

The application itself consists of two unique applications running in the ARINC 653 system: a target application and the FAILSAFE model-based health monitoring application. The target application is a high-level simulation of the Shuttle Abort Control System (ACS), developed specifically for this task. The target application is a two-partition application with one partition allocated to the sequencing behavior, and one partition allocated to the application I/O. The health monitor application executes in its own partition. The three application partitions communicate via ARINC 653 ports and message queues, which are specified in the system module.xml configuration file. Real-time system data is provided to the health monitor via the use of ARINC 653 sampling ports that al-

lows the health monitor application to intercept any traffic coming across the ports of interest.

This task was turned into a goal-based function that, when working in concert with the software health manager, aims to work around software and hardware problems in order to maximize abort performance results. In order to make it a compelling demonstration for current aerospace initiatives, the prototype has been additionally imposed on a number of requirements derived from NASA's Constellation Program.

Lastly, the ARINC 653 standard imposes a number of requirements on the system integrator for developing the requisite error handler process. Under ARINC 653, the health monitoring (HM) service is invoked by an applica-

tion calling the application error service, or by the operating system or hardware detecting a fault. It is these HM and error process details that are implemented with the MDS technology, showing how a static-analytic approach is appropriate for identifying fault determination details, and showing how the framework supports acting upon state estimation and control features in order to achieve safety-related goals.

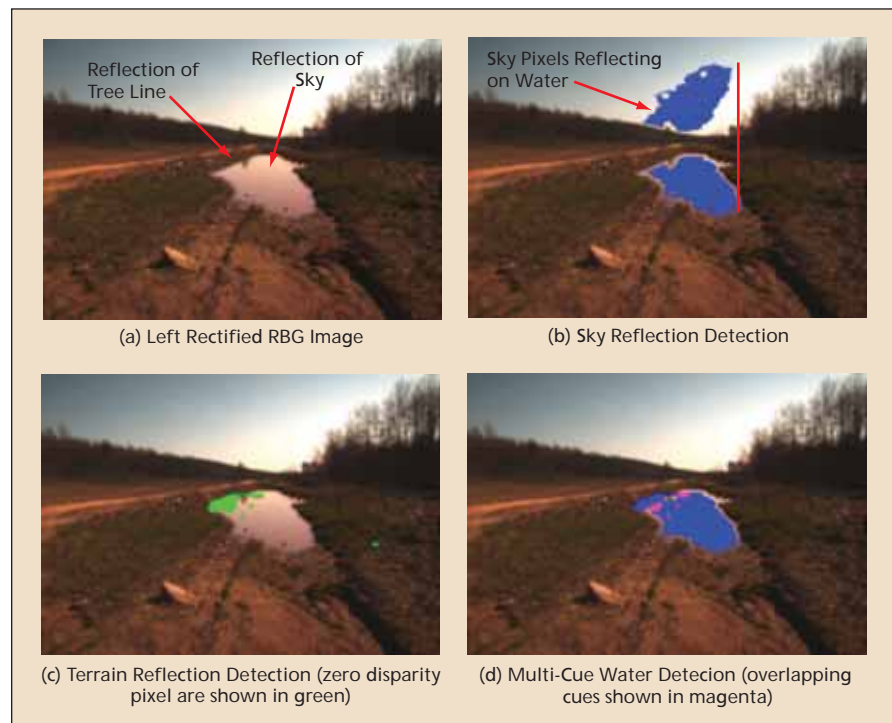
This work was done by Gregory A. Horvath, David A. Wagner, and Hui Ying Wen of Caltech and Matthew Barry of Kestrel Technology for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46981.

Water Detection Based on Sky Reflections

NASA's Jet Propulsion Laboratory, Pasadena, California

This software has been designed to detect water bodies that are out in the open on cross-country terrain at mid- to far-range (approximately 20–100 meters), using imagery acquired from a stereo pair of color cameras mounted on a terrestrial, unmanned ground vehicle (UGV). Non-traversable water bodies, such as large puddles, ponds, and lakes, are indirectly detected by detecting reflections of the sky below the horizon in color imagery. The appearance of water bodies in color imagery largely depends on the ratio of light reflected off the water surface to the light coming out of the water body. When a water body is far away, the angle of incidence is large, and the light reflected off the water surface dominates. We have exploited this behavior to detect water bodies out in the open at mid- to far-range. When a water body is detected at far range, a UGV's path planner can begin to look for alternate routes to the goal position sooner, rather than later. As a result, detecting water hazards at far range generally reduces the time required to reach a goal position during autonomous navigation. This software implements a new water detector based on sky reflections that geometrically locates the exact pixel in the sky that is reflecting on a candidate water pixel on the ground, and predicts if the ground pixel is water based on color similarity and local terrain features (see figure).



