Books & Reports

Criteria for Modeling in LES of Multicomponent Fuel Flow

A report presents a study addressing the question of which large-eddy simulation (LES) equations are appropriate for modeling the flow of evaporating drops of a multicomponent liquid in a gas (e.g., a spray of kerosene or diesel fuel in air). The LES equations are obtained from the direct numerical simulation (DNS) equations in which the solution is computed at all flow length scales, by applying a spatial low-pass filter. Thus, in LES the small scales are removed and replaced by terms that cannot be computed from the LES solution and instead must be modeled to retain the effect of the small scales into the equations. The mathematical form of these models is a subject of contemporary research.

For a single-component liquid, there is only one LES formulation, but this study revealed that for a multicomponent liquid, there are two non-equivalent LES formulations for the conservation equations describing the composition of the vapor. Criteria were proposed for selecting the multicomponent LES formulation that gives the best accuracy and increased computational efficiency. These criteria were applied in examination of filtered DNS databases to compute the terms in the LES equations. The DNS databases are from mixing layers of diesel and kerosene fuels. The comparisons resulted in the selection of one of the multicomponent LES formulations as the most promising with respect to all criteria.

This work was done by Josette Bellan and Laurent Selle of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-45065

Computerized Machine for Cutting Space Shuttle Thermal Tiles

A report presents the concept of a machine aboard the space shuttle that would cut oversized thermal-tile blanks to precise sizes and shapes needed to replace tiles that were damaged or lost during ascent to orbit. The machine would include a computer-controlled jigsaw enclosed in a clear acrylic shell that would prevent escape of cutting debris. A vacuum motor would collect the debris into a reservoir and would hold a tile blank securely in place. A database stored in the computer would contain the unique shape and dimensions of every tile.

Once a broken or missing tile was identified, its identification number would be entered into the computer, wherein the cutting pattern associated with that number would be retrieved from the database. A tile blank would be locked into a crib in the machine, the shell would be closed (proximity sensors would prevent activation of the machine while the shell was open), and a "cut" command would be sent from the computer. A blade would be moved around the crib like a plotter, cutting the tile to the required size and shape. Once the tile was cut, an astronaut would take a space walk for installation.

This work was done by Luis E. Ramirez and Lisa A. Reuter of The Boeing Co. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24140-1

Orbiting Depot and Reusable Lander for Lunar Transportation

A document describes a conceptual transportation system that would support exploratory visits by humans to locations dispersed across the surface of the Moon and provide transport of humans and cargo to sustain one or more permanent Lunar outpost. The system architecture reflects requirements to (1) minimize the amount of vehicle hardware that must be expended while maintaining high performance margins and (2) take advantage of emerging capabilities to produce propellants on the Moon while also enabling efficient operation using propellants transported from Earth.

The system would include reusable single-stage lander spacecraft and a depot in a low orbit around the Moon. Each lander would have descent, landing, and ascent capabilities. A crew-taxi version of the lander would carry a pressurized crew module; a cargo version could carry a variety of cargo containers. The depot would serve as a facility for storage and for refueling with propellants delivered from Earth or propellants produced on the Moon. The depot could receive propellants and cargo sent from Earth on a variety of spacecraft. The depot could provide power and orbit maintenance for crew vehicles from Earth and could serve as a safe haven for lunar crews pending transport back to Earth.

This work was done by Andrew Petro of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24231-1

FPGA-Based Networked Phasemeter for a Heterodyne Interferometer

A document discusses a component of a laser metrology system designed to measure displacements along the line of sight with precision on the order of a tenth the diameter of an atom. This component, the phasemeter, measures the relative phase of two electrical signals and transfers that information to a computer.

Because the metrology system measures the differences between two optical paths, the phasemeter has two inputs, called measure and reference. The reference signal is nominally a perfect square wave with a 50- percent duty cycle (though only rising edges are used). As the metrology system detects motion, the difference between the reference and measure signal phases is proportional to the displacement of the motion. The phasemeter, therefore, counts the elapsed time between rising edges in the two signals, and converts the time into an estimate of phase delay.

The hardware consists of a circuit board that plugs into a COTS (commercial, off-the-shelf) Spartan-III FPGA (field-programmable gate array) evaluation board. It has two BNC inputs, (reference and measure), a CMOS logic chip to buffer the inputs, and an Ethernet jack for transmitting reduceddata to a PC. Two extra BNC connectors can be attached for future expandability, such as external synchronization. Each phasemeter handles one metrology channel. A bank of six phasemeters (and two zero-crossing detector cards) with an Ethernet switch can monitor the rigid body motion of an object.

This device is smaller and cheaper than existing zero-crossing phasemeters. Also, because it uses Ethernet for communication with a computer, instead of a VME bridge, it is much easier to use. The phasemeter is a key part of the Precision Deployable Apertures and Structures strategic R&D effort to design large, deployable, segmented space telescopes.