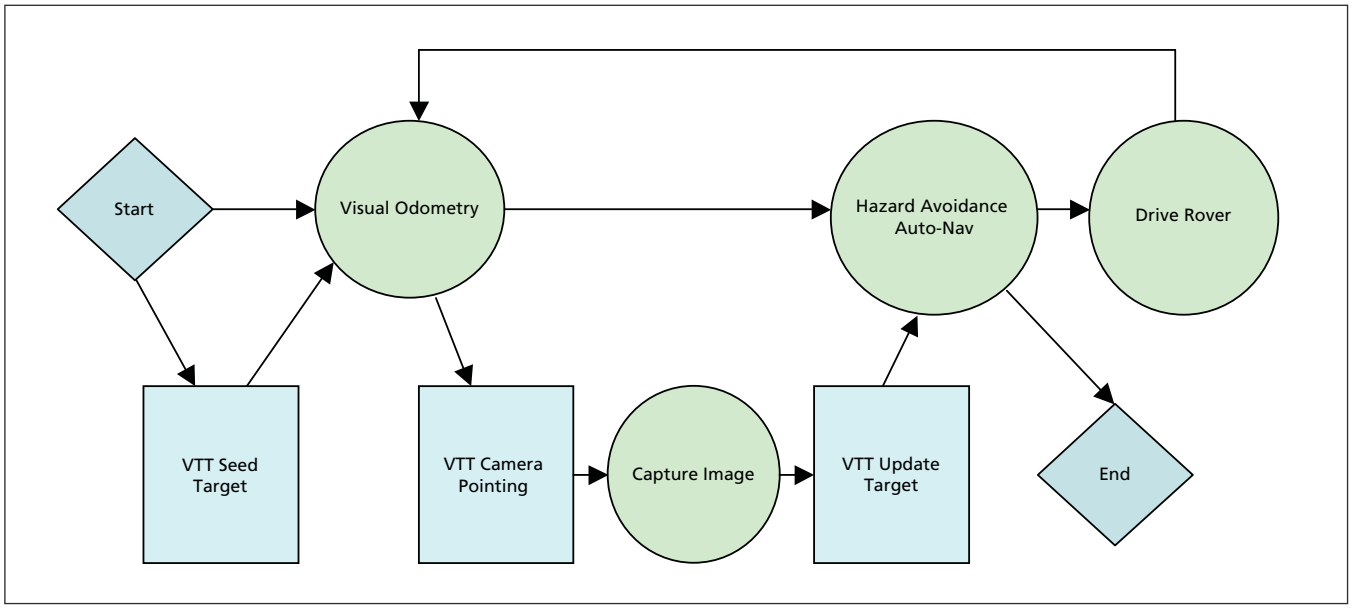

Functional Flow of VTT integrated into MER flight software. VTT module functions (square boxes) are additions to the existing MER flight software (circles).

Artistic Rendition of MER.

Each VTT update takes about 50 seconds. VTT has helped to make it possible to approach a target over a 10-m traverse and place an instrument on the target during a single sol, whereas previously, such approach and placement took 3 sols. Alternatively, VTT can be used to simply image a target as the rover passes it. VTT can be used in conjunction with any combination of blind driving, autonomous navigation with hazard avoidance, and/or visual odometry.

This program was written by Won Kim, Jeffrey Biesiadecki, and Khaled Ali of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45019.

SPICE Module for the Satellite Orbit Analysis Program (SOAP)

NASA's Jet Propulsion Laboratory, Pasadena, California

A SPICE module for the Satellite Orbit Analysis Program (SOAP) precisely represents complex motion and maneuvers in an interactive, 3D animated environment with support for user-defined quantitative outputs. ("SPICE" stands for Spacecraft, Planet, Instrument, Camera-matrix, and Events). This module enables the SOAP software to exploit NASA mission ephemeris represented in the JPL Ancillary Information Facility (NAIF) SPICE formats. Ephemeris types supported include position, velocity, and orientation for spacecraft and planetary bodies including the Sun, planets, natural satellites, comets, and asteroids. Entire missions can now be imported into SOAP for 3D visualization, playback, and analysis.

The SOAP analysis and display features can now leverage detailed mission files to offer the analyst both a numerically correct and aesthetically pleasing combination of results that can be varied to study many hypothetical scenarios. The software provides a modeling and simulation environment that can encompass a broad variety of problems using orbital prediction. For example, ground coverage analysis, communications analysis, power and thermal analysis, and 3D visualization that provide the user with insight into complex geometric relations are included.

The SOAP SPICE module allows distributed science and engineering teams to share common mission models of

known pedigree, which greatly reduces duplication of effort and the potential for error. The use of the software spans all phases of the space system lifecycle, from the study of future concepts to operations and anomaly analysis. It allows SOAP software to correctly position and orient all of the principal bodies of the Solar System within a single simulation session along with multiple spacecraft trajectories and the orientation of mission payloads. In addition to the 3D visualization, the user can define numeric variables and *x*–*y* plots to quantitatively assess metrics of interest.

This work was done by Robert Carnright and Claude Hildebrand of Caltech and David Stodden and John Coggi of The Aerospace Corporation for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45057.

