# Software

## Software For Displaying Data From Planetary Rovers

Science Activity Planner (SAP) DownlinkBrowser is a computer program that assists in the visualization of processed telemetric data [principally images, image cubes (that is, multispectral images), and spectra] that have been transmitted to Earth from exploratory robotic vehicles (rovers) on remote planets. It is undergoing adaptation to (1) the Field Integrated Design and Operations (FIDO) rover (a prototype Mars-exploration rover operated on Earth as a test bed) and (2) the Mars Exploration Rover (MER) mission. This program has evolved from its predecessor — the Web Interface for Telescience (WITS) software — and surpasses WITS in the processing, organization, and plotting of data. SAP DownlinkBrowser creates Extensible Markup Language (XML) files that organize data files, on the basis of content, into a sortable, searchable product database, without the overhead of a relational database. The data-display components of SAP DownlinkBrowser (descriptively named ImageView, 3DView, OrbitalView, PanoramaView, ImageCubeView, and SpectrumView) are designed to run in a memory footprint of at least 256MB on computers that utilize the Windows, Linux, and Solaris operating systems.

*This program was written by Mark Powell, Paul Backes, Jeffrey Norris, Marsette Vona, and Robert Steinke 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 Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-30673.*

## Software for Refining or Coarsening Computational Grids

A computer program performs calculations for refinement or coarsening of computational grids of the type called "structured" (signifying that they are geometrically regular and/or are specified by relatively simple algebraic expressions). This program is designed to facilitate analysis of the numerical effects of changing structured grids utilized in computational fluid dynamics (CFD) software. Unlike prior grid-refinement and -coarsening programs, this program is not limited to doubling or halving: the user can specify any refinement or coarsening ratio, which can have a noninteger value. In addition to this ratio, the program accepts, as input, a grid file and the associated restart file, which is basically a file containing the most recent iteration of flow-field variables computed on the grid. The program then refines or coarsens the grid as specified, while maintaining the geometry and the stretching characteristics of the original grid. The program can interpolate from the input restart file to create a restart file for the refined or coarsened grid. The program provides a graphical user interface that facilitates the entry of input data for the grid-generation and restart-interpolation routines.

*This program was written by Russell Daines and Jody Woods of Lockheed Martin Corp. for* **Stennis Space Center**.

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00167.*

## Software for Diagnosis of Multiple Coordinated Spacecraft

Distributed Real-Time Model-Based Diagnosis (DRMD) is a computer program for diagnosing faults in multiple spacecraft cooperating in a specific task (e.g., flying in formation to constitute an interferometer). DRMD takes advantage of both (1) the superiority of model-based software for representing complex hardware systems (though not necessarily for making diagnoses in real time) and (2) the ability of rule-based software to provide diagnoses in real time. A multiple-spacecraft system is modeled as a set of interacting subsystems that comprise interacting components, each of which operates in one of a number of modes that define the relationships between its inputs and outputs. Then diagnosis is performed following a knowledge-compilation approach implemented in a three-step process: (1) A representation of the system is expanded into a network of processed components at compilation time; (2) a Boolean equation for the system is constructed at compilation time; and (3) the equation is evaluated iteratively at run time. The programming language used to express the model of the system defines observables and commands local to each subsystem, thereby facilitating the distribution of portions of the Boolean equation to multiple computers on the multiple spacecraft.

*This program was written by Anthony Barrett of Caltech and Seung Chung of MIT 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 Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-30876.*

## Software Helps Retrieve Information Relevant to the User

The Adaptive Indexing and Retrieval Agent (ARNIE) is a code library, designed to be used by an application program, that assists human users in retrieving desired information in a hypertext setting. Using ARNIE, the program implements a computational model for interactively learning what information each human user considers relevant in context. The model, called a "relevance network," incrementally adapts retrieved information to users' individual profiles on the basis of feedback from the users regarding specific queries. The model also generalizes such knowledge for subsequent derivation of relevant references for similar queries and profiles, thereby, assisting users in filtering information by relevance. ARNIE thus enables users to categorize and share information of interest in various contexts. ARNIE encodes the relevance and structure of information in a neural network dynamically configured with a genetic algorithm. ARNIE maintains an internal database, wherein it saves associations, and from which it returns associated items in response to a query. A C++ compiler for a platform on which ARNIE will be utilized is necessary for creating the

ARNIE library but is not necessary for the execution of the software.

