tle impact to missions otherwise. Diagnostic information could then be transmitted to experienced technicians on the ground in a timely manner to determine whether pressure vessels have been impacted, are structurally unsound, or can be safely used to complete the mission.

This work was done by Don J. Roth and Charles T. Nichols of Glenn Research Center, and was sponsored by the NASA Nondestructive Evaluation Working Group. Further information is contained in a TSP (see page 1).

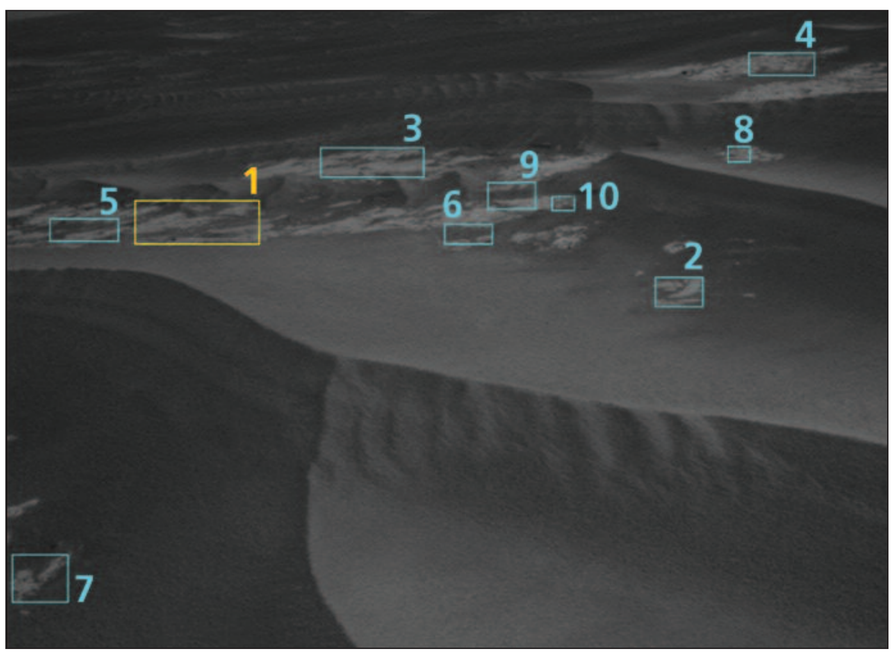
Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-19032-1

The **Front Panel** is divided into the following main sections: (1) Run-time menu; File, Options, Help; (2) AE & Fast Fourier Transform graphs; (3) AE analysis settings; and (4) AE statistics.

Memory-Efficient Onboard Rock Segmentation

NASA's Jet Propulsion Laboratory, Pasadena, California

Rockster-MER is an autonomous perception capability that was uploaded to the Mars Exploration Rover Opportunity in December 2009. This software provides the vision front end for a larger software system known as AEGIS (Autonomous Exploration for Gathering Increased Science), which was recently named 2011 NASA Software of the Year. As the first step in AEGIS, Rockster-MER analyzes an image captured by the rover, and detects and automatically identifies the boundary contours of rocks and regions of outcrop present in the scene. This initial segmentation step reduces the data volume from millions of pixels into hundreds (or fewer) of rock contours. Subsequent stages of AEGIS then prioritize the best rocks according to scientist-defined preferences and take high-resolution, follow-up observations (see figure). Rockster-MER has performed robustly from the outset on the Mars surface under challenging conditions.



The **top ten objects** detected by Rockster-MER running onboard the Opportunity rover on Sol 2221. Note: Rockster-MER detects and segments the objects; the ranking is provided by AEGIS according to a set of scientist-specified attribute weightings.

Rockster-MER is a specially adapted, embedded version of the original Rockster algorithm ("Rock Segmentation Through Edge Regrouping," (NPO-44417) *Software Tech Briefs*, September 2008, p. 25). Although the new version performs the same basic task as the original code, the software has been (1) significantly upgraded to overcome the severe onboard resource limitations (CPU, memory, power, time) and (2) "bullet-proofed" through code reviews and extensive testing and profiling to avoid the occurrence of faults. Because of the limited computational power of the RAD6000 flight processor on Opportunity (roughly two orders of magnitude slower than a modern workstation), the algorithm was heavily tuned to improve its speed. Several functional elements of the original algorithm were removed as a result of an extensive cost/benefit analysis conducted on a large set of archived rover images. The algorithm was also required to operate below a stringent 4MB high-water memory ceiling; hence, numerous tricks and strategies were introduced to reduce the memory footprint. Local filtering operations were re-coded to operate on horizontal data stripes across the image. Data types were reduced to smaller sizes where possible. Binary-valued intermediate results were squeezed into a more compact, one-bit-per-pixel representation through bit packing and bit manipulation macros. An estimated 16-fold reduction in memory footprint relative to the original Rockster algorithm was achieved. The resulting memory footprint is less than four times the base image size. Also, memory allocation calls were modified to draw from a static pool and consolidated to reduce memory management overhead and fragmentation.

