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The CaSSIS Digital Terrain Model generation and Archiving at OAPD

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Abstract

The Colour and Stereo Surface Imaging System (CaSSIS) [1] on the ExoMars Trace Gas Orbiter is a multi-spectral stereo push-frame camera. CaSSIS is capable of providing two images of the same target from two different points of view along the same orbit. These acquisitions will be given as inputs for the photogrammetric products generation (digital terrain models and orthophotos). All the stereo data products generated by the different institutes and science teams involved in the CaSSIS project will be archived in a repository set up at INAF (National Institute of Astrophysics) of Padova and by the OAPD (Astronomical Observatory of Padova) team. The repository will be accessed through a website (http://cassis.oapd.inaf.it/), it will provide the ability of on-line visualization and download of the stereo products that will be delivered periodically after their validation. The single archive will offer the benefits of having all the stereo data products from CaSSIS at one place providing easy data accessibility to the entire team. Initially the data will be available only to the CaSSIS team and later on, after the expiration of the proprietary period, also to the public.
The website will be linked to CaST (http://skoll.unibe.ch/cast/), the web application for the creation, editing, searching and prioritizing of targets for CaSSIS, and is now accessible for public image suggestions.

1. Introduction

The previous and ongoing exploration missions to Mars provide significant amounts of data at different resolution (HRSC [2], HiRISE [3], CTX [4]). CaSSIS is the European stereo acquisition system with the highest resolution operating around the red planet. Eighteen months after its arrival around Mars in October 2016, the TGO is ready for its nominal science mission and from the end of April 2018, CaSSIS has started to produce its stereo pairs.
The system foresees the acquisition of multiple consecutive framelets that are mosaicked in a single image covering an area of 9.4x47 km.

The camera combines stereo and multispectral capabilities enhancing the ability of the science team to investigate terrain and geology. DTMs and the coloured orthophotos will improve significantly the quantitative analysis of the geomorphology and geology of target areas. In this context, the CaSSIS team is working on the creation of a robust and efficient pipeline that starting from the stereo image pre-processing, through a photogrammetric process, is able to provide accurate three-dimensional data to be collected in the repository for the delivery.

2. Stereo Data Product specifications

The stereo data in the OAPD repository will be 8 Bit orthoimages considering the complete mosaics of all the framelets in all the color bands and from both stereo images. These data products will be very useful for the key new science enabled by CaSSIS.
The repository will include also the DTMs that shall be 32-bit signed with elevations relative to the MOLA datum. The DTM spatial resolution is strictly correlated to the image quality and to the accuracy of the orientation data so the grid spacing will depend on the acquisition conditions. For the time being, a nominal stereo pair acquired at 5 m/pix will provide a DTM with 20 m/post sampling as for the case presented in [5] and produced with the 3DPD SW.

The geometric reference for both planimetry and height is a sphere of radius r=3396190 m as defined by the MOLA team.

3. Stereo Data Generation

All the institutes affiliated with the CaSSIS team are invited to generate DTMs from the instrument images.
The photogrammetric pipeline proposed by the OAPD will contain automatic procedures for the creation of the complete orthoimages from the framelets, for the definition of an initial disparity map and the disparity refinement at the sub-pixel level and for the triangulation phase arriving to the DTM production [6].
The framelets are mosaicked at the height identified by the triangulation of a set of a tie points extracted with the SURF [7] operator. The DTM generation SW is based on stereo image matching using pyramid-based least-squares correlation process. The 3D point determination by forward intersection is followed by heights interpolation. A bundle adjustment procedure will be considered for the correction of the orientation data applied also for the orthoimage generation.

4. Quality Assessment

In order to assess the quality of the DTMs determined by stereo-photogrammetry, from a metrical point of view, the horizontal precision/resolution, the expected vertical precision and the estimated vertical accuracy will be taken in account. Also a qualitative assessment of the abundance and appearance of artifacts in the DTM will be considered. Auxiliary/metadata files describing those aspects will be submitted to the repository for each DTM uploaded in an XML format.

5. Data Exploitation

The access to the web repository (Figure 1) linked to the map-based visualisation provided by CaST will be very useful for the exploitation of the CaSSIS data. A shape file, provided to CaST by the stereo data producer, will allow the definition of the target position on the Mars global reference frame connecting different source of data/information at the same time. The science team will benefit in their investigations when taking advantage of all the data sources available.

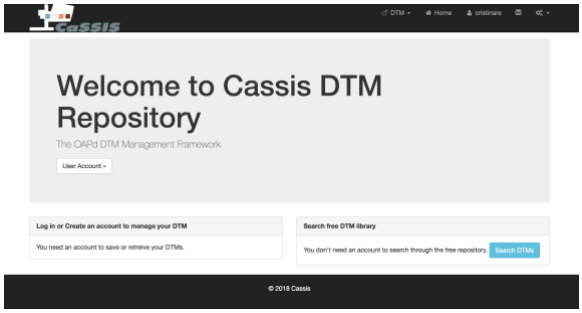

Figure 1: Home page of the Repository set up at the OAPD.

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