Software

Program Predicts Time Courses of Human/Computer Interactions

CPM X is a computer program that predicts sequences of, and amounts of time taken by, routine actions performed by a skilled person performing a task. Unlike programs that simulate the interaction of the person with the task environment, CPM X predicts the time course of events as consequences of encoded constraints on human behavior. The constraints determine which cognitive and environmental processes can occur simultaneously and which have sequential dependencies. The input to CPM X comprises (1) a description of a task and strategy in a hierarchical description language and (2) a description of architectural constraints in the form of rules governing interactions of fundamental cognitive, perceptual, and motor operations. The output of CPM X is a Program Evaluation Review Technique (PERT) chart that presents a schedule of predicted cognitive, motor, and perceptual operators interacting with a task environment. The CPM X program allows direct, *a priori* prediction of skilled user performance on complex human-machine systems, providing a way to assess critical interfaces before they are deployed in mission contexts.

This program was written by Alonso Vera of **Ames Research Center** *and Andrew Howes of Cardiff University. 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-15028-1.

Chimera Grid Tools

Chimera Grid Tools (CGT) is a software package for performing computational fluid dynamics (CFD) analysis utilizing the Chimera-overset-grid method. For modeling flows with viscosity about geometrically complex bodies in relative motion, the Chimera-overset-grid method is among the most computationally cost-effective methods for obtaining accurate aerodynamic results. CGT contains a large collection of tools for generating overset grids, preparing inputs for computer programs that solve equations of flow on the grids, and post-processing of flow-solution data. The tools in CGT include grid editing tools, surface-grid-generation tools, volume-grid-generation tools, utility scripts, configuration scripts, and tools for post-processing (including generation of animated images of flows and calculating forces and moments exerted on affected bodies). One of the tools, denoted OVERGRID, is a graphical user interface (GUI) that serves to visualize the grids and flow solutions and provides central access to many other tools. The GUI facilitates the generation of grids for a new flow-field configuration. Scripts that follow the grid generation process can then be constructed to mostly automate grid generation for similar configurations. CGT is designed for use in conjunction with a computer-aided-design program that provides the geometry description of the bodies, and a flow-solver program.

This program was written by William M. Chan and Stuart E. Rogers of **Ames Research Center**, *Steven M. Nash of ELORET Corp., Pieter G. Buning of Langley Research Center, and Robert L. Meakin of the U.S. Army Aeroflightdynamics Directorate. 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 Technology Partnerships Division, Ames Research Center, (650) 604-2954. Refer to ARC-15399-1.

Astronomer's Proposal Tool

Astronomer's Proposal Tool (APT) is a computer program that assists astronomers in preparing their Phase 1 and Phase 2 Hubble Space Telescope science programs. APT is a successor to the Remote Proposal Submission System 2 (RPS2) program, which has been rendered obsolete by more recent advances in computer software and hardware. APT exploits advances associated with widespread use of the Internet, multiplatform visual development software tools, and overall increases in the power of desktop computer hardware, all in such a way as to make the preparation and submission of proposals more intuitive and make observatory operations less cumbersome. APT provides documentation and help that are friendly, up to date, and easily accessible to users of varying levels of expertise, while defining an extensible framework that is responsive to changes in both technology and observatory operations. APT consists of two major components: (1) a set of software tools that are intuitive, visual, and responsive and (2) an integrated software environment that unifies all the tools and makes them interoperable. The APT tools include the Visual Target Tuner, Proposal Editor, Exposure Planner, Bright Object Checker, and Visit Planner.

This program was written by a team of software developers led by Tony Krueger at the Space Telescope Science Institute for **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*
GSC-14946-1

Conservative Patch Algorithm and Mesh Sequencing for PAB3D

A mesh-sequencing algorithm and a conservative patched-grid-interface algorithm (hereafter "Patch Algorithm") have been incorporated into the PAB3D code, which is a computer program that solves the Navier-Stokes equations for the simulation of subsonic, transonic, or supersonic flows surrounding an aircraft or other complex aerodynamic shapes. These algorithms are efficient, flexible, and have added tremendously to the capabilities of PAB3D. The mesh-sequencing algorithm makes it possible to perform preliminary computations using only a fraction of the grid cells (provided the original cell count is divisible by an integer) along any grid coordinate axis, independently of the other axes. The patch algorithm addresses another critical need in multi-block grid situation where the cell faces of adjacent grid blocks may not coincide, leading to errors in calculating fluxes of conserved physical quantities across interfaces between the blocks. The patch algorithm, based on the Stokes integral formulation of the applicable conservation laws, effectively matches each of the interfacial cells on one side of the block interface to the corresponding fractional cell area pieces on the other side. This approach is comprehensive and unified such that all interface topology is automatically processed without user intervention. This algorithm is implemented in a preprocessing code that creates a cell-by-cell database that will maintain flux conservation at any level of full or reduced grid density as the user may choose by way of the mesh-sequencing algorithm. These two algorithms have enhanced the numerical accuracy of the code, reduced the time and effort for grid preprocessing, and provided users with the flexibility of performing computations at any desired full or reduced grid resolution to suit their specific computational requirements.

