based on the unsteady hinge moment results. The stall detection algorithm provided a warning of stall several degrees prior to actual stall. In this way, the envelope monitoring system can alert the flight crew to the current aircraft envelope boundaries for both longitudinal and lateral control.

The system uses a combination of three separate detection algorithms based on the unsteady hinge moment signal to provide a warning at a preset number of degrees prior to stall. Results from the three algorithms are averaged to provide a single warning prediction. The averaging of the three separate algorithms provides a level of redundancy in the calculation and can also be used as a measure of the confidence of the stall boundary warning prediction. For the majority of the cases, the detection algorithm produced a warning within ±0.7° of the set boundary value. There appears to be sufficient signal to provide a stall warning boundary out to approximately 4° prior to stall. Output from the detector function for the range of shown contaminations collapses onto a single curve, as a function of the angle-of-attack prior to stall. By collapsing onto a single curve, the developed detector function-based system can use a simple threshold approach to set a variable warning boundary, up to several degrees prior to stall.

This work was done by Michael Kerho of Rolling Hills Research Corp. and Michael B. Bragg and Phillip J. Ansell of the University of Illinois at Urbana-Champaign for Dryden Flight Research Center. Further information is contained in a TSP (see page 1). DRC-010-014

Nemesis Autonomous Test System

NASA's Jet Propulsion Laboratory, Pasadena, California

A generalized framework has been developed for systems validation that can be applied to both traditional and autonomous systems. The framework consists of an automated test case generation and execution system called Nemesis that rapidly and thoroughly identifies flaws or vulnerabilities within a system. By applying genetic optimization and goal-seeking algorithms on the test equipment side, a "war game" is conducted between a system and its complementary nemesis. The end result of the war games is a collection of scenarios that reveals any undesirable behaviors of the system under test.

The software provides a reusable framework to evolve test scenarios using genetic algorithms using an operation model of the system under test. It can automatically generate and execute test cases that reveal flaws in behaviorally complex systems. Genetic algorithms focus the exploration of tests on the set of test cases that most effectively reveals the flaws and vulnerabilities of the system under test. It leverages advances in state- and model-based engineering, which are essential in defining the behavior of autonomous systems. It also uses goal networks to describe test scenarios.

This work was done by Kevin J. Barltrop, Cin-Young Lee, Gregory A. Horvath, and Bradley J. Clement 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 Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47596.

Mirror Metrology Using Nano-Probe Supports

Any application requiring precise measurement of a flexible object could benefit from this invention.

Goddard Space Flight Center, Greenbelt, Maryland

Thin, lightweight mirrors are needed for future x-ray space telescopes in order to increase x-ray collecting area while maintaining a reduced mass and volume capable of being launched on existing rockets. However, it is very difficult to determine the undistorted shape of such thin mirrors because the mounting of the mirror during measurement causes distortion. Traditional kinematic mounts have insufficient supports to control the distortion to measurable levels and prevent the mirror from vibrating during measurement. Over-constrained mounts (non-kinematic) result in an unknown force state causing mirror distortion that cannot be determined or analytically removed. In order to measure flexible mirrors, it is necessary to over-constrain the mirror. Over-constraint causes unknown distortions to be applied to the mirror. Even if a kinematic constraint system can be used, necessary imperfections in the kinematic assumption can lead to an unknown force state capable of distorting the mirror. Previously, thicker, stiffer, and heavier mirrors were used to achieve low optical figure distortion. These mirrors could be measured to an acceptable level of precision using traditional kinematic mounts. As lighter weight precision optics have developed, systems such as the whiffle tree or hydraulic supports have been used to provide additional mounting supports while maintaining the kinematic assumption.

The purpose of this invention is to over-constrain a mirror for optical measurement without causing unacceptable or unknown distortions. The invention uses force gauges capable of measuring 1/10,000 of a Newton attached to nano-actuators to support a thin x-ray optic with known and controlled forces to allow for figure measurement and knowledge of the undeformed mirror figure. The mirror is hung from strings such that it is minimally distorted and in a known force state. However, the hanging mirror cannot be measured because it is both swinging and vibrating. In order to stabilize the mirror for measurement, nano-probes support the mirror, causing the mirror to be over-constrained.