Improved Systematic Pointing Error Model for the DSN Antennas

New pointing models have been developed for large reflector antennas whose construction is founded on elevation over azimuth mount. At JPL, the new models were applied to the Deep Space Network (DSN) 34-meter antenna’s subnet for corrections of their systematic pointing errors; it achieved significant improvement in performance at Ka-band (32-GHz) and X-band (8.4-GHz). The new models provide pointing improvements relative to the traditional models by a factor of two to three, which translate to approximately 3-dB performance improvement at Ka-band. For radio science experiments where blind pointing performance is critical, the new innovation provides a new enabling technology.

Besides the addition of spherical harmonics terms, the new models differ from the traditional ones in that the coefficients for the cross-elevation and elevation corrections are completely independent and may be different, while in the traditional model, some of the terms are identical. In addition, the new software allows for all-sky or mission-specific model development, and can utilize the previously used model as an a priori estimate for the development of the updated models.

Observability and Estimation of Distributed Space Systems via Local Information-Exchange Networks

An agreement protocol is used as a mechanism for observing formation states from local measurements.

Spacecraft formation flying involves the coordination of states among multiple spacecraft through relative sensing, inter-spacecraft communication, and control. Most existing formation-flying estimation algorithms can only be supported via highly centralized, all-to-all, static relative sensing. New algorithms are proposed that are scalable, modular, and robust to variations in the topology and link characteristics of the formation exchange network. These distributed algorithms rely on a local information exchange network, relaxing the assumptions on existing algorithms.

Distributed space systems rely on a signal transmission network among multiple spacecraft for their operation. Control and coordination among multiple spacecraft in a formation is facilitated via a network of relative sensing and inter-spacecraft communications. Guidance, navigation, and control rely on the sensing network. This network becomes
An improved computational model for simulating flows in liquid-propellant injectors in rocket engines has been developed. Models like this one are needed for predicting fluxes of heat in, and performances of, the engines. An important part of predicting performance is predicting fluctuations of temperature, fluctuations of concentrations of chemical species, and effects of turbulence on diffusion of heat and chemical species. Customarily, diffusion effects are represented by parameters known in the art as the Prandtl and Schmidt numbers. Prior formulations include ad hoc assumptions of constant values of these parameters, but these assumptions and, hence, the formulations, are inaccurate for complex flows.

In the improved model, these parameters are neither constant nor specified in advance: instead, they are variables obtained as part of the solution. Consequently, this model represents the effects of turbulence on diffusion of heat and chemical species more accurately than prior formulations do, and may enable more-accurate prediction of mixing and flows of heat in rocket-engine combustion chambers. The model has been implemented within CRUNCH CFD, a proprietary computational fluid dynamics (CFD) computer program, and has been tested within that program. The model could also be implemented within other CFD programs.

This work was done by Ashvin Hosangadi, James Chenoweth, Kevin Brinckman, and Sanford Dash of Combustion Research and Flow Technology, Inc. for Marshall Space Flight Center. Inquiries concerning rights for the commercial use of this invention should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32533-1.