and further processing 3D vision products in order to enable a comprehensive overview of the existing data. Orbiter imagery covering these sites exists to a sufficient quality that allows a seamless embedding of the surface data. The PRoViDE major objectives are summarized as follows:

- Generate a **vision data catalogue** by identifying candidate planetary imagery to be used for 3D vision processing, covering all relevant robotic sites of recent and ongoing missions such as Viking, Pathfinder, MER, MSL, Phoenix, Huygens, and Lunar ground-level panoramas & stereoscopic & multi-view images from Apollo, Russian Lunokhod and selected Luna missions.
- Find relevant **lunar surface image data sets, and extract 3D information** therefrom, especially by combining with images from the LRO narrow-angle sub-metre camera.
- **A more comprehensive 3D vision processing** of the mentioned planetary surface missions (heritage of PRoVisG [1]), using the images identified in the vision data catalogue.
- Provide the **highest resolution & accuracy remote sensing vision data processing results** for the mentioned mission sites to embed the robotic imagery and its products into spatial planetary context including updating local-to-global transformations to enable all rover imagery to be co-registered to orbital imagery.
- **Collect 3D Vision processing results into a 3D spatial data base**, connected to relevant high-quality remote sensing products.
- **Seamlessly integrate orbit and ground vision data** of recent, ongoing and planned missions including the simulation of ground-level imagery from orbital data for future landing sites.

- Explore and exploit **added-value mechanisms** such as BRDF (Bi-directional Reflectance Distribution Functions), shape-from-shading (SFS), and the use of additional unexpected (serendipitous) image combinations (e.g. stereo pairs) leading to a better 3D description of the surface.
- Define and execute use cases for scientific exploitation of newly generated 3D vision products, their presentation and visualisation.
- Demonstrate the processing and data base concept during independent **MSL data evaluation & visualisation campaigns.**
- Demonstrate the potential of existing and forthcoming planetary surface vision data by **highly realistic real-time visualisation**.
- Disseminate key data & its presentation by means of a **web-based GIS and rendering tool** in order to serve the educational, publicity and scientific objectives of Europe's planetary robotic missions.
- **Collect new requirements** for future vision sensor setups, operational scenarios and vision strategies in future planetary surface missions.
- Establish **new products for planetary research**, namely BRDF, stereo DEM densification by SFS, and through these, radiometrically corrected rendering & re-lighting of planetary image scenes.
- Increase past and present missions' science return.
- Derive new requirements / constraints / objectives for future missions such as a unique spatial data base (e.g. ExoMars 2019).

3. Technical & Scientific Approach

The main PRoViDE scheme is depicted in Figure 1. Robotic missions ground surface vision data and orbital data covering the operational sites of the probes are being collected in a Data Catalogue including the specification of use cases for further scientific exploitation. The vision data in the catalogue is processed to various sets of 3D Vision products stored in a data base (PRoDB) and made accessible via a GIS (PRoGIS). The products are presented through a real-time visualisation engine to experts, and by a www engine to the general public.

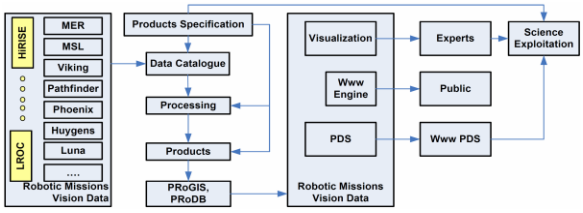

Figure 1: PRoViDE overall layout.

3. Current Status

By the time of writing this Abstract (May 2013), major parts of the vision data to be processed have been identified. First attempts of Lunar vision data processing from Lunokhod records have been made. HiRISE DEMs have been co-registered with MER poses and camera orientations, and a joint visualisation of orbiter and surface image products is under way. Updates of 3D vision processing in synergy with ongoing ExoMars PanCam development [2] have been started. Preliminary processing of released MSL data has been conducted.

4. Conclusions

PRoViDE presents the first comprehensive 3D vision processing of all surface image data sets available from robotic probes on Mars, the Moon (including human spaceflight data) and other planetary bodies, and embeds the 3D vision products into the spatial context of the corresponding orbiter imagery. Novel real-time immersive data visualisation allows seamless access. Processing frameworks, data base and GIS technology are ready to combine the imagery captured so far by Planetary surface probes into a unique set of 3D products for each site. PRoViDE will realize a large part of this global challenge, including the presentation of high-level results by visualisation. The teams involved in PRoViDE are fully aware of ongoing and near-future missions, particularly those heading towards Mars. In that sense, PRoViDE represents a significant step towards a new and sustainable method for better exploiting planetary science & exploration data.

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