Water is Detected indirectly by detecting sky and terrain reflections.

Assuming a water body can be modeled as a horizontal mirror, a ray of incident light reflected off the surface of a water body enters a pixel of a camera's focal plane array (FPA). Since the angle of incidence is equal to the angle of reflection (according to the law of reflection), a direct ray from the tail of the incident ray (and within the same

vertical plane as the incident ray) will enter the camera's FPA at a pixel whose color will indicate the color of the sky being reflected along the reflected ray. Because the distance between the camera and the sky is much larger than the distance between the camera and candidate water points at normal detection ranges, the direct ray and the incident

ray will be nearly parallel, and the angle between the direct ray and the reflected ray can be approximated as two times the glancing angle. Calculations to locate the pixel a direct ray enters are simple and involve for any candidate water pixel conversion of the 2D

image coordinates to a 3D unit vector, negation of the z component of the unit vector, and conversion of the modified unit vector back to 2D image coordinates.

This work was done by Arturo L. Rankin and Larry H. Matthies 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-47092.

Nonlinear Combustion Instability Prediction

Marshall Space Flight Center, Alabama

The liquid rocket engine stability prediction software (LCI) predicts combustion stability of systems using LOX-LH₂ propellants. Both longitudinal and transverse mode stability characteristics are calculated. This software has the unique feature of being able to predict system limit amplitude.

New methods for predicting stability have been created based on a detailed

physical understanding of the combustion instability problem, which has resulted in a computationally predictive algorithm that allows determination of pressure oscillation frequencies and geometry, growth rates for component modes of oscillation, development of steepened wave structures, limit (maximum) amplitude of oscillations, and changes in mean operation chamber conditions.

The program accommodates any combustion-chamber shape. The program can run on desktop computer systems, and is readily upgradeable as new data become available.

This program was written by Gary Flandro of the University of Tennessee, Space Institute, Calspan Center, for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32549-1.

JMISR Interactive eXplorer

NASA's Jet Propulsion Laboratory, Pasadena, California

MISR (Multi-angle Imaging Spectroradiometer) Interactive eXplorer (MINX) is an interactive visualization program that allows a user to digitize smoke, dust, or volcanic plumes in MISR multiangle images, and automatically retrieve height and wind profiles associated with those plumes. This innovation can perform 9-camera animations of MISR level-1 radiance images to study the 3D relationships of clouds and plumes. MINX also enables archiving MISR aerosol properties and Moderate Resolution Imaging Spectroradiometer (MODIS) fire radiative power along with the heights and winds. It can correct geometric misregistration between cameras by correlating off-nadir camera scenes with corresponding nadir scenes and

then warping the images to minimize the misregistration offsets. Plots of BRF (bidirectional reflectance factor) vs. camera angle for points clicked in an image can be displayed. Users get rapid access to map views of MISR path and orbit locations and overflight dates, and past or future orbits can be identified that pass over a specified location at a specified time. Single-camera, level-1 radiance data at 1,100- or 275-meter resolution can be quickly displayed in color using a browse option.

This software determines the heights and motion vectors of features above the terrain with greater precision and coverage than previous methods, based on an algorithm that takes wind direction into consideration. Human interpreters can precisely identify plumes

and their extent, and wind direction. Overposting of MODIS thermal anomaly data aids in the identification of smoke plumes. The software has been used to preserve graphical and textural versions of the digitized data in a Web-based database that currently contains more than 7,000 smoke plumes (<http://www-misr2.jpl.nasa.gov/EPA-Plumes/>).

This work was done by David L. Nelson of Columbus Technologies and Services; David J. Diner; Charles K. Thompson, Jeffrey R. Hall, and Brian E. Rheingans of Caltech; Michael J. Garay of Raytheon; and Dominic Mazzoni of Google, Inc. for NASA's Jet Propulsion Laboratory. For more information, download the MINX software package and User's Guide at <http://www.openchannelsoftware.com/projects/MINX/>. NPO-47098

Characterization of Cloud Water-Content Distribution

NASA's Jet Propulsion Laboratory, Pasadena, California

The development of realistic cloud parameterizations for climate models requires accurate characterizations of sub-grid distributions of thermodynamic

variables. To this end, a software tool was developed to characterize cloud water-content distributions in climate-model sub-grid scales.

This software characterizes distributions of cloud water content with respect to cloud phase, cloud type, precipitation occurrence, and geo-location