New Layer in JMARS

J.Zhou[1], B. Ayhan[1], J. Yin[1], C. Kwan[1], S. Vance[2]

[1]Signal Processing Inc., [2]Jet Propulsion Laboratory, Caltech

Introduction

JMARS (Java Mission-planning and Analysis for Remote Sensing) is a geospatial information system (GIS) developed by ASU's Mars Space Flight Facility to provide mission planning and data analysis tools for NASA planetary mission data to scientists, students of all ages, and to the general public [1]. We developed a custom layer for JMARS to show the traverse maps of Mars rovers: Spirit, Opportunity and Curiosity (see Fig. 1). The tool allows users to visualize spectral measurements (APXS and LIBS) collected by the rovers' instruments (Fig. 2) and their oxide composition estimations generated by scientists (Fig. 4). When a particular sol day (Mars day) is selected, the graphics window of the JMARS software shows the site location of the rover at that sol day (see Fig. 3). The HiRISE data layer is also loaded to show the high resolution image of Mars (In Fig. 1 and Fig. 3).

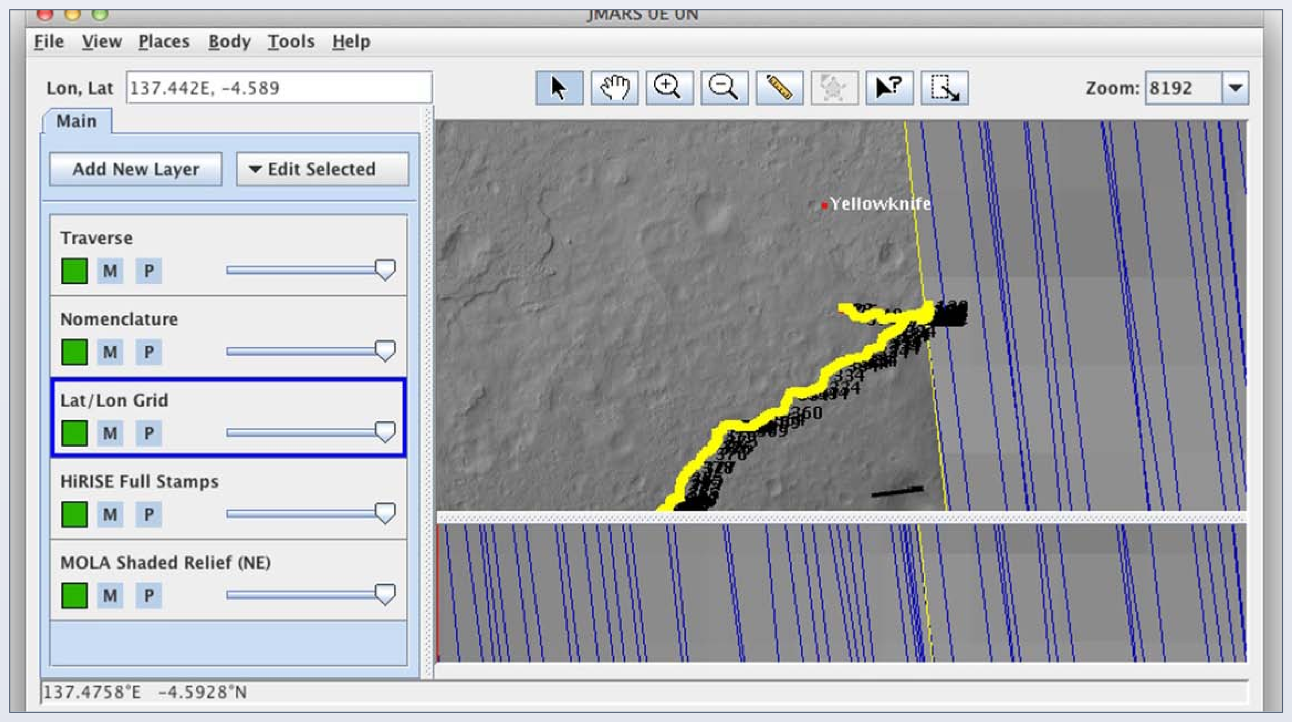

Fig.1 Rover Traverse Layer developed for JMARS

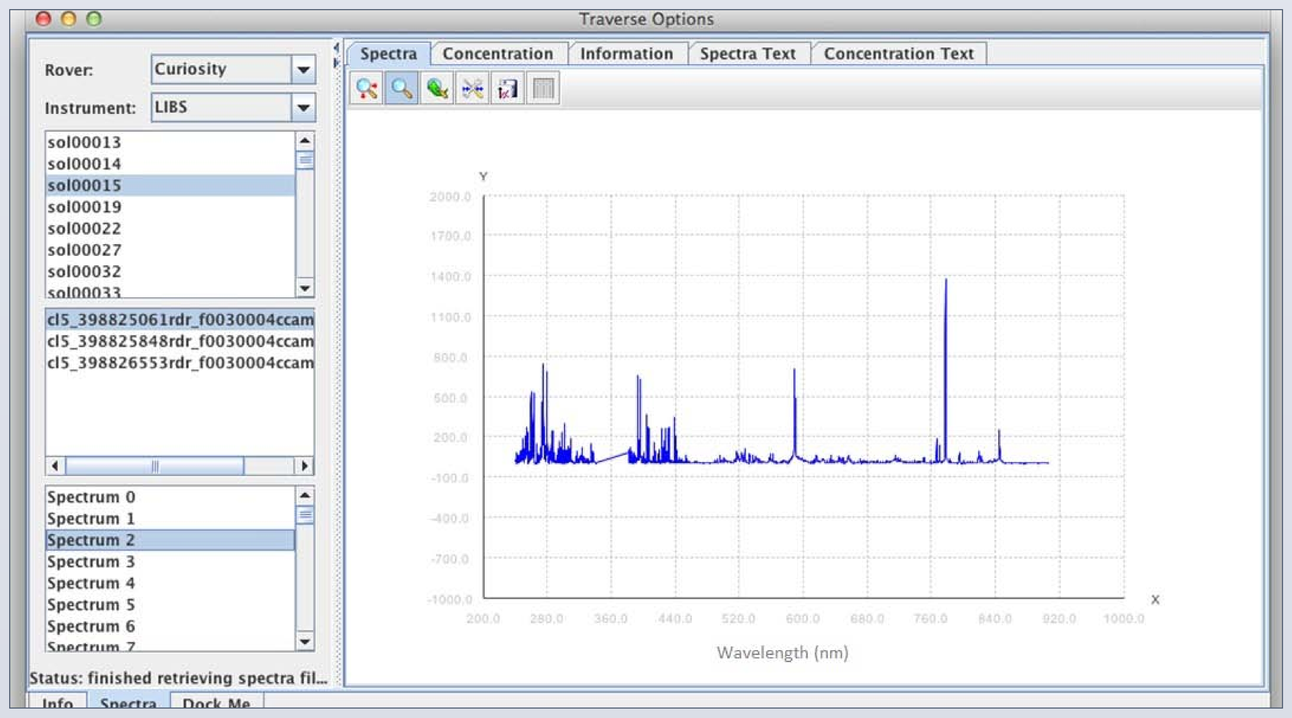

Fig.2 Options panel for the Traverse Layer

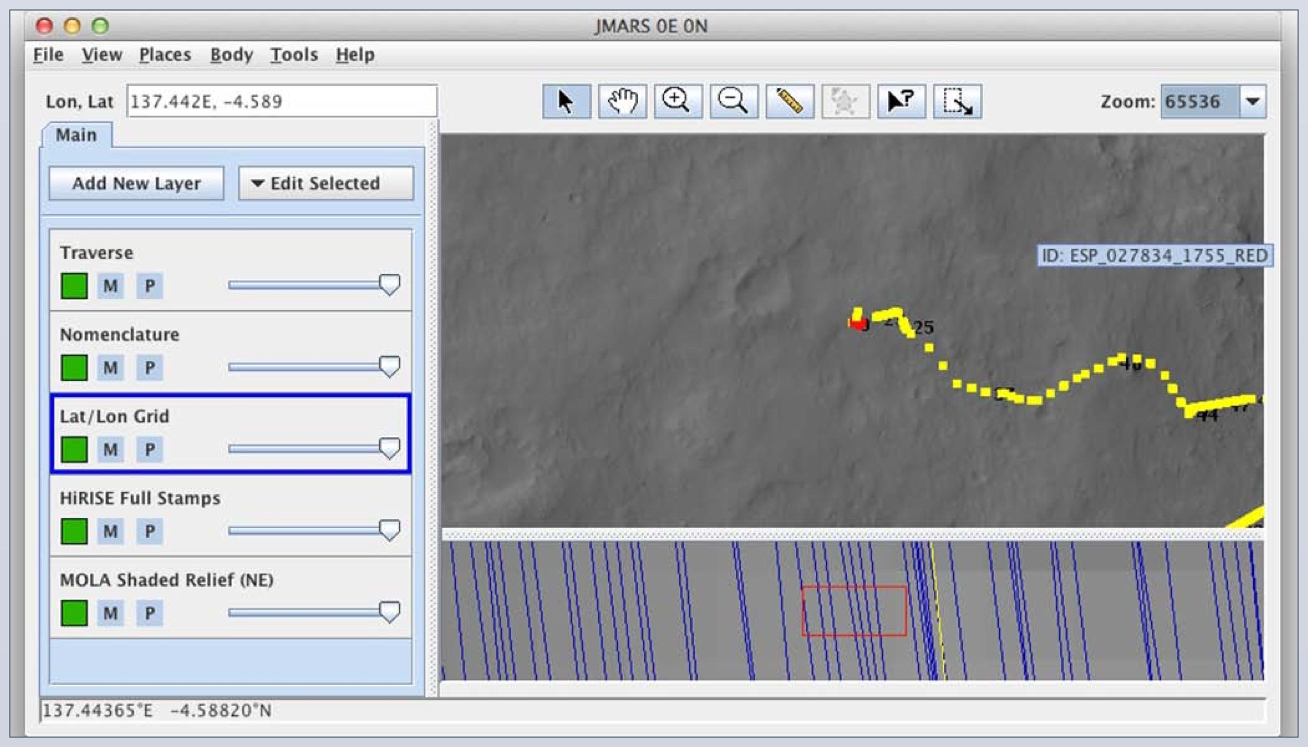

Fig.3 Location highlights (red dots) for the selected sol day.

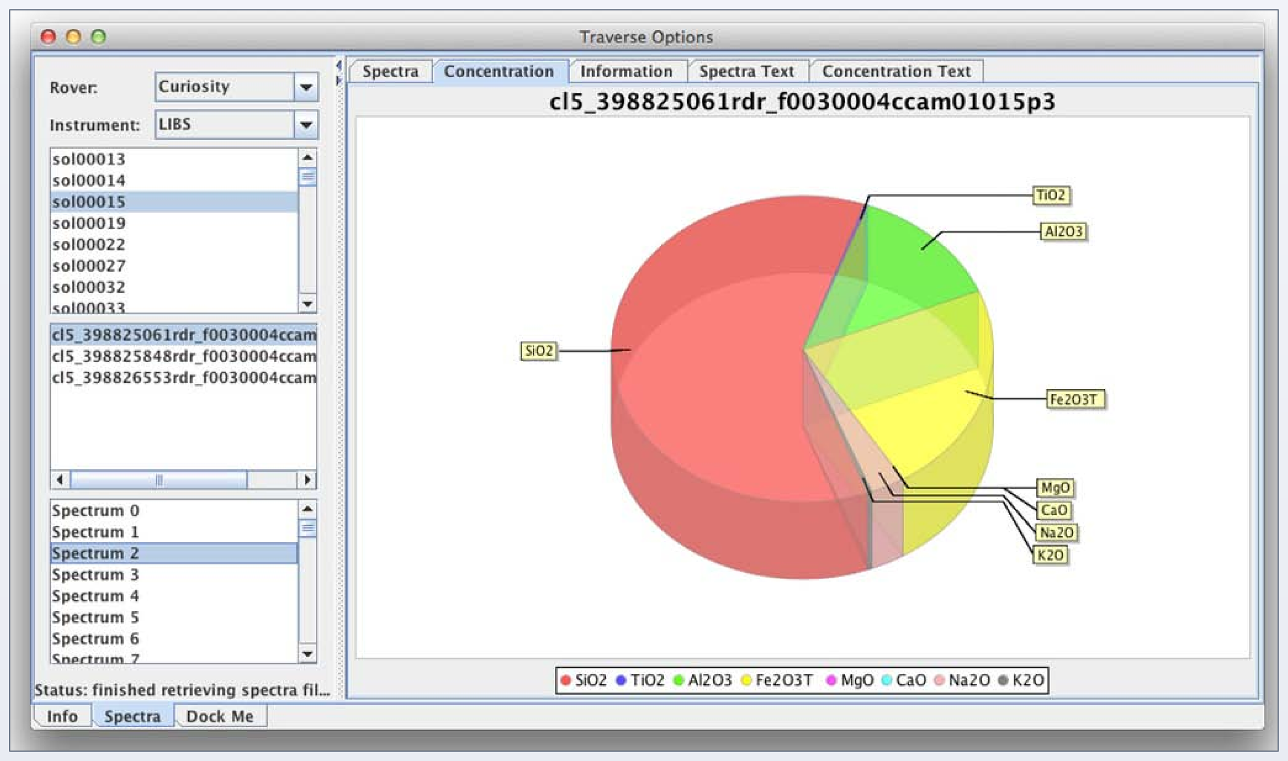

Fig.4 Oxide composition estimations for a selected sol day using ChemCam LIBS measurements (Curiosity rover).

