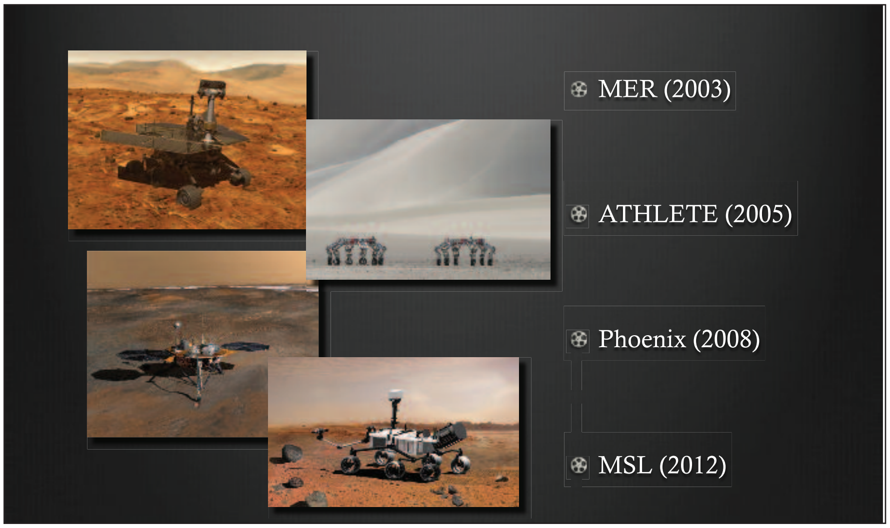


Missions using RSVP.

the ODS for further processing prior to uplink to each rover. RSVP is composed of two main subsystems. The first, called the Robot Sequence Editor (RoSE), understands the MSL activity and command dictionaries and takes care of converting incoming activity level inputs into command sequences. The Rover Planners use the RoSE component of RSVP to put together command sequences and to view and manage command level resources like time, power, temperature, etc. (via a transparent real-time connection to SEQGEN).

The second component of RSVP is called HyperDrive, a set of high-fidelity computer graphics displays of the Martian surface in 3D and in stereo. The Rover Planners can explore the environment around the rover, create commands related to motion of all kinds, and see the simulated result of those commands via its underlying tight coupling with flight navigation, motor, and arm software. This software is the evolutionary replacement for the Rover Sequencing and Visualization software used to create command sequences (and visualize the Martian surface) for the Mars Exploration Rover mission.

This work was done by Brian K. Cooper, Scott A. Maxwell, Frank R. Hartman, John R. Wright, Jeng Yen, Nicholas T. Toole, and Zareh Gorjian of Caltech; and Jack C. Morrison of Northrop Grumman for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

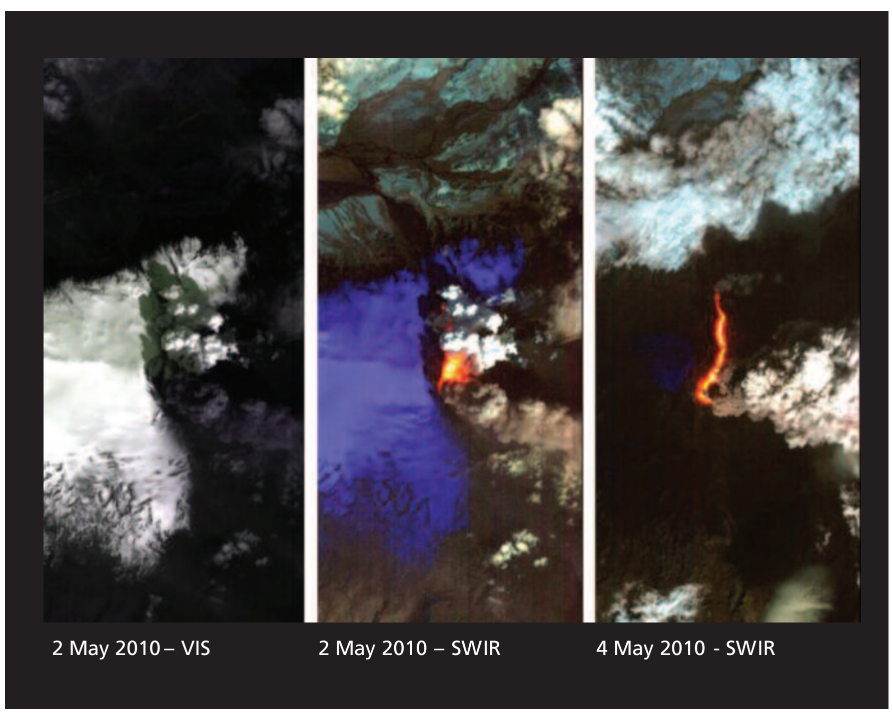
This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-48690.

Automating Hyperspectral Data for Rapid Response in Volcanic Emergencies

NASA's Jet Propulsion Laboratory, Pasadena, California

In a volcanic emergency, time is of the essence. It is vital to quantify eruption parameters (thermal emission, effusion rate, location of activity) and distribute this information as quickly as possible to decision-makers in order to enable effective evaluation of eruption-related risk and hazard. The goal of this work was to automate and streamline processing of spacecraft hyperspectral data, automate product generation, and automate distribution of products.

