MARS-3D

ExoMars & Mars 2020 3D Vision 2023/24

Programm / Ausschreibung	ASAP, ASAP, ASAP 18. Ausschreibung (2021)	**Status**	abgeschlossen
Projektstart	01.01.2023	**Projektende**	31.12.2024
Zeitraum	2023 - 2024	**Projektlaufzeit**	24 Monate
Keywords	Space Exploration; 3D Vision; Visualization; ExoMars; Mars 2020		

Projektbeschreibung

JR und VRVis haben in den letzten Jahren (und bis Ende 2022) die Instrumentenentwicklung und die Missionswissenschaft mit der Bereitstellung von 3D-Vision und Visualisierungssoftware für die Mars 2020 Mastcam-Z und ExoMars 2020 PanCam Instrumente unterstützt, mit Gerhard Paar von JOANNEUM RESEARCH als Mastcam-Z Co-Investigator (Co-I), PanCam Lead Co-I für 3D Vision und CLUPI & WISDOM Co-I. Die hier vorgeschlagene Mars-3D-Aktivität wird die Vorbereitungen für den 3D-Vision-Beitrag der ExoMars-PanCam-Mission bis zur Landung im Juni 2023 abschließen, den 3D-Vision-Betrieb der PanCam-Mission nach der Landung unterstützen und darüber hinaus den Betrieb der PanCam-Mission mit den genannten 3D-Vision-/Visualisierungs-/Kalibrierungskomponenten bis zum Ende der nominellen Mission unterstützen, mit einem Planungsspielraum bis Ende 2024. Der Mastcam-Z 3D-Vision- und Impakt-Wissenschaftsbeitrag (in Zusammenarbeit mit der ÖAW) wird im selben Zeitraum mit maximaler Synergie erfolgen. Weitere Möglichkeiten im Bereich der 3D-Vision und Impaktforschung werden für ExoMars CLUPI und WISDOM genutzt. Hauptziel ist die Publikation wissenschaftlicher Ergebnisse aus Geologie, Morphologie, Aeologie und Impaktforschung, die sich speziell aus den Möglichkeiten der 3D Vision und Visualisierung eröffnen, gemeinsam mit den jeweiligen Instrumententeams.

Abstract

JR and VRVis during the past few years (and until end 2022) are supporting instrument development and mission science with provision of 3D vision and visualization software for the Mars 2020 Mastcam-Z and ExoMars 2020 PanCam Instruments, with Gerhard Paar from JOANNEUM RESEARCH as Mastcam-Z Co-I, PanCam Lead Co-I for 3D Vision and CLUPI & WISDOM Co-I. The Mars-3D activity proposed here will complete the preparations for the ExoMars PanCam mission 3D vision contribution until its landing in June 2023, support Post-landing-to-Egress PanCam 3D vision operations and further will support PanCam mission operations with the named 3D vision / visualization / calibration components until the end of the nominal mission with a contingency until end 2024. The Mastcam-Z 3D vision and impact science contribution (in cooperation with ÖAW) will be set forth in the same period with maximum synergy. Further opportunities in the 3D vision and impact science domain will be taken for ExoMars CLUPI and WISDOM. The main goal is the publication of scientific results from geology, morphology, aeology and impact research, which open up especially from the possibilities of 3D vision and visualization, together with the respective instrument teams.

Endberichtkurzfassung

The NASA Mars 2020 Perseverance Rover mission landed on Mars on 18 th February 2021 to undertake the next key steps in our understanding of Mars' potential as a habitat for past or present life. Among other instruments, Perseverance carries Mastcam-Z, a stereoscopic zoomable multispectral camera coordinated by Arizona State University. Gerhard Paar from JOANNEUM RESEARCH (JR) is one of about a dozen international Mastcam-Z Co-Investigators (Co-Is), with Austrian collaborators from JR, VRVis (Dr. Christoph Traxler and Team), the Austrian Academy of Sciences, (ÖAW; Dr. Andreas Bechtold) and three collaborators from Imperial College London.

The Mars-3D project covered 3D vision building blocks, assembling 3D models, data fusion products and visualizations from Mastcam-Z stereo pairs in various scales for further scientific analysis and interpretation.

The Planetary Robotics Vision Processing (PRoViP) suite of stereo processing & data fusion by JR was continuosly maintained and was fully operational with tactical processing 24/7/365 with more than 99% of operations time. The underlying satellite image products (Digital Terrain Model – DTM and Ortho image) were updated as visualization basis whenever a new version was ready from JPL, the NASA Jet Propulsion Laboratory. New processing assets were integrated into PRoViP such as prototype co-registration, anaglyph, manual pointing correction, and meta data from the Planetary Data System (PDS).
The Planetary Robotics 3D Viewer PRo3D by VRVis was improved with new capabilities, specifically in its video-assembly feature ("Sequenced Bookmarks"), harmonized SW deployment (including Mac platform) & coordinate transform, 3D Geographical Information System (GIS) functionality, especially blending of multiple textures to support multspectral data; contour lines for various data types. and optimizations in kd-tree and 3D graphics overlay representations.
A prototype of a panoramic 2D / 2 ½ D viewer (PRoPano) was integrated, based on a new backbone, with exemplary handling of targets.

The Austrian team was/is embedded in daily operations and is continuing to participate in the regular publication waves of the mission with a few dozens of publication contributions so far, emphasizing on impact science, aeolian, soil and geologic analysis, as well as provision of outreach data products and in particular illustrative videos as available on https://www.youtube.com/@pro3dspace120/videos .

As an example of high-accuracy mapping and visualization product, the 10 sample tubes as dropped by Perseverance in the so-called "Three Forks" region were documented in position and pose in a publication for the 10 th international conference of Mars.

Many scientific findings of Mars 2020 were supported by the work as conducted in Mars-3D, such as the help in selection of "preferred samples" (Figure 3), or works on geology and analysis of regolith. The JR / VRVis / ÖAW Team contributed to mission science discussions and several dozens of scientific publications during the project period between January 2023 and December 2024. See also the https://www.youtube.com/@pro3dspace120 YouTube Channel and the example in Figure 4.

All the activities were documented and discussed within the European and US space exploration community in numerous workshops, meetings and conferences in Austria and abroad.

Mars-3D also further prepared and tested the 3D vision building blocks for the panoramic camera instrument PanCam on board the ExoMars Rosalind Franklin rover to land on Mars in 2030. The processing chain as integrated in the ExoMars Rover Operations Control Centre was continuously updated, tests using ExoMars GTM (Ground Test Model) “Amalia” were conducted and its camera calibration was supported. Active participation with 3D-related presentations in ExoMars plenary meetings took place.

The main Mars-3D stemming participations in publications can be listed as follows – some of them were conducted in synergy with other activities of JR/VRVis/ÖAW:

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Projektkoordinator

- JOANNEUM RESEARCH Forschungsgesellschaft mbH

Projektpartner

- Österreichische Akademie der Wissenschaften
- VRVis GmbH