Data used in Traverse Layer

All data were downloaded from PDS Geosciences Node [2]. We collected APXS and LIBS data from three Mars rovers: Spirit, Opportunity and Curiosity. Curiosity corresponds to MSL in the data archive; Spirit corresponds to MER1 and Opportunity corresponds to MER2. To download the data, we use the ftp server. For instance, all Curiosity data can be downloaded from ftp://pds-geosciences.wustl.edu/msl/.

The data have different levels. The lowest level data is binary with the name "edr". The next level name is "rdr", which contains text data. We downloaded rdr data and put those data to our own web server. The hierarchy of data is:

rover -> instrument -> sol -> file -> spectrum

Each higher level item contains multiple low level items. For instance, in each sol, there are multiple measurements saved in different files. In each file, there are multiple spectra. Based on the data hierarchy, we implemented the GUI as shown in Fig. 1.

Oxide composition data tables from Curiosity were downloaded from wustl.edu web server. Because for Spirit and Opportunity, there are no composition data tables, we generated composition estimations for Spirit and Opportunity (APXS data) partially, by utilizing composition estimations in [8] and using composition estimation techniques [7].

Even though traverse maps of the rovers are available [3], to the best of our knowledge, NASA has not released rover traverse data in terms of longitude latitude coordinates. We obtained the desired lat/long coordinates of rover traverses from other sources [4, 5, 6]. The locations for Curiosity in [6] are approximate and in the software they need to be updated with more accurate locations in the future. We then wrote a program to convert the original traverse data to our own format in JSON and used it in our visualization software.

Software Design

JMARS is a software using client server architecture as shown in Fig. 5. The data are stored on the server. The JMARS client handles communication with server and visualizing the data. The communication is through HTTP protocol. Following this architecture, we created a data server with HTTP communication protocol. In JMARS, we developed a layer called Traverse layer which follows JMARS layer API. The traverse layer communicates with our data server and visualizes the data in JMARS software.

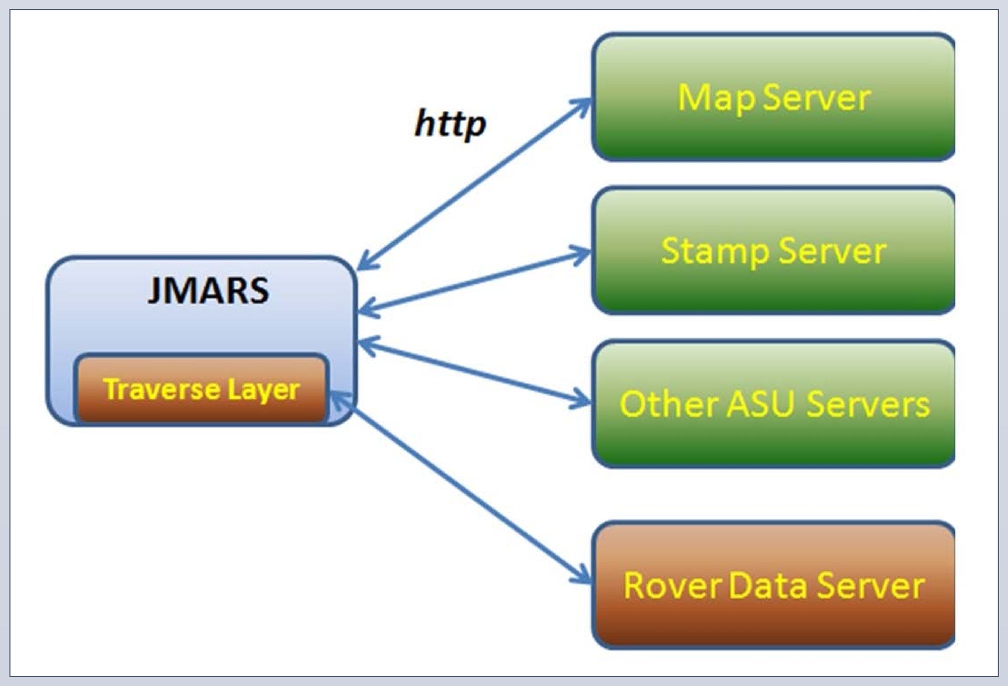

Fig.5 Client server architecture of JMARS and the Traverse Layer / Rover Data Server from SPI (in brown color).

