ENHANCEMENT of JMARS. J. Yin[1], B. Ayhan[1], C. Kwan[1] , W. Wang[2], S. Li[2], H. Qi[2], and S. Vance[3] [1]Signal Processing, Inc., 9700 Great Seneca Highway, Rockville, MD 20850, [2]University of Tennessee Knoxville, Min H. Kao Building, Suite 340, 1520 Middle Drive, Knoxville, TN 37996, [3]Jet Propulsion Laboratory, Caltech, Mail Stop 183-601, 4800 Oak Grove Dr., Pasadena, CA 91109.

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]. It provides convenient accessing and visualization of imagery data coming from various Mars missions such as MGS TES, Odyssey THEMIS, MER Mini-TES, and MRO HiRISE. Map and image datasets from Mars missions are generally at the size of terabytes. JMARS breaks each file into small pieces and stores them in the database so data computation and images can be produced quickly.

Chemical composition estimation is one of the important goals of past, present and future Mars rovers. The existing Spirit and Opportunity rovers are equipped with millimeter wave imaging spectrometers to detect the chemical composition in Mars rocks. Each time a rover comes close to a rock, it removes the Martian dust from the surface and takes the images of the rock. The probe continues to carry out the same procedure at different locations of the same rocks in order to collect enough spectral information to extract the features and classify the chemical composition of the rock. It is a time-consuming process to identify a special location which may contain certain abnormal chemical composition in the rock. Recently, NASA scientists found that Laser Induced Breakdown Spectroscopy (LIBS) and Alpha Particle X-ray Spectrometer (APXS) techniques are able to carry out the analysis of the rock's chemical composition on Mars with much better performance. LIBS can detect the chemical composition in a fast pace and APXS can identify the composition with much higher accuracy.

We are developing a Java version of chemical composition detection tool for JMARS package to enhance the current software version, allowing users to examine and analyze collected LIBS spectra. The sample spectra would be processed through a chemical composition estimation system to obtain a list of elemental compositions of the target rocks. Similarly, for any collected APXS spectrum of the rocks or soil samples, the tool will produce a list of elemental composition with more accurate percentages. The soil or rock samples with different characteristics as compared to earlier collections of soil/rock samples will also be detected with this tool. The generated results will then be sent back to JMARS users for display.

Software Overview: The chemical composition detection engines (CCDE) developed by our team are software tools to recognize the chemical composition of rocks through LIBS and APXS systems. The simulation program emulates the rock sample selection process, which locates a number of potential rocks around the rover by using NavCam and HazCam images. The LIBS spectra data are collected from some rocks within the vicinity of the rover. The simulation program then makes use of the functions in CCDE to perform material analysis of the Martian rocks.

In this project, we will place the algorithms of the CCDE in the existing JMARS software. In order to achieve a smooth integration, the new software architecture, modules, and associated elements will follow similar programming structure patterns in the existing JMARS. The CCDE will be embedded in the JMARS as part of the functions in JMARS. Besides, the security, surface maps of MARS and control operations are also directly using the JMARS modules without any additional modification. Any modules from CCDE are converted to JMARS formats in order to conform to the existing software architecture in JMARS.

The architecture of JMARS is based on a client and server structure as shown in Fig. 1. Users will be able to download the client software from the JMARS website and install on their PCs. The client modules have limited computation abilities, and most computtionally intenstive tasks occur on the JMARS servers. The client modules would thus provide a prompt, convenient, and flexible geographical environment for users to explore the surface images from Mars. Modules are programmed in a single Java application for portability purposes. Thus, JMARS clients can run on Windows, SunOS, Mac, and Linux environments without making any changes in the Java codes. The Java Virtual Machine run-time libraries will take care of the portability issues.

On the other hand, the modules in the servers are completely different. Each server module is a separate entity which is assigned to a specific processing task. They are normally installed on a powerful network workstation or cloud. For example, the map server in JMARS uses a Web Map Services (WMS) to provide Mars maps. Since the source code is not available on the Internet, we presume that it must be a large compli-

cated map server where the server can not only store many small pieces of maps in the database, but also can retrieve, transform, and process these maps at a reasonable speed. The computational power of the workstation must thus be sufficiently high. Besides, the server supports many users from all over the world. The quantity of simultaneous network connections to the server must be also high. As a result, JMARS users will seldom feel the traffic.

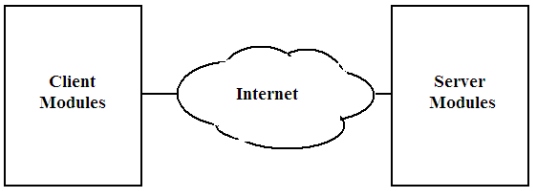

Fig. 1: The basic structure of JMARS.

JMARS with integrated CCDE tools will use the same architecture. The client provides the tool to display the rover route maps, rock/soil composition, and other associated similarity and anomaly measures. When a user chooses to use the functions to study the chemical components of the collected soil/rock samples in a region, the requests are sent to a new map server which contains rover routes, data collection sites, and annotation data. Those items are retrieved and sent back to the JMARS client. The user selects a specific site at the data collection sites to evaluate the chemical composition of the collected data samples at that site. The request is sent to another server which contains the corresponding LIBS and APXS spectra data. The down-sampled spectra and composition estimation results data are sent back to the client for display.

Goal: We are still in the design and development stage. One of the GUIs for spectrum analysis is shown in Fig. 2. The objective of this paper is to present our high level and detailed level system architecture and some preliminary results. We expect to produce a functional prototype by Spring of 2014.

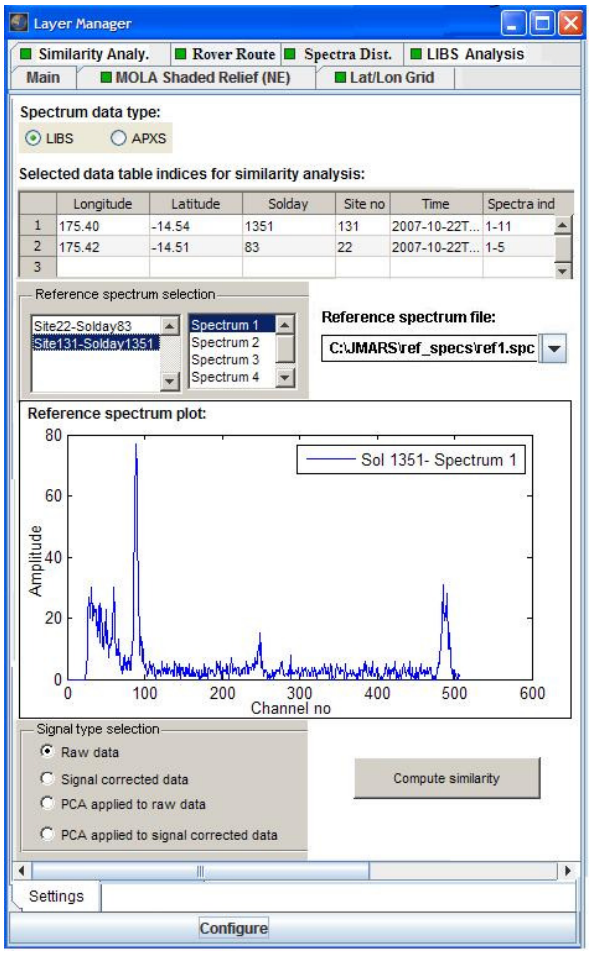

Fig. 2: The proposed GUI for Spectrum Similarity Analysis Layer.

References:

[1] JMARS, https://jmars.mars.asu.edu/.

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