Software

The PICWidget

The Plug-in Image Component Widget (PICWidget) is a software component for building digital imaging applications. The component is part of a methodology described in "GIS Methodology for Planning Planetary-Rover Operations" (NPO-41812), which appears elsewhere in this issue of *NASA Tech Briefs*. Planetary rover missions return a large number and wide variety of image data products that vary in complexity in many ways. Supported by a powerful, flexible image-data-processing pipeline, the PICWidget can process and render many types of imagery, including (but not limited to) thumbnail, subframed, downsampled, stereoscopic, and mosaic images; images coregistred with orbital data; and synthetic red/green/blue images. The PICWidget is capable of efficiently rendering images from data representing many more pixels than are available at a computer workstation where the images are to be displayed. The PICWidget is implemented as an Eclipse plug-in using the Standard Widget Toolkit, which provides a straightforward interface for re-use of the PICWidget in any number of application programs built upon the Eclipse application framework. Because the PICWidget is tile-based and performs aggressive tile caching, it has flexibility to perform faster or slower, depending whether more or less memory is available.

This work was done by Jeffrey Norris, Jason Fox, Kenneth Rabe, I-Hsiang Shu, and Mark Powell 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 Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-41813.*

Fusing Symbolic and Numerical Diagnostic Computations

"X-2000 Anomaly Detection Language" denotes a developmental computing language, and the software that establishes and utilizes the language, for fusing two diagnostic computer programs, one implementing a numerical analysis method, the other implementing a symbolic analysis method into a unified event-based decision analysis software system for real-time detection of events (e.g., failures) in a spacecraft, aircraft, or other complex engineering system. The numerical analysis method is performed by beacon-based exception analysis for multi-missions (BEAMs), which has been discussed in several previous *NASA Tech Briefs* articles. The symbolic analysis method is, more specifically, an artificial-intelligence method of the knowledge-based, inference engine type, and its implementation is exemplified by the Spacecraft Health Inference Engine (SHINE) software. The goal in developing the capability to fuse numerical and symbolic diagnostic components is to increase the depth of analysis beyond that previously attainable, thereby increasing the degree of confidence in the computed results. In practical terms, the sought improvement is to enable detection of all or most events, with no or few false alarms.

This program was written by Mark James 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 Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42512.

Probabilistic Reasoning for Robustness in Automated Planning

A general-purpose computer program for planning the actions of a spacecraft or other complex system has been augmented by incorporating a subprogram that reasons about uncertainties in such continuous variables as times taken to perform tasks and amounts of resources to be consumed. This subprogram computes parametric probability distributions for time and resource variables on the basis of user-supplied models of actions and resources that they consume. The current system accepts bounded Gaussian distributions over action duration and resource use. The distributions are then combined during planning to determine the net probability distribution of each resource at any time point. In addition to a full combinatoric approach, several approximations for arriving at these combined distributions are available, including maximum-likelihood and pessimistic algorithms. Each such probability distribution can then be integrated to obtain a probability that execution of the plan under consideration would violate any constraints on the resource. The key idea is to use these probabilities of conflict to score potential plans and drive a search toward planning low-risk actions. An output plan provides a balance between the user's specified averseness to risk and other measures of optimality.

This program was written by Steven Schaffer, Bradley Clement, and Steve 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 Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42152.

Short-Term Forecasting of Radiation Belt and Ring Current

A computer program implements a mathematical model of the radiation-belt and ring-current plasmas resulting from interactions between the solar wind and the Earth's magnetic field, for the purpose of predicting fluxes of energetic electrons (10 keV to 5 MeV) and protons (10 keV to 1 MeV), which are hazardous to humans and spacecraft. Given solar-wind and interplanetary-magnetic-field data as inputs, the program solves the convection-diffusion equations of plasma distribution functions in the range of 2 to 10 Earth radii. Phenomena represented in the model include particle drifts resulting from the gradient and curvature of the magnetic field; electric fields associated with the rotation of the Earth, convection, and temporal variation of the magnetic field; and losses along particle-drift paths. The model can readily accommodate new magnetic- and electric-field submodels and new information regarding physical processes that drive the radiation-belt and ring-current plasmas. Despite the complexity of the model, the program can be run in real time on ordinary computers. At present, the program can calculate present electron and proton fluxes; after further development, it should be able to predict the fluxes 24 hours in advance.