Rockster-MER has now been run onboard Opportunity numerous times as part of AEGIS with exceptional performance. Sample results are available on the AEGIS website at http://aegis.jpl.nasa.gov.

This work was done by Michael C. Burl, David R. Thompson, Benjamin J. Bornstein, and Charles K. deGranville of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

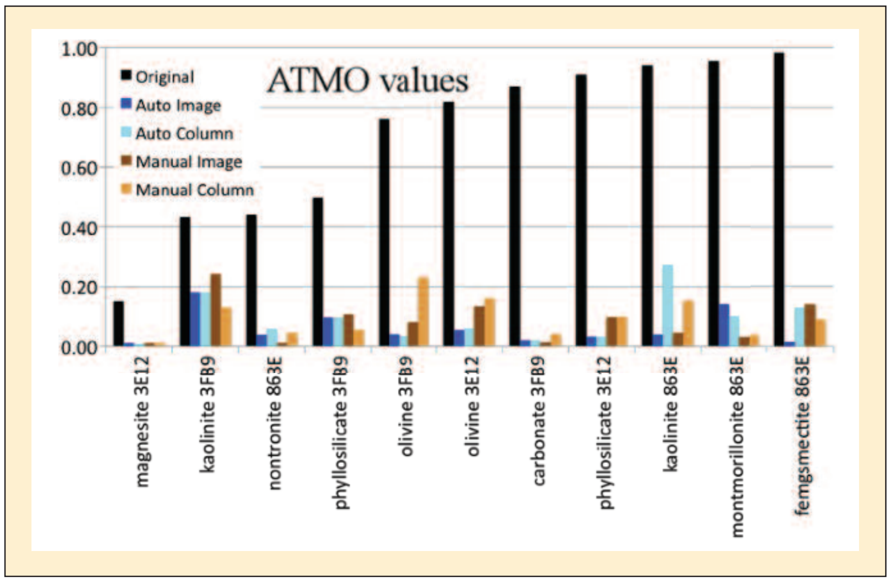
This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-47954.

Advanced Multimission Operations System (ATMO)

NASA's Jet Propulsion Laboratory, Pasadena, California

The HiiHat toolbox developed for CAT/ENVI provides principal investigators direct, immediate, flexible, and seamless interaction with their instruments and data from any location. Offering segmentation and neutral region division, it facilitates the discovery of key endmembers and regions of interest larger than a single pixel.

Crucial to the analysis of hyperspectral data from Mars or Earth is the removal of unwanted atmospheric signatures. For Mars and the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), residual atmospheric CO_2 absorption is both directly problematic and indicative of processing errors with implications to the scientific utility of any particular image region. Estimating this residual error becomes key both in selecting regions of low distortion, and also to select mitigating methods, such as neutral region division. This innovation, the ATMO estimator, provides a simple, 0-1 normalized scalar that estimates this distortion (see figure). The metric is defined as the coefficient of determination of a quadratic fit in the region of distorting atmospheric absorption (≈2 μm). This mimics the behavior of existing CRISM team mineralogical indices to estimate the presence of known, interesting mineral signatures. This facilitates the ATMO metric's assimilation into existing planetary geology workflows.



Automatic Method matches manual for atmospheric correction.

This work was done by Lukas Mandrake and David R. Thompson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-47670.

Robot Sequencing and Visualization Program (RSVP)

NASA's Jet Propulsion Laboratory, Pasadena, California

The Robot Sequencing and Visualization Program (RSVP) is being used in the Mars Science Laboratory (MSL) mission for downlink data visualization and command sequence generation. RSVP reads and writes downlink data products from the operations data server (ODS) and writes uplink data products to the ODS. The primary users of RSVP are members of the Rover Planner team (part of the Integrated Planning and Execution Team (IPE)), who use it to perform traversability/articulation analyses, take activity plan input from the Science and Mission Planning teams, and create a set of rover sequences to be sent to the rover every sol (see figure).

The primary inputs to RSVP are downlink data products and activity plans in the ODS database. The primary outputs are command sequences to be placed in