cluding the basic principles that a starting configuration is randomly selected from within the parameter space, the algorithm tests other configurations with the goal of finding the globally optimal solution, and the region from which new configurations can be selected shrinks as the search continues. The key difference between these algorithms is that in the SA algorithm, a single path, or trajectory, is taken in parameter space, from the starting point to the globally optimal solution, while in the RBSA algorithm, many trajectories are taken; by exploring multiple regions of the parameter space simultane-

ously, the algorithm has been shown to converge on the globally optimal solution about an order of magnitude faster than when using conventional algorithms.

Novel features of the RBSA algorithm include:

1. More efficient searching of the parameter space due to the branching structure, in which multiple random configurations are generated and multiple promising regions of the parameter space are explored;
2. The implementation of a trust region for each parameter in the parameter space, which provides a natural way of

enforcing upper- and lower-bound constraints on the parameters; and
3. The optional use of a constrained gradient-search optimization, performed on the continuous variables around each branch's configuration in parameter space to improve search efficiency by allowing for fast fine-tuning of the continuous variables within the trust region at that configuration point.

*This work was done by Matthew Bolcar, J. Scott Smith, and David Aronstein of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15908-1*

# ❯ Method for Pre-Conditioning a Measured Surface Height Map for Model Validation

**This method can be implemented in most optical modeling and simulation software.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

This software allows one to up-sample or down-sample a measured surface map for model validation, not only without introducing any re-sampling errors, but also eliminating the existing measurement noise and measurement errors. Because the re-sampling of a surface map is accomplished based on the analytical expressions of Zernike-polynomials and a power spectral density model, such re-sampling does not introduce any aliasing and interpolation errors as is done by the conventional interpolation and FFT-based (fast-Fourier-transform-based) spatial-filtering method. Also, this new method automatically eliminates the measurement noise and other measurement errors such as artificial discontinuity.

The developmental cycle of an optical system, such as a space telescope, includes, but is not limited to, the following two steps: (1) deriving requirements or specs on the optical quality of individual optics before they are fabricated through optical modeling and simulations, and (2) validating the optical model using the measured surface

height maps after all optics are fabricated. There are a number of computational issues related to model validation, one of which is the "pre-conditioning" or pre-processing of the measured surface maps before using them in a model validation software tool.

This software addresses the following issues: (1) up- or down-sampling a measured surface map to match it with the gridded data format of a model validation tool, and (2) eliminating the surface measurement noise or measurement errors such that the resulted surface height map is continuous or smoothly-varying. So far, the preferred method used for re-sampling a surface map is two-dimensional interpolation. The main problem of this method is that the same pixel can take different values when the method of interpolation is changed among the different methods such as the "nearest," "linear," "cubic," and "spline" fitting in Matlab. The conventional, FFT-based spatial filtering method used to eliminate the surface measurement noise or measurement errors can also suffer from aliasing effects.

During re-sampling of a surface map, this software preserves the low spatial-frequency characteristic of a given surface map through the use of Zernike-polynomial fit coefficients, and maintains mid- and high-spatial-frequency characteristics of the given surface map by the use of a PSD model derived from the two-dimensional PSD data of the mid- and high-spatial-frequency components of the original surface map. Because this new method creates the new surface map in the desired sampling format from analytical expressions only, it does not encounter any aliasing effects and does not cause any discontinuity in the resultant surface map.

*This work was done by Erkin Sidick of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47593.*