This project provides a better onboard tool for the crew to safely test ideas for reconfigurations before calling the ground, and send the changes directly. The layout provides clear detail for power channels, module locations, and data ports, and allows for intuitive "drag-and-drop" connections from the database. The software will allow only compatible connections to occur, and will flag violations if they exist. It also allows the user to flag unique constraints that might not be caught by the software's existing rules and calculations.

The PiP Tool includes reporting capabilities that allow the user to export database information and configuration information to Excel to share with others or run detailed comparisons and searches as needed.

This work was done by Kathleen E. Andrea-Liner, Brion J. Au, Blake R. Fisher, Watchara Rodbumrung, Jeffrey C. Hamic, Kary Smith, and David S.Beadle of the United Space Alliance for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24872-1

Frequency Correction for MIRO Chirp Transformation Spectroscopy Spectrum

NASA's Jet Propulsion Laboratory, Pasadena, California

This software processes the flyby spectra of the Chirp Transform Spectrometer (CTS) of the Microwave Instrument for Rosetta Orbiter (MIRO). The tool corrects the effect of Doppler shift and local-oscillator (LO) frequency shift during the flyby mode of MIRO operations. The frequency correction for CTS flyby spectra is performed and is integrated with multiple spectra into a high signal-to-noise averaged spectrum at the rest-frame RF frequency. This innovation also generates the 8 molecular line spectra by dividing continuous 4,096-channel CTS spectra. The 8 line spectra can then be readily used for scientific investigations.

A spectral line that is at its rest frequency in the frame of the Earth or an asteroid will be observed with a time-varying Doppler shift as seen by MIRO. The frequency shift is toward the higher RF frequencies on approach, and toward lower RF frequencies on departure. The magnitude of the shift depends on the flyby velocity. The result of time-varying Doppler shift is that of an observed spectral line will be seen to move from channel to channel in the CTS spectrometer. The direction (higher or lower frequency) in the spectrometer depends on the spectral line frequency under consideration. In order to analyze the flyby spectra, two steps are required. First, individual spectra must be corrected for the Doppler shift so that individual spectra can be superimposed at the same rest frequency for integration purposes. Second, a correction needs to be applied to the CTS spectra to account for the LO frequency shifts that are applied to asteroid mode.

This work was done by Seungwon Lee 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 Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47304.

Nonlinear Estimation Approach to Real-Time Georegistration from Aerial Images

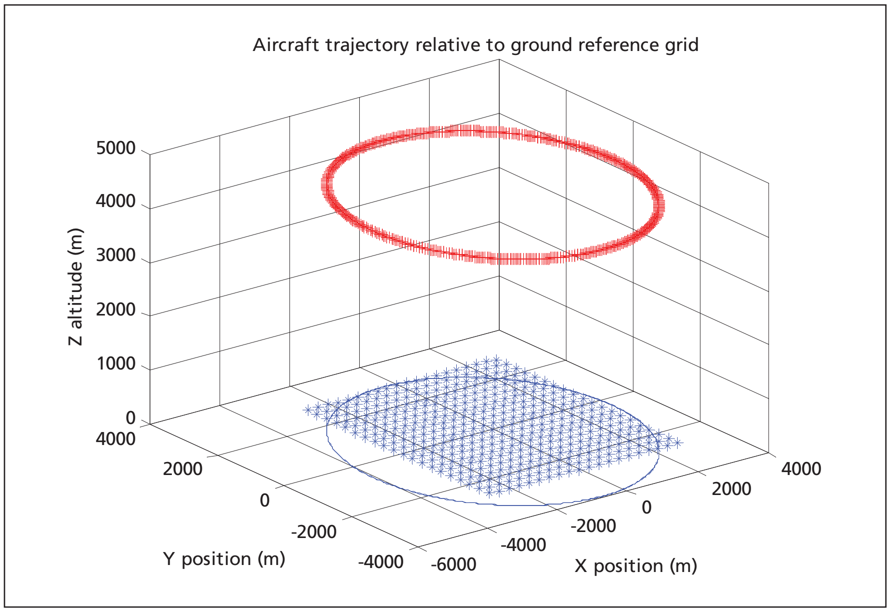
This technology can be used for real-time search and rescue operations and surveillance applications using cameras mounted on aircraft or UAVs.

NASA's Jet Propulsion Laboratory, Pasadena, California

When taking aerial images, it is important to know locations of specific points of interest in an Earth-centered coordinate system (latitude, longitude, height) (see figure). The correspondence between a pixel location in the image and its Earth coordinate is known as georegistration. There are two main technical challenges arising in the intended application. The first is that no known features are assumed to be available in any of the images. The second is that the intended applications are real time. Here, images are taken at regular intervals (i.e. once per second), and it is desired to make decisions in real time based on the geolocation of specific objects seen in the images as they arrive. This is in sharp contrast to most current methods for geolocation that operate "after-the-fact" by processing, on the ground, a database of stored images using computationally intensive methods.

