# Technology Focus: Sensors

## Distributed Aerodynamic Sensing and Processing Toolbox

*Dryden Flight Research Center, Edwards, California*

A Distributed Aerodynamic Sensing and Processing (DASP) toolbox was designed and fabricated for flight test applications with an Aerostructures Test Wing (ATW) mounted under the fuselage of an F-15B on the Flight Test Fixture (FTF). DASP monitors and processes the aerodynamics with the structural dynamics using nonintrusive, surface-mounted, hot-film sensing. This aerodynamic measurement tool benefits programs devoted to static/dynamic load alleviation, body freedom flutter suppression, buffet control, improvement of aerodynamic efficiency through cruise control, supersonic wave drag reduction through shock control, etc.

This DASP toolbox measures local and global unsteady aerodynamic load distribution with distributed sensing. It determines correlation between aerodynamic "observables" (aero forces) and structural dynamics, and allows control authority increase through aeroelastic shaping and active flow control.

It offers improvements in flutter suppression and, in particular, body freedom flutter suppression, as well as aerodynamic performance of wings for increased range/endurance of manned/unmanned flight vehicles. Other improvements include inlet performance with closed-loop active flow control, and development and validation of advanced analytical and computational tools for unsteady aerodynamics.

*This work was done by Martin Brenner and Christine Jutte of Dryden Flight Research Center and Arun Mangalam of Tao Systems, Inc. Further information is contained in a TSP (see page 1).* *DRC-009-031*

## Collaborative Supervised Learning for Sensor Networks

**This technique could be applied to sensor networks for intruder detection, target tracking, and data mining in cell-phone networks.**

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

Collaboration methods for distributed machine-learning algorithms involve the specification of communication protocols for the learners, which can query other learners and/or broadcast their findings preemptively. Each learner incorporates information from its neighbors into its own training set, and they are thereby able to "bootstrap" each other to higher performance.

Each learner resides at a different node in the sensor network and makes observations (collects data) independently of the other learners. After being "seeded" with an initial labeled training set, each learner proceeds to learn in an iterative fashion. New data is collected and classified. The learner can then either broadcast its most confident classifications for use by other learners, or can query neighbors for their classifications of its least confident items. As such, collaborative learning combines elements of both passive (broadcast) and active (query) learning. It also uses ideas from ensemble learning to combine the multiple responses to a given query into a single useful label.

This approach has been evaluated against current non-collaborative alternatives, including training a single classifier and deploying it at all nodes with no further learning possible, and permitting learners to learn from their own most confident judgments, absent interaction with their neighbors. On several data sets, it has been consistently found that active collaboration is the best strategy for a distributed learner network. The main advantages include the ability for learning to take place autonomously by collaboration rather than by requiring intervention from an oracle (usually human), and also the ability to learn in a distributed environment, permitting decisions to be made *in situ* and to yield faster response time.

*This work was done by Kiri L. Wagstaff of Caltech, Umaa Rebbapragada of Tufts University, and Terran Lane of the University of New Mexico for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46914*

## Hazard Detection Software for Lunar Landing

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

The Autonomous Landing and Hazard Avoidance Technology (ALHAT) Project is developing a system for safe and precise manned lunar landing that involves novel sensors, but also specific algorithms. ALHAT has selected imaging LIDAR (light detection and ranging) as the sensing modality for onboard hazard detection because imaging LIDARs can rapidly generate direct measurements of the lunar surface elevation from high altitude. Then, starting with the LIDAR-based Hazard Detection and Avoidance (HDA) algorithm developed for Mars Landing, JPL has developed a