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Geodata workflow for the AMADEE-18 Mars analog mission

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Abstract

During the AMADEE-18 Mars analog field campaign, a human-robotic Mars mission was simulated in the Dhofar region in Oman, where a field crew was supported by a Mission Support Center (MSC) in near-real time. Instrument workflows, pilot data analysis was emulated in a workflow as it is to be expected for future a human-robotic Mars mission. We report on an innovative geodata workflow, ensuring an efficient mapping and deployment interaction of geographical information between the field crew and the MSC.

1. Introduction

AMADEE-18 was an international Mars analog simulation mission of the Austrian Space Forum (OeWF), in partnership with the Oman Astronomical Society. The mission took place in the Dhofar region in Oman in February 2018, including 19 experiments looking into engineering, geoscience and human factors research for future human-robotic Mars missions (Fig.1).

A highly trained field crew, including 7 analog astronauts with high-fidelity spacesuit simulators were directed in real-time by a control center on "Mars" during Extravehicular Activity (EVA) and through time-delayed communications by the Mission Support Center on "Earth" in Austria.

1.1 Exploration cascade

The experiment selection and deployment modalities were choreographed according to an “exploration cascade”, representing a logical data acquisition, transfer and interpretation workflow as a basis for the operational planning. The concept included carefully designed flight plans of the field crew, data transfer of instrument data in near-real time (with a 10min signal delay), a pilot interpretation of the data by the principal investigators and a subsequent influencing of the flight plan, connecting both scientific needs with spaceflight-typical workflows.

Figure 1: Kepler-Station for the AMADEE-18 Mars simulation in Oman.

1.2. Mars-analog geopositioning

As a global positioning system will not be available for the first human Mars mission, relative positioning techniques including horizon profile or inertial navigation, complemented with triangulation based upon signal travel times might allow for navigational capabilities comparable to terrestrial GPS. The spacesuit simulators utilized GPS signals to mimic those projected navigation capabilities.

2. Geodata management

2.1. Geodata sources and preparation

The base layer data upon which subsequent analysis and planning was founded, were the following: an optical aerial image with a resolution of 0.5 m and a digital elevation model (DEM) with a resolution of 5 m, both acquired via the Oman National Survey Authority. Additionally, as the AMADEE-15 mission [2] showed the importance of not only spatial, but also temporal resolution, data by Planet [5] was used, which has a high update rate at a resolution of 3 m.

Before mission start, the DEM was analyzed to classify the region w.r.t. inclines. High inclines, which may be exhausting or even dangerous to climb, were avoided. Also the experiment teams had access to the data to identify areas of interest, and communicate them for in-mission traverse planning.

During the mission itself, the Flight Planning (FP) team developed the daily traverse plans. Those plans specified the locations where to perform scientific experiments, and traverses in between. The FP team was assisted by the Remote Science Support (RSS) team and external PIs with respect to the scientific value of potential target sites. Traverse plans also need to consider operational constraints (see e.g. [3]), such as communication infrastructure and flight rules for extra-vehicular activities. Hence, eg, the coverage obtained by a specific setup of WLAN antennas was modeled based on the DEM with a viewshed analysis.

2.2. Geodata deployment workflow

Traverse planning and geodata analysis efforts in previous missions showed shortcomings when using stand-alone software like Google Earth without a sophisticated workflow for managing and distributing the data [4]. Furthermore, the MARS2013 mission [1] showed the necessity for a system to assist the analog astronauts to orient themselves at the area of operations [4]. This requires to efficiently make the output of the planning process available to devices deployed in the field.

During AMADEE-18 we implemented a workflow for handling geodata to allow efficient collaborative editing and sharing of data between teams. Data was stored on a central server and made available to clients using open standards as defined by the Open Geospatial Consortium (OGC). This allows to access the data via any standard compliant software. The workflow relied heavily on the use of transactional capabilities of the Web Feature Service (WFS) protocol, allowing to directly edit data on the server from within the client software. To allow sharing a specific version of a data set, read-only copies of the current state could be created.

We used GeoServer [1] as server software, as it provides an open-source and OGC compliant implementation of the required protocols and supports a wide range of data formats. Management may be automated using a REST API, which was utilized to implement the functionality for copying layers and preparing templates for individual teams.

Whenever a team created a versioned snapshot of their work, the data was transferred automatically to another server instance in the field. The process also implemented the time-delayed transfer as required in the context of the analog simulation. Base layer data was prepared beforehand and deployed on the field server. Clients in the field could then retrieve all published data locally. This included the space suit simulator, allowing the automated display of the most recent data on the Head-Up-Display.

Positions of the analog astronauts were recorded automatically by the space suit simulator using GPS. Current data was transmitted continuously with a time-delay to the MSC via the internal telemetry system, providing "live" tracking. All logged positions were also transferred after each EVA via other established communication channels developed during previous missions. Data was then imported into the server and made available to all teams as input for their next plans and record of actual experiment locations. This allowed integration with already existing workflows whilst still utilizing the capabilities of the new system

[1] http://geoserver.org

References

[1] Groemer, G., Soucek A., Frischauf N., et al.: The MARS2013 Mars analog mission. Astrobiology Vol.14 (5), pp. 360-376, 2014.

[2] Groemer, G., Losiak, A., Soucek, A., et al.: The AMADEE-15 Mars simulation. Acta Astronautica Vol. 129, pp. 277-290, 2016.

[3] Hörz, F., Lofgren, G. E., Gruener, J. E., et. al.: The traverse planning process for D-RATS 2010. Acta Astronautica, Vol. 90 (2), pp. 254-267, 2013.

[4] Losiak, A., Gołębiowska, I., Orgel, C., et al.: Remote science support during MARS2013: testing a map-based system of data processing and utilization for future long-duration planetary missions. Astrobiology Vol. 14 (5), pp. 417-430, 2014.

[5] Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com.