

# Computer Programs

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## Electronic Systems

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### Software for a GPS-Reflection Remote-Sensing System

A special-purpose software Global Positioning System (GPS) receiver designed for remote sensing with reflected GPS signals is described in "Delay/Doppler-Mapping GPS-Reflection Remote-Sensing System" (NPO-30385), which appears elsewhere in this issue of *NASA Tech Briefs*. The input accepted by this program comprises raw (open-loop) digitized GPS signals sampled at a rate of about 20 MHz. The program processes the data samples to perform the following functions: detection of signals; tracking of phases and delays; mapping of delay, Doppler, and delay/Doppler waveforms; dual-frequency processing; coherent integrations as short as 125  $\mu$ s; decoding of navigation messages; and precise time tagging of observable quantities. The software can perform these functions on all detectable satellite signals without dead time. Open-loop data collected over water, land, or ice and processed by this software can be further processed to extract geophysical information. Possible examples include mean sea height, wind speed and direction, and significant wave height (for observations over the ocean); bistatic-radar terrain images and measures of soil moisture and biomass (for observations over land); and estimates of ice age, thickness, and surface density (for observations over ice).

*This program was written by Stephen Lowe of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free on-line at [www.nasatech.com](http://www.nasatech.com).*

*This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-30386.*

## Mathematics and Information Sciences

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### Software for Building Models of 3D Objects via the Internet

The Virtual EDF Builder (where "EDF" signifies Electronic Development Fixture) is a computer program that facilitates the use of the Internet for building and displaying digital models of three-dimensional (3D) objects that ordinarily comprise assemblies of solid models created previously by use of computer-aided-design (CAD) programs. The Virtual EDF Builder resides on a Unix-based server computer. It is used in conjunction with a commercially available Web-based plug-in viewer program that runs on a client computer. The Virtual EDF Builder acts as a translator between the viewer program and a database stored on the server. The translation function includes the provision of uniform resource locator (URL) links to other Web-based computer systems and databases. The Virtual EDF builder can be used in two ways: (1) If the client computer is Unix-based, then it can assemble a model locally; the computational load is transferred from the server to the client computer. (2) Alternatively, the server can be made to build the model, in which case the server bears the computational load and the results are downloaded to the client computer or workstation upon completion.

*This program was written by Tim Schramer and Jeff Jensen of Boeing North American, Inc., for Johnson Space Center. For further information, access the Technical Support Package (TSP) free on-line at [www.nasatech.com](http://www.nasatech.com). MSC-22988*

### "Virtual Cockpit Window" for a Windowless Aerospacecraft

A software system processes navigational and sensory information in real time to generate a three-dimensional-appearing image of the external environment for viewing by crewmembers of a windowless aerospacecraft. The design of the particular aerospacecraft (the X-38) is such that the addition of a real transparent cockpit window to the airframe would have resulted in unacceptably large increases in weight and cost.

When exerting manual control, an aircrew needs to see terrain, obstructions, and other features around the aircraft in order to land safely. The X-38 is capable of automated landing, but even when this capability is utilized, the crew still needs to view the external environment: From the very beginning of the United States space program, crews have expressed profound

dislike for windowless vehicles. The well-being of an aircrew is considerably promoted by a three-dimensional view of terrain and obstructions. The present software system was developed to satisfy the need for such a view. In conjunction with a computer and display equipment that weigh less than would a real transparent window, this software system thus provides a "virtual cockpit window."

The key problem in the development of this software system was to create a realistic three-dimensional perspective view that is updated in real time. The problem was solved by building upon a pre-existing commercial program — LandForm C3 — that combines the speed of flight-simulator software with the power of geographic-information-system software to generate real-time, three-dimensional-appearing displays of terrain and other features of flight environments. In the development of the present software, the pre-existing program was modified to enable it to utilize real-time information on the position and attitude of the aerospacecraft to generate a view of the external world as it would appear to a person looking out through a window in the aerospacecraft. The development included innovations in realistic horizon-limit modeling, three-dimensional stereographic display, and interfaces for utilization of data from inertial-navigation devices, Global Positioning System receivers, and laser rangefinders. Map and satellite imagery from the National Imagery and Mapping Agency can also be incorporated into displays.

After further development, the present software system and the associated display equipment would be capable of providing a data-enriched view: In addition to terrain and obstacles as they would be seen through a cockpit window, the view could include flight paths, landing zones, aircraft in the vicinity, and unobstructed views of portions of the terrain that might otherwise be hidden from view. Hence, the system could also contribute to safety of flight and landing at night or under conditions of poor visibility.

In recent tests, so precise was the software modeling that during the initial phases of the flight the software running on a monitor beside the video camera produced nearly identical views.

*This work was done by Michael F. Abernathy of Rapid Imaging Software, Inc., for Johnson Space Center. For fur-*