*This program was written by Nathalie Mathé and James Chen of* **Ames Research Center.** *Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14136.*

## Software for Simulating a Complex Robot

RoboSim (Robot Simulation) is a computer program that simulates the poses and motions of the Robonaut — a developmental anthropomorphic robot that has a complex system of joints with 43 degrees of freedom and multiple modes of operation and control. RoboSim performs a full kinematic simulation of all degrees of freedom. It also includes interface components that duplicate the functionality of the real Robonaut interface with control software and human operators. Basically, users see no difference between the real Robonaut and the simulation. Consequently, new control algorithms can be tested by computational simulation, without risk to the Robonaut hardware, and without using excessive Robonaut-hardware experimental time, which is always at a premium. Previously developed software incorporated into RoboSim includes Enigma (for graphical displays), OSCAR (for kinematical computations), and NDDS (for communication between the Robonaut and external software). In addition, RoboSim incorporates unique inverse-kinematical algorithms for chains of joints that have fewer than six degrees of freedom (e.g., finger joints). In comparison with the algorithms of OSCAR, these algorithms are more readily adaptable and provide better results when using equivalent sets of data.

*This program was written by S. Michael Goza of* **Johnson Space Center**. *Further information is contained in a TSP (see page 1).* MSC-23602

## Software for Planning Scientific Activities on Mars

Mixed-Initiative Activity Plan Generator (MAPGEN) is a ground-based computer program for planning and scheduling the scientific activities of instrumented exploratory robotic vehicles, within the limitations of available resources onboard the vehicle. MAPGEN is a combination of two prior software systems: (1) an activity-planning program, APGEN, developed at NASA's Jet Propulsion Laboratory and (2) the Europa planner/scheduler from NASA Ames Research Center. MAPGEN performs all of the following functions:

- Automatic generation of plans and schedules for scientific and engineering activities;
- Testing of hypotheses (or "what-if" analyses of various scenarios);
- Editing of plans;
- Computation and analysis of resources; and
- Enforcement and maintenance of constraints, including resolution of temporal and resource conflicts among planned activities.

MAPGEN can be used in either of two modes: one in which the planner/scheduler is turned off and only the basic APGEN functionality is utilized, or one in which both component programs are used to obtain the full planning, scheduling, and constraint-maintenance functionality.

*This program was written by Mitchell Ai-Chang, John Bresina, Ari Jonsson, Jennifer Hsu, Bob Kanefsky, Paul Morris, Kanna Rajan, and Jeffrey Yglesias of* **Ames Research Center** *and Len Charest and Pierre Maldague of NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-15053.*

## Software for Training in Pre-College Mathematics

The Intelligent Math Tutor (IMT) is a computer program for training students in pre-college and college-level mathematics courses, including fundamentals, intermediate algebra, college algebra, and trigonometry. The IMT can be executed on a server computer for access by students via the Internet; alternatively, it can be executed on students' computers equipped with compact-disk/read-only-memory (CD-ROM) drives. The IMT provides interactive exercises, assessment, tracking, and an on-line graphing calculator with algebraic-manipulation capabilities. The IMT provides an innovative combination of content, delivery mechanism, and artificial intelligence. Careful organization and presentation of the content make it possible to provide intelligent feedback to the student based on performance on exercises and tests. The tracking and feedback mechanisms are implemented within the capabilities of a commercial off-the-shelf development software tool and are written in the Unified Modeling Language to maximize reuse and minimize development cost. The graphical calculator is a standard feature of most college and pre-college algebra and trigonometry courses. Placing this functionality in a Java applet decreases the cost, provides greater capabilities, and provides an opportunity to integrate the calculator with the lessons.

*This program was written by Robert O. Shelton of* **Johnson Space Center** *and Travis A. Moebes and Scot Van Alstine of Science Applications International Corp. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*
MSC-23150