The software rapidly processes hyperspectral data, correcting for incident sunlight where necessary, and atmospheric transmission; detects thermally anomalous pixels; fits data with model black-body thermal emission spectra to determine radiant flux; calculates atmospheric convection thermal removal; and then calculates total heat loss. From these results, an estimation of effusion rate is made. Maps are generated of thermal emission and location (see figure). Products are posted online, and relevant parties notified. Effusion rate data are added to historical record and



Visible and Short-Wave Infrared Images of volcanic eruption in Iceland in May 2010.

plotted to identify spikes in activity for persistently active eruptions. The entire process from start to end is autonomous.

Future spacecraft, especially those in deep space, can react to detection of transient processes without the need to communicate with Earth, thus increasing science return. Terrestrially, this removes the need for human intervention.

This work was done by Ashley G. Davies, Joshua R. Doubleday, and Steve A. Chien 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-48123.

Raster-Based Approach to Solar Pressure Modeling

Combinations of simple geometry yield answers to complex light pressure problems.

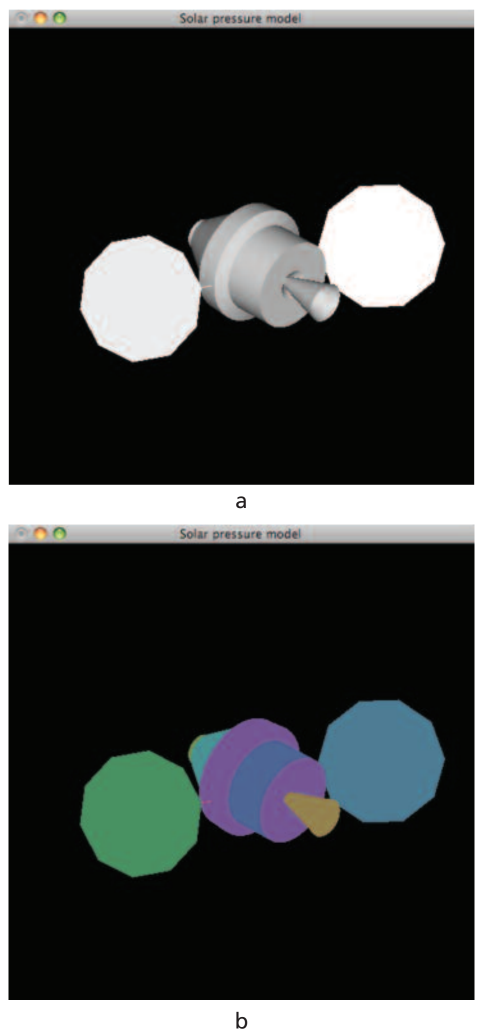
John H. Glenn Research Center, Cleveland, Ohio

An algorithm has been developed to take advantage of the graphics processing hardware in modern computers to efficiently compute high-fidelity solar pressure forces and torques on spacecraft, taking into account the possibility of self-shading due to the articulation of spacecraft components such as solar arrays. The process is easily extended to compute other results that depend on three-dimensional attitude analysis, such as solar array power generation or free molecular flow drag.

The impact of photons upon a spacecraft introduces small forces and moments. The magnitude and direction of the forces depend on the material properties of the spacecraft components being illuminated. The parts of the components being lit depends on the orientation of the craft with respect to the Sun, as well as the gimbal angles for any significant moving external parts (solar arrays, typically). Some components may shield others from the Sun.

The purpose of this innovation is to enable high-fidelity computation of solar pressure and power generation effects of illuminated portions of spacecraft, taking self-shading from spacecraft attitude and movable components into account. The key idea in this innovation is to compute results dependent upon complicated geometry by using an image to break the problem into thousands or millions of sub-problems with simple geometry, and then the results from the simpler problems are combined to give high-fidelity results for the full geometry.

This process is performed by constructing a 3D model of a spacecraft using an appropriate computer language (OpenGL), and running that model on a modern computer's 3D accelerated video processor. This quickly and accurately generates a view of the model (as shown on a computer screen) that takes rotation and articulation of spacecraft components into account. When this view is interpreted as the spacecraft as seen by the Sun, then only the portions of the craft visible in the view are illuminated.



A typical view (a) of the **Crew Exploration Vehicle** (CEV) with the solar array gimbals optimized to point the arrays in the Sun direction, and (b) a view of the CEV with surfaces color-coded to help identify spacecraft material properties.

The view as shown on the computer screen is composed of up to millions of pixels. Each of those pixels is associated with a small illuminated area of the spacecraft. For each pixel, it is possible to compute its position, angle (surface normal) from the view direction, and the spacecraft material (and therefore, optical coefficients) associated with that area. With this information, the area associated with each pixel can be modeled as a simple flat plate for calculating solar pressure. The vector sum of these individual flat plate models is a high-fidelity approximation of the solar pressure forces and torques on the whole vehicle.

In addition to using optical coefficients associated with each spacecraft material to calculate solar pressure, a power generation coefficient is added for computing solar array power generation from the sum of the illuminated areas. Similarly, other area-based calculations, such as free molecular flow drag, are also enabled.

Because the model rendering is separated from other calculations, it is relatively easy to add a new model to explore a new vehicle or mission configuration. Adding a new model is performed by adding OpenGL code, but a future version might read a mesh file exported from a computer-aided design (CAD) system to enable very rapid turnaround for new designs

This work was done by Theodore W. Wright II of Glenn Research Center. For more information, contact kimberly.a.dalgleish@nasa.gov.

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-19019-1.