This program was written by S. P. Pao of **Langley Research Center** *and K. S. Abdol-Hamid of Analytical Services and Materials, Inc. Further information is contained in a TSP (see page 1). LAR-17043-1*

Fitting Nonlinear Curves by Use of Optimization Techniques

MULTIVAR is a FORTRAN 77 computer program that fits one of the members of a set of six multivariable mathematical models (five of which are nonlinear) to a multivariable set of data. The inputs to MULTIVAR include the data for the independent and dependent variables plus the user's choice of one of the models, one of the three optimization engines, and convergence criteria. By use of the chosen optimization engine, MULTIVAR finds values for the parameters of the chosen model so as to minimize the sum of squares of the residuals. One of the optimization engines implements a routine, developed in 1982, that utilizes the Broydon-Fletcher-Goldfarb-Shanno (BFGS) variable-metric method for unconstrained minimization in conjunction with a one-dimensional search technique that finds the minimum of an unconstrained function by polynomial interpolation and extrapolation without first finding bounds on the solution. The second optimization engine is a faster and more robust commercially available code, denoted Design Optimization Tool, that also uses the BFGS method. The third optimization engine is a robust and relatively fast routine that implements the Levenberg-Marquardt algorithm.

This program was written by Scott A. Hill of **Langley Research Center**. *Further information is contained in a TSP (see page 1). LAR-17091-1*

Tool for Viewing Faults Under Terrain

Multi Surface Light Table (MSLT) is an interactive software tool that was developed in support of the QuakeSim project, which has created an earthquake-fault database and a set of earthquake-simulation software tools. MSLT visualizes the three-dimensional geometries of faults embedded below the terrain and animates time-varying simulations of stress and slip. The fault segments, represented as rectangular surfaces at dip angles, are organized into collections, that is, faults. An interface built into MSLT queries and retrieves fault definitions from the QuakeSim fault database. MSLT also reads time-varying output from one of the QuakeSim simulation tools, called "Virtual California." Stress intensity is represented by variations in color. Slips are represented by directional indicators on the fault segments. The magnitudes of the slips are represented by the duration of the directional indicators in time. The interactive controls in MSLT provide a virtual trackball, pan and zoom, translucency adjustment, simulation playback, and simulation movie capture. In addition, geographical information on the fault segments and faults is displayed on text windows. Because of the extensive viewing controls, faults can be seen in relation to one another, and to the terrain. These relations can be realized in simulations. Correlated slips in parallel faults are visible in the playback of Virtual California simulations.

This software was written by Herbert L Siegel and P. Peggy Li 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 (818) 393-2827. Refer to NPO-40781.

Automated Synthesis of Long Communication Delays for Testing

Planetary-Ohio Network Emulator (p-ONE) is a computer program for local laboratory testing of high bandwidth data-communication systems subject to long delays in propagation over interplanetary distances. p-ONE is installed on a personal computer connected to two bidirectional Ethernet interfaces, denoted A and B, that represent local-area networks at opposite ends of a long propagation path. Traffic that is to be passed between A and B is encapsulated in IP (Internet Protocol) packets (e.g., User Data Protocol, UDP). Intercepting this traffic between A and B in both directions, p-ONE time-tags each packet and stores it in memory or on the hard disk of the computer for a user-specified interval that equals the propagation delay to be synthesized. At the expiration of its storage time, each such packet is sent to its destination (that is, if it was received from A, it is sent to B, or vice versa). The accuracy of the p-ONE software is very high, with zero packet loss through the system and negligible latency. Optionally, p-ONE can be configured to delay all network traffic to and from all network addresses on each Ethernet interface or to selectively delay traffic between specific addresses or traffic of specific types. p-ONE works well with Linux and is also designed to be compatible with other operating systems.

This program was written by Marc Seibert of **Glenn Research Center** *and James McKim of RS Information Systems. Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17440-1.

Solving Nonlinear Euler Equations With Arbitrary Accuracy

A computer program that efficiently solves the time-dependent, nonlinear Euler equations in two dimensions to an arbitrarily high order of accuracy has been developed. The program implements a modified form of a prior arbitrary-accuracy simulation algorithm that is a member of the class of algorithms known in the art as modified expansion solution approximation (MESA) schemes. Whereas millions of lines of code were needed to implement the prior MESA algorithm, it is possible to implement the present MESA algorithm by use of one or a few pages of Fortran code, the exact amount depending on the specific application. The ability to solve the Euler equations to arbitrarily high accuracy is especially beneficial in simulations of aeroacoustic effects in settings in which fully nonlinear behavior is expected — for example, at stagnation points of fan blades, where linearizing assumptions break down. At these locations, it is necessary to solve the full nonlinear Euler equations, and inasmuch as the acoustical energy is of the order of 4 to 5 orders of magnitude below that of the mean flow, it is necessary to achieve an overall fractional error of less than 10^{-6} in order to faithfully simulate entropy, vortical, and acoustical waves.

This work was done by Rodger W. Dyson of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*