Software

⟩ Wallops Ship Surveillance System

Approved as a Wallops control center backup system, the Wallops Ship Surveillance Software is a day-of-launch risk analysis tool for spaceport activities. The system calculates impact probabilities and displays ship locations relative to boundary lines. It enables rapid analysis of possible flight paths to preclude the need to cancel launches and allow execution of launches in a timely manner. Its design is based on low-cost, large-customer-base elements including personal computers, the Windows operating system, C/C++ object-oriented software, and network interfaces. In conformance with the NASA software safety standard, the system is designed to ensure that it does not falsely report a safe-for-launch condition. To improve the current ship surveillance method, the system is designed to prevent delay of launch under a safe-for-launch condition.

A single workstation is designated the controller of the official ship information and the official risk analysis. Copies of this information are shared with other networked workstations. The program design is divided into five subsystems areas:
1. Communication Link – threads that control the networking of workstations;
2. Contact List – a thread that controls a list of protected item (ocean vessel) information;
3. Hazard List – threads that control a list of hazardous item (debris) information and associated risk calculation information;
4. Display – threads that control operator inputs and screen display outputs; and
5. Archive – a thread that controls archive file read and write access.

Currently, most of the hazard list thread and parts of other threads are being reused as part of a new ship surveillance system, under the SureTrak project.

This work was done by Donna C. Smith of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15623-1

⟩ Source Lines Counter (SLiC) Version 4.0

Source Lines Counter (SLiC) is a software utility designed to measure software source code size using logical source statements and other common measures for 22 of the programming languages commonly used at NASA and the aerospace industry. Such metrics can be used in a wide variety of applications, from parametric cost estimation to software defect analysis. SLiC has a variety of unique features such as automatic code search, automatic file detection, hierarchical directory totals, and spreadsheet-compatible output. SLiC was written for extensibility; new programming language support can be added with minimal effort in a short amount of time. SLiC runs on a variety of platforms including UNIX, Windows, and Mac OSX. Its straightforward command-line interface allows for customization and incorporation into the software build process for tracking development metrics.

This work was done by Erik W. Monson, Kevin A. Smith, Brian J. Newport, Roli D. Gostelow, Jairus M. Hihn, and Ronald K. Kandt of Caltech 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-45962.

⟩ Guidance, Navigation, and Control Program

The Rendezvous and Proximity Operations Program (RPOP) is real-time guidance, navigation, and control (GN&C) domain piloting-aid software that provides 3D Orbiter graphics and runs on the Space Shuttle's Criticality-3 Payload and General Support Computer (PGSC) in the crew cockpit. This software provides the crew with "Situational Awareness" during the rendezvous and proximity operations phases of flight. RPOP can be configured from flight to flight, accounting for mission-specific flight scenarios and target vehicles, via initialization load (I-load) data files. The software provides real-time, automated, closed-loop guidance recommendations and the capability to integrate the crew's manual backup techniques.

The software can bring all relative navigation sensor data, including the Orbiter's GPC (general purpose computer) data, into one central application to provide comprehensive situational awareness of the rendezvous and proximity operations trajectory.

RPOP also can separately maintain trajectory estimates (past, current, and predicted) based on certain data types and co-plot them, in order to show how the various navigation solutions compare. RPOP's best estimate of the relative trajectory is determined by a relative Kalman filter processing data provided by the sensor suite's most accurate sensor, the trajectory control sensor (TCS). Integrated with the Kalman filter is an algorithm that identifies the reflector that the TCS is tracking.

Because RPOP runs on PC laptop computers, the development and certification lifecycles are more agile, flexible, and cheaper than those that govern the Orbiter FSW (flight software) that runs in the GPC. New releases of RPOP can be turned around on a 3- to 6-month template, from new Change Request (CR) to certification, depending on the complexity of the changes.

This work was done by Heather Hinkel, Scott Tamblyn, and William L. Jackson of NASA's Johnson Space Center; Chris Foster of Jacobs Engineering (ESCG); Jack Brazzel and Thomas R. Manning of McDonnell Douglas Space Systems; and Fred Clark, Pete Spehar, Jim D. Barrett, and Zoran Milenkovic of Lockheed Martin. Further information is contained in a TSP (see page 1). MSC-24473-1

⟩ Single-Frame Terrain Mapping Software for Robotic Vehicles

This software is a component in an unmanned ground vehicle (UGV) perception system that builds compact, single-frame terrain maps for distribution to other systems, such as a world model or an operator control unit, over a local area network (LAN). Each cell in the map encodes an elevation value, terrain classification, object classification, terrain traversability, terrain roughness, and a confidence value into four bytes of memory. The input to this software component is a range image (from a lidar or stereo vision system), and optionally a terrain classification image and an object classification image, both registered to the range image. The single-frame terrain map generates estimates of the support surface elevation, ground cover elevation, and minimum canopy elevation; gener-

ates terrain traversability cost; detects low overhangs and high-density obstacles; and can perform geometry-based terrain classification (ground, ground cover, unknown).

