Automated Targeting for the MER Rovers

Tara Estlin, Rebecca Castano, Robert C. Anderson, Daniel Gaines, Benjamin Bornstein,
Charles De Granville, David Thompson, Michael Burl, and Michele Judd
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109
818-393-5344
firstname.lastname@jpl.nasa.gov

The Onboard Autonomous Science Investigation System (OASIS) evaluates geologic data gathered by a planetary rover. The system is designed to operate onboard a rover identifying and reacting to serendipitous science opportunities, such as rocks with novel properties. OASIS operates by analyzing data the rover gathers, and then using machine learning techniques, prioritizing the data based on criteria set by the science team. This prioritization can be used to organize data for transmission back to Earth and it can be used to search for specific targets it has been told to find by the science team. If one of these targets is found, it is identified as a new science opportunity and a "science alert" is sent to a planning and scheduling system. After reviewing the rover's current operational status to ensure that it has enough resources to complete its traverse and act on the new science opportunity, OASIS can change the command sequence of the rover in order to obtain additional science measurements. In this paper we will provide a brief overview of the OASIS system and its past applications. We then introduce a new area of OASIS work, which is to provide autonomous targeting capabilities for remote sensing instruments onboard the Mars Exploration Rovers (MER) mission.

OASIS has already been shown to provide a number of autonomous science capabilities. One is to prioritize gathered images for downlink based on the analysis results. This ensures that the image containing the most novel rock or containing the rock that best matches the scientists' target specification will be given a high priority for downlink. Another capability is to support opportunistic traverse science, where new science targets are dynamically identified in traverse imagery and if resources allow, additional measurements of interesting rocks are scheduled and executed before the rover continues its traverse.

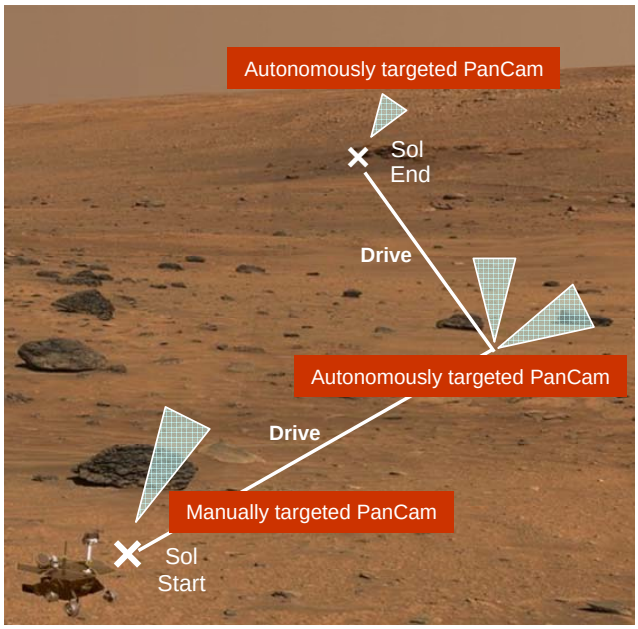

Figure 1 - New MER capability for automated targeting. The OASIS software will enable MER to analyze images onboard to autonomously select and sequence targeted remote-sensing observations using the MER panoramic camera as an example of a limited FOV, remote-sensing instrument.

Currently, OASIS is being applied on a new front. OASIS is providing a new rover mission technology that enables *targeted* remote-sensing science in an automated fashion during or after rover traverses. Currently, targets for remote sensing instruments, especially narrow field-of-view (FOV) instruments (such as the MER Miniature Thermal Emission Spectrometer (Mini-TES) or the 2009 MSL ChemCam Spectrometer) must be selected manually based on imagery already on the ground with the operations team. OASIS will enable the rover flight software to analyze imagery onboard in order to autonomously select and sequence targeted remote-sensing observations in an opportunistic fashion (as shown in Figure 1). This capability is especially useful for multi-sol (i.e., multi-day) plans where a drive is performed on the first sol and only untargeted remote sensing can be before the second and third sols since another communication cycle with Earth has not yet occurred.

This OASIS capability is planned for upload to the MER Rovers in Spring 2009. Since the Mini-TES spectrometer is no longer functioning on the MER Opportunity rover and is not expected to last much longer on the MER Spirit rover, the OASIS automated targeting capability will be demonstrated using the MER Panoramic Cameras. To better represent a limited FOV instrument, the Panoramic Cameras will be used to acquire sub-framed, high resolution images of selected targets. When run, OASIS will perform the following tasks: 1) identify an interesting science target (based on parameter settings from scientists) in imagery from the MER Navigation Cameras and 2) schedule an opportunistic response where high-resolution, subframed Panoramic Camera image is taken of the selected target. The resulting Panoramic Camera image will be downlinked with other standard MER data products.