Information Technology

Space Operations Learning Center

Goddard Space Flight Center, Greenbelt, Maryland

The Space Operations Learning Center (SOLC) is a tool that provides an online learning environment where students can learn science, technology, engineering, and mathematics (STEM) through a series of training modules. SOLC is also an effective media for NASA to showcase its contributions to the general public. SOLC is a Web-based environment with a learning platform for students to understand STEM through interactive modules in various engineering topics.

SOLC is unique in its approach to develop learning materials to teach school-aged students the basic concepts of space operations. SOLC utilizes the latest Web and software technologies to present this educational content in a fun and engaging way for all grade levels. SOLC uses animations, streaming video, cartoon characters, audio narration, interactive games and more to deliver educational concepts. The Web portal organizes all of these training modules in an easily accessible way for visitors worldwide.

SOLC provides multiple training modules on various topics. At the time of this reporting, seven modules have been developed: Space Communication, Flight Dynamics, Information Processing, Mission Operations, Kids Zone 1, Kids Zone 2, and Save The Forest. For the first four modules, each contains three components: Flight Training, Flight License, and Fly It! Kids Zone 1 and 2 include a number of educational videos and games designed specifically for grades K-6. Save The Forest is a space operations mission with four simulations and activities to complete, optimized for new touch screen technology. The Kids Zone 1 module has recently been ported to Facebook to attract wider audience.

This work was done by Ben Lui, Barbara Milner, Dan Binebrink, and Heng Kuok of Goddard Space Flight Center. For more information, visit http://solc.gsfc.nasa.gov. GSC-16063-1

OVERSMART Reporting Tool for Flow Computations Over Large Grid Systems

Ames Research Center, Moffett Field, California

Structured grid solvers such as NASA's OVERFLOW compressible Navier-Stokes flow solver can generate large data files that contain convergence histories for flow equation residuals, turbulence model equation residuals, component forces and moments, and component relative motion dynamics variables. Most of today's large-scale problems can extend to hundreds of grids, and over 100 million grid points. However, due to the lack of efficient tools, only a small fraction of information contained in these files is analyzed.

OVERSMART (OVERFLOW Solution Monitoring And Reporting Tool) provides a comprehensive report of solution convergence of flow computations over large, complex grid systems. It produces a one-page executive summary of the behavior of flow equation residuals, turbulence model equation residuals, and component forces and moments. Under the automatic option, a matrix of commonly viewed plots such as residual histograms, composite residuals, sub-iteration bar graphs, and component forces and moments is automatically generated. Specific plots required by the user can also be prescribed via a command file or a graphical user interface. Output is directed to the user's computer screen and/or to an html file for archival purposes.

The current implementation has been targeted for the OVERFLOW flow solver, which is used to obtain a flow solution on structured overset grids. The OVERSMART framework allows easy extension to other flow solvers.

This work was done by David L. Kao and William M. Chan of Ames Research Center. OVERSMART is part of the Chimera Grid Tools software package (ARC-16025-1), which is available for U.S. general release. Please contact Martha Del Alto, Software Release Authority, at Martha.E.DelAlto@nasa.gov for further inquiries. Further information is contained in a TSP (see page 1). ARC-16025-1A

Large Eddy Simulation (LES) of Particle-Laden Temporal Mixing Layers

NASA's Jet Propulsion Laboratory, Pasadena, California

High-fidelity models of plume-regolith interaction are difficult to develop because of the widely disparate flow conditions that exist in this process. The gas in the core of a rocket plume can often be modeled as a time-dependent, high-temperature, turbulent, reacting continuum flow. However, due to the vacuum conditions on the lunar surface, the mean molecular path in the outer parts of the plume is too long for the continuum assumption

to remain valid. Molecular methods are better suited to model this region of the flow. Finally, granular and multiphase flow models must be employed to describe the dust and debris that are displaced from the surface, as well as how a crater is formed in the regolith. At present, standard commercial CFD (computational fluid dynamics) software is not capable of coupling each of these flow regimes to provide an accurate representation of this flow process, necessitating the development of custom software.

This software solves the fluid-flow-governing equations in an Eulerian framework, coupled with the particle transport equations that are solved in a Lagrangian framework. It uses a fourth-order explicit Runge-Kutta scheme for temporal integration, an eighth-order central finite differencing scheme for spatial discretization. The non-linear terms in the governing equations are recast in cubic skew symmetric form to reduce aliasing error. The second derivative viscous terms are computed using eighth-order narrow stencils that pro-

vide better diffusion for the highest resolved wave numbers. A fourth-order Lagrange interpolation procedure is used to obtain gas-phase variable values at the particle locations.

Projection of Stabilized Aerial Imagery Onto Digital Elevation Maps for Geo-Rectified and Jitter-Free Viewing

Projection code is faster, cleaner, and easier to integrate.

NASA's Jet Propulsion Laboratory, Pasadena, California

As imagery is collected from an airborne platform, an individual viewing the images wants to know from where on the Earth the images were collected. To do this, some information about the camera needs to be known, such as its position and orientation relative to the Earth. This can be provided by common inertial navigation systems (INS). Once the location of the camera is known, it is useful to project an image onto some representation of the Earth. Due to the non-smooth terrain of the Earth (mountains, valleys, etc.), this projection is highly non-linear. Thus, to ensure accurate projection, one needs to project onto a digital elevation map (DEM). This allows one to view the images over-

laid onto a representation of the Earth.

A code has been developed that takes an image, a model of the camera used to acquire that image, the pose of the camera during acquisition (as provided by an INS), and a DEM, and outputs an image that has been geo-rectified. The world coordinate of the bounds of the image are provided for viewing purposes. The code finds a mapping from points on the ground (DEM) to pixels in the image. By performing this process for all points on the ground, one can "paint" the ground with the image, effectively performing a projection of the image onto the ground. In order to make this process efficient, a method was developed for finding a region of in-

terest (ROI) on the ground to where the image will project.

This code is useful in any scenario involving an aerial imaging platform that moves and rotates over time. Many other applications are possible in processing aerial and satellite imagery.

Iterative Transform Phase Diversity: An Image-Based Object and Wavefront Recovery

Goddard Space Flight Center, Greenbelt, Maryland

The Iterative Transform Phase Diversity algorithm is designed to solve the problem of recovering the wavefront in the exit pupil of an optical system and the object being imaged. This algorithm builds upon the robust convergence capability of Variable Sampling Mapping (VSM), in combination with the known success of various deconvolution algorithms. VSM is an alternative method for enforcing the amplitude

constraints of a Misell-Gerchberg-Saxton (MGS) algorithm. When provided the object and additional optical parameters, VSM can accurately recover the exit pupil wavefront. By combining VSM and deconvolution, one is able to simultaneously recover the wavefront and the object.

To recover the exit pupil wavefront, and the unknown object, first one must collect image plane data of the optical

system under test. To increase convergence robustness, diversity images are collected. Next, a guess of the wavefront is made. This can be based on a prior estimate, or a simpler random solution of small values. This guess of the exit pupil and the image data will provide a starting point for VSM phase retrieval.

After several iterations of VSM phase retrieval, the algorithm will estimate the point spread function (PSF) based on