The solution is a nonlinear estimation algorithm that combines processed real-time camera images with vehicle position and attitude information obtained from an onboard GPS receiver. This approach provides accurate georegistration estimates (latitude, longitude, height) of arbitrary features and/or points of interest seen in the camera images. This solves the georegistration problem at the modest cost of augmenting the camera information with a GPS receiver carried onboard the vehicle.

The nonlinear estimation algorithm is based on a linearized Kalman filter structure that carries 19 states in its current implementation. Six of the 19 states are calibration parameters associated with the initial camera pose. One of the states calibrates the scale factor associated with all camera-derived information. The remaining 12 states are used to model the current kinematic state of the vehicle (position, velocity, acceleration, and attitude).



Aircraft Trajectory relative to ground reference gid.

The new georegistration approach was validated by computer simulation based on an aircraft flying at a speed of 70 m/s in a 3-km radius circle at an altitude of 15,000 ft (≈4,600 m), using a camera pointed at the ground toward the center of the circle. Results from using the nonlinear estimation algorithm, in combination with GPS and camera images taken once per second, indicate that after 20 minutes of operation, real-time georegistration errors are reduced to values of less than 2 m, 1 sigma, on the ground.

The new method is very modular and cleanly separates computer vision functions from optimal estimation functions. This allows the vision and estimation functions to be developed separately, and leverages the power of modern estimation theory to fuse information in an optimal manner. Heuristics are avoided, which are generally suboptimal, as are other methods that require human-in-the-loop intervention, ad hoc parameter weightings, and awkward stitching together of various types of data.

The work is applicable to any scientific or engineering application that requires finding the geolocation of specific objects seen in a sequence of camera images. For example, in a surveying application, the precise location and height of a mountain peak can be determined by having an airplane take aerial images while circling around it.

This work was done by David S. Bayard and Curtis W. Padgett of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

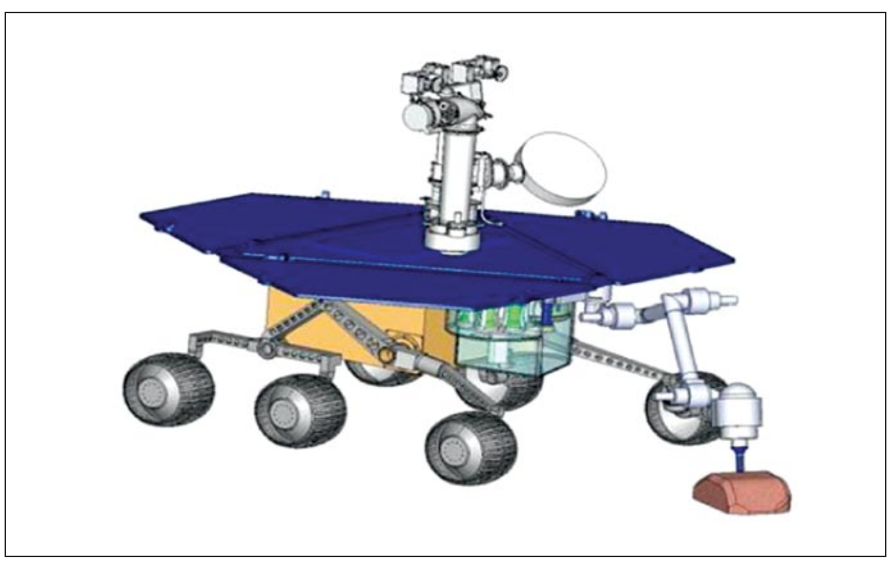
This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47255.

Optimal Force Control of Vibro-Impact Systems for Autonomous Drilling Applications

A method is investigated how to maximize energy transfer to tools used in drilling, and can be applied to regular power tools.

NASA's Jet Propulsion Laboratory, Pasadena, California

The need to maintain optimal energy efficiency is critical during the drilling operations performed on future and current planetary rover missions (see figure). Specifically, this innovation seeks to solve the following problem. Given a spring-loaded percussive drill driven by a voice-coil motor, one needs to determine the optimal input voltage waveform (periodic function) and the optimal hammering period that minimizes the dissipated energy, while ensuring that the hammer-to-rock impacts are made with sufficient (user-defined) impact velocity (or impact energy).



Planetary Rover equipped with a rotary percussive drill.

To solve this problem, it was first observed that when voice-coil-actuated percussive drills are driven at high power, it is of paramount importance to ensure that the electrical current of the device remains in phase with the velocity of the