The Traverse layer design is shown in Fig. 6. To ease integration and testing, we implement the spectral visualization GUI in a separate package, net.signalpro.mars.spectra. This package can be a standalone app for visualizing rover spectral data without installing JMARS. On the JMARS side, the traverse layer only implements the code visualizing the rover's traverse map and delegates the spectral visualization task to the spectra GUI package. Fig. 6 shows major components of each package. In essence, we separated the data model, data reader, and data visualization.

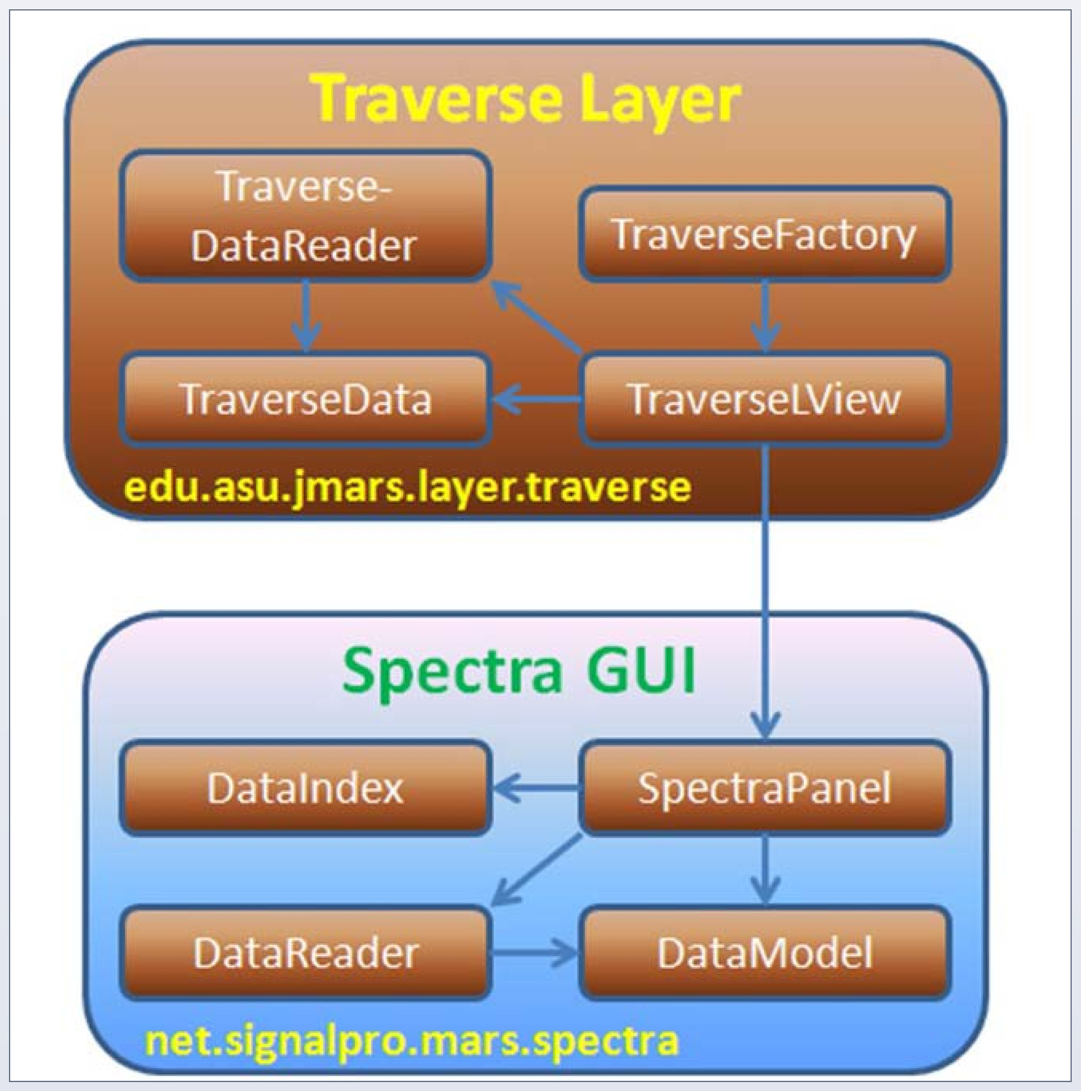

Fig.6 Traverse layer design and the associated spectra GUI.

Future Work

We passed our software to the JMARS team at ASU. We plan to expand the current tool to allow users to program interactive functions such as oxide composition analysis, anomaly detection and visualization. We are interested in collaborating directly with potential users, both to improve the tool and to generate new insights into processes on Mars. Interested users can contact Dr. Chiman Kwan at chiman.kwan@signalpro.net.

References

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