A new origin is automatically selected for each single-frame terrain map in global coordinates such that it coincides with the corner of a world map cell. That way, single-frame terrain maps correctly line up with the world map, facilitating the merging of map data into the world map. Instead of using 32 bits to store the floating-point elevation for a map cell, the vehicle elevation is assigned to the map origin elevation and reports the change in elevation (from the origin elevation) in terms of the number of discrete steps. The single-frame terrain map elevation resolution is 2 cm. At that resolution, terrain elevation from –20.5 to 20.5 m (with respect to the vehicle's elevation) is encoded into 11 bits.

For each four-byte map cell, bits are assigned to encode elevation, terrain roughness, terrain classification, object classification, terrain traversability cost, and a confidence value. The vehicle's current position and orientation, the map origin, and the map cell resolution are all included in a header for each map. The map is compressed into a vector prior to delivery to another system.

This work was done by Arturo L. Rankin 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-47039.

Auto Draw From Excel Input Files

The design process often involves the use of Excel files during project development. To facilitate communications of the information in the Excel files, drawings are often generated. During the design process, the Excel files are updated often to reflect new input. The problem is that the drawings often lag the updates, often leading to confusion of the current state of the design.

The use of this program allows visualization of complex data in a format that is more easily understandable than pages of numbers. Because the graphical output can be updated automatically, the manual labor of diagram drawing can be eliminated. The more frequent update of system diagrams can reduce confusion and reduce errors and is likely

to uncover symmetric problems earlier in the design cycle, thus reducing rework and redesign.

This work was done by Karl F. Strauss, Renaud Goullioud, Brian Cox, and James M. Grimes of Caltech 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-46926.

Observation Scheduling System

Software has been designed to schedule remote sensing with the Earth Observing One spacecraft. The software attempts to satisfy as many observation requests as possible considering each against spacecraft operation constraints such as data volume, thermal, pointing maneuvers, and others. More complex constraints such as temperature are approximated to enable efficient reasoning while keeping the spacecraft within safe limits. Other constraints are checked using an external software library. For example, an attitude control library is used to determine the feasibility of maneuvering between pairs of observations. This innovation can deal with a wide range of spacecraft constraints and solve large scale scheduling problems like hundreds of observations and thousands of combinations of observation sequences.

This work was done by Steve A. Chien, Daniel Q. Tran, Gregg R. Rabideau, and Steven R. Schaffer of Caltech 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-47189.

CFDP for Interplanetary Overlay Network

The CCSDS (Consultative Committee for Space Data Systems) File Delivery Protocol for Interplanetary Overlay Network (CFDP-ION) is an implementation of CFDP that uses ION's DTN (delay tolerant networking) implementation as its UT (unit-data transfer) layer. Because the DTN protocols effect automatic, reliable transmission via multiple relays, CFDP-ION need only satisfy the requirements for Class 1 ("unacknowledged") CFDP. This keeps the implementation small, but without loss of capability.

This innovation minimizes processing resources by using zero-copy objects for file data transmission. It runs without modification in VxWorks, Linux, Solaris, and OS/X. As such, this innovation can be used without modification in both flight and ground systems. Integration with DTN enables the CFDP implementation itself to be very simple; therefore, very small. Use of ION infrastructure minimizes consumption of storage and processing resources while maximizing safety.

This work was done by Scott C. Burleigh of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47084.

X-Windows Widget for Image Display

XvicImage is a high-performance X-Windows (Motif-compliant) user interface widget for displaying images. It handles all aspects of low-level image display. The fully Motif-compliant image display widget handles the following tasks:

- Image display, including dithering as needed
- Zoom
- Pan
- Stretch (contrast enhancement, via lookup table)
- Display of single-band or color data
- Display of non-byte data (ints, floats)
- Pseudocolor display
- Full overlay support (drawing graphics on image)
- Mouse-based panning
- Cursor handling, shaping, and planting (disconnecting cursor from mouse)
- Support for all user interaction events (passed to application)
- Background loading and display of images (doesn't freeze the GUI)
- Tiling of images.

It does not read images directly, so it can work with any image file format. It is the application's responsibility to read the image and supply it to XvicImage. The xvd and tp programs (part of the VICAR image processing package) are dependent on XvicImage for their operation.

This work was done by Robert G. Deen of Caltech 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-46922.