Facilitating Analysis of Multiple Partial Data Streams

NASA's Jet Propulsion Laboratory, Pasadena, California

Robotic Operations Automation: Mechanisms, Imaging, Navigation report Generation (ROAMING) is a set of computer programs that facilitates and accelerates both tactical and strategic analysis of time-sampled data — especially the disparate and often incomplete streams of Mars Explorer Rover (MER) telemetry data described in the immediately preceding article. As used here, "tactical" refers to the activities over a relatively short time (one Martian day in the original MER application) and "strategic" refers to a longer time (the entire multi-year MER missions in the original application).

Prior to installation, ROAMING must be configured with the types of data of interest, and parsers must be modified to understand the format of the input data (many example parsers are provided, including for general CSV files). Thereafter, new data from multiple disparate sources are automatically resampled into a single common annotated spreadsheet stored in a readable space-separated format, and these data can be processed or plotted at any time scale. Such processing or plotting makes it possible to study not only the details of a particular activity spanning only a few seconds, but also longer-term trends. ROAMING makes it possible to generate mission-wide plots of multiple engineering quantities [e.g., vehicle tilt as in Figure 1(a), motor current, numbers of images] that, heretofore could be found only in thousands of separate files.

ROAMING also supports automatic annotation of both images and graphs. In the MER application, labels given to terrain features by rover scientists and engineers are automatically plotted in all received images based on their associated camera models (see Figure 2), times measured in seconds are mapped to Mars local time, and command names or arbitrary time-labeled events can be used to label engineering plots, as in Figure 1(b).

This work was done by Mark W. Maimone and Robert R. Liebersbach of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45367.

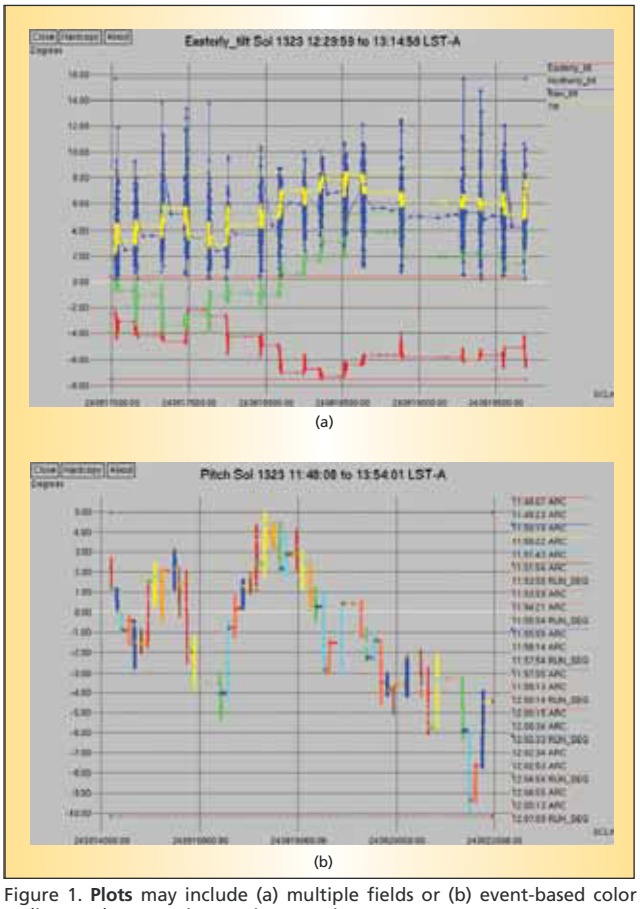

Figure 1. **Plots** may include (a) multiple fields or (b) event-based color coding, and support interactive zooming.

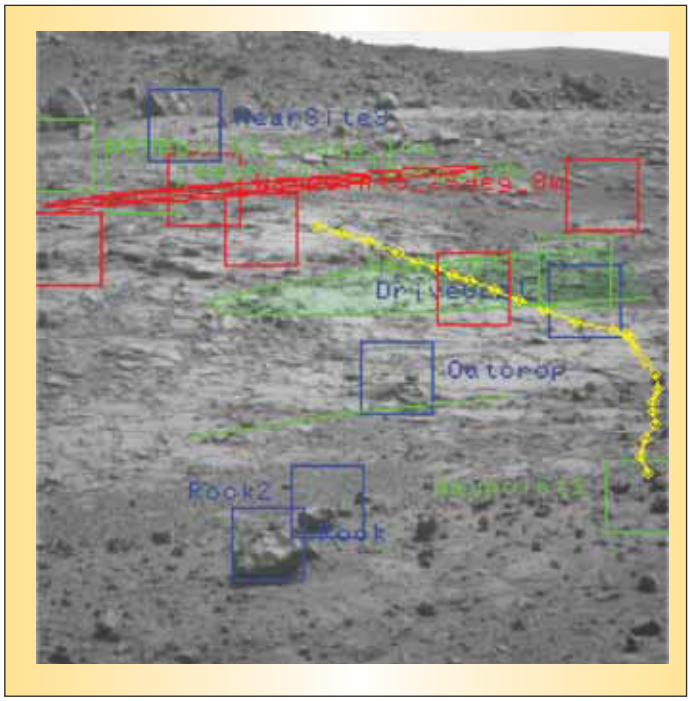

Figure 2. **Images** are automatically annotated with detailed drive information.