Adaptive MGS Phase Retrieval
NASA’s Jet Propulsion Laboratory, Pasadena, California

Adaptive MGS Phase Retrieval software uses the Modified Gerchberg-Saxton (MGS) algorithm, an image-based sensing method that can turn any focal plane science instrument into a wavefront sensor, avoiding the need to use external metrology equipment. Knowledge of the wavefront enables intelligent control of active optical systems.

The software calculates the optical path difference (wavefront) errors in the exit pupil of an optical system using only intensity images of a point of light. The light input may be a star, laser, or any point source measured at symmetric positions about focus and at the pupil. As such, the software is a key enabling technology for space telescopes. With only a basic understanding of the optical system parameters (e.g. imaging wavelength, f/number, measurement positions, etc.), the software evolves an internal model of the optical system to best match the data ensemble. Once optimized, the software proceeds to accurately estimate the wavefront of light as it travels through the optical system.

The MGS software is highly adaptable to a large range of optical systems and includes many innovative features. This version does not require an extensive and complete understanding of the system under test. Instead, using Automatic Model Adaptation, only the most basic system characteristics must be known. The algorithm adapts these parameters to best fit the data ensemble. These steps are crucial in achieving extremely high accuracy in the wavefront solution at the system exit-pupil. In addition, a convergence-monitoring feature allows the algorithm to stop when the wavefront solution has been reached to within a specified error tolerance level.

The software also facilitates the application of prior system knowledge to better deal with high-dynamic range wavefront errors. This is especially important where the error magnitude is much greater than the imaging wavelength (a significant problem in wavefront sensing). The software can use wavefront models based on previous runs or optical measurements, or predictions from external models, to initiate a prior phase estimate, through its Prior Phase Builder Graphical User Interface. The prior phase is treated by the software as a Numerical Nulling Reference, which is evolved in an outer-inner loop during computation, until it contains the full solution. The innermost iteration then has the simpler job of estimating the low-dynamic range residual difference of the true wavefront error from the Nulling Reference model. This allows the inner loop to operate around null, where it is most accurate and robust.

In addition to the wavefront solution, the software can provide an improved set of system parameters. For example, the result can report the true position of best focus and true f/number in the optical system.

This program was written by Scott A. Basinger, Siddharayappa Bikkannavar, David Cohen, Joseph J. Green, John Lou, Catherine Ohara, David Redding, and Fang Shi 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 (626) 395-2322. Refer to NPO-43857.

Simulating the Gradually Deteriorating Performance of an RTG
NASA’s Jet Propulsion Laboratory, Pasadena, California

Degra (now in version 3) is a computer program that simulates the performance of a radioisotope thermoelectric generator (RTG) over its lifetime. Degra is provided with a graphical user interface that is used to edit input parameters that describe the initial state of the RTG and the time-varying loads and environment to which it will be exposed. Performance is computed by modeling the flows of heat from the radioactive source and through the thermocouples, also allowing for losses, to determine the temperature drop across the thermocouples. This temperature drop is used to determine the open-circuit voltage, electrical resistance, and thermal conductance of the thermocouples. Output power can then be computed by relating the open-circuit voltage and the electrical resistance of the thermocouples to a specified time-varying load voltage.