MULTI-MISSION GEOGRAPHIC INFORMATION SYSTEM: UPDATES AND MARS SCIENCE OPERATIONS STATUS.
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Introduction: The Multi-mission geographic information system, MMGIS, is a planetary science mission operations tool developed under the NASA Advanced Multi-Mission Operations System (AMMOS), providing geospatial functionality as part of a spatial data infrastructure for planetary science operations [1]. MMGIS provides a low-cost, open source solution for planetary missions [2]. It provides workflows and a web-based interface to combine mission basemaps with science products in their proper geospatial context including instrument results. The software is deployed on three active surface missions: the Mars Science Laboratory rover, the InSight lander, and Mars2020 rover. We’re presenting an update on MMGIS and a look at its use in Mars science operations.

Open Source Release: Our open source release has been updated to version 1.2 on github under an Apache 2.0 license: https://github.com/NASA-AMMOS/MMGIS. Periodic updates will continue to be made several times a year. We accept pull requests and merge branches into the master, after internal code review for consistency, security, and pertinence.

Updates: A general description of MMGIS’ capabilities can be found here [1] and release notes here [2]. Since the initial v1.0 open source release, we’ve subsequently made three updates with the current version at v1.2 [2]. The application framework is now entirely Node-JS based [3], removing any dependencies for a stand-alone webserver. For security, we’ve added a local users option that stores authenticated users in the MMGIS database. Otherwise, single-sign on (SSO) or an LDAP server in front of the MMGIS instance could be utilized.

To serve larger amounts of data, for example orbital image footprints that can number in the tens of thousands which is difficult to serve dynamically as GeoJSON, we’ve added vector tiles as one of our default formats. Vector tiles serve as a way to crop data to a regularized known extent (i.e. a “tile”) to reduce the data size. We use the Mapbox vector tile format [3] either as a standalone file (.mvt) or served from a spatial database/geoserver. In addition, we added an option to upload datasets to a PostgreSQL/POSTGIS database that can serve the vector data out as either GeoJSON (our original default format) or as vector tiles.

Since the Mars2020 rover mission is cloud based, we’ve increased our functionality to work within an EC2 (Amazon) instance, along with being able to access data on an S3 bucket (i.e. cloud storage) and Elastic Block Storage (EBS, a cloud-based network drive).

To increase layer functionality, you can now adjust brightness, contrast, transparency, as well as blend any raster layer with layers below it. In addition, we’ve abstracted out layer “kinds” as a way to code in vector layer specific functionality (e.g. display and image when you click on the layer).

Mission Operations: MMGIS has been deployed on both the Curiosity rover mission (Figure 1), adapted to the InSight lander mission (Figure 2), and expanded for the Mars2020 rover mission (Figure 3). For Curiosity, the MMGIS instance serves as a way for science team members to see rover traverse progress, view the most recent ground mosaics, and where science targets were acquired. In addition, its been used successfully for strategic rover planning to help develop a safe route up Mt. Sharp given science desirements and evaluating mobility requirements (slope, terrain types). On InSight, we added an ‘Instrument Placement’ tool that was used to visually and qualitatively assess deployment of the seismometer (SEIS) and heat probe (HP3) instruments to the surface. For the Mars2020 rover mission, we adapted MMGIS to add an advanced vector drawing tool called CAMP (CAnpaign Mapping and Planning) for strategic science operations. MMGIS-CAMP is fully Dockerized and cloud-deployed version using a Amazon RDS PostgreSQL/POSTGIS database to store science team member mapping, and later strategic science targets and drive paths. The Mars2020 geologic mapping team successfully generated a 1:5000 scale geologic unit map using MMGIS-CAMP with over 60 science team members located at their home institutions [4]. This greatly facilitated conversations about the geology and standardized the tools use and dataset creation.

Future Work: MMGIS will continue to support and expand to support the existing missions as well as future missions like Mars Sample Return. Also, we plan to integrate more compatibility with cloud resources (e.g. Labdas) and web-friendly raster formats (i.e. cloud GeoTIFF).

Figure 1: MSL-based MMGIS web mapping instance with NAVCAM in situ view on left and orbital view on right. CHEMCAM ‘quicklook’ oxide data is displayed for target ‘The Tam’ as an interactive bar graph displaying percent of major oxides for each of ten LIBS shots.

Figure 2: MMGIS instance for the InSight mission. The ‘Instrument Placement’ tool was built to allow qualitative and quantitative assessment of the seismometer and heat probe in the lander’s workspace. Instrument outlines were based off of instrument CAD models and also simulated tether placement based on attachment points and dimensions. A 3D view used ‘as-built’ CAD models and surface data to simulate deployment (right side of image).

Figure 3: CAMP interface added to MMGIS.