



Technology Focus: Sensors

Airport Remote Tower Sensor Systems

Better weather information will be available for guiding approaches and landings.

Ames Research Center, Moffett Field, California

Networks of video cameras, meteorological sensors, and ancillary electronic equipment are under development in collaboration among NASA Ames Research Center, the Federal Aviation Administration (FAA), and the National Oceanic Atmospheric Administration (NOAA). These networks are to be established at and near airports to provide real-time information on local weather conditions that affect aircraft approaches and landings.

The prototype network is an airport approach-zone camera system (AAZCS), which has been deployed at San Francisco International Airport (SFO) and San Carlos Airport (SQL). The AAZCS includes remotely controlled color video cameras located on top of SFO and SQL air-traffic control towers. The

cameras are controlled by the NOAA Center Weather Service Unit located at the Oakland Air Route Traffic Control Center and are accessible via a secure Web site. The AAZCS cameras can be zoomed and can be panned and tilted to cover a field of view 220° wide. The NOAA observer can see the sky condition as it is changing, thereby making possible a real-time evaluation of the conditions along the approach zones of SFO and SQL.

The next-generation network, denoted a remote tower sensor system (RTSS), will soon be deployed at the Half Moon Bay Airport and a version of it will eventually be deployed at Los Angeles International Airport. In addition to remote control of video cameras via secure Web links, the RTSS offers real-time weather observations, remote sens-

ing, portability, and a capability for deployment at remote and uninhabited sites. The RTSS can be used at airports that lack control towers, as well as at major airport hubs, to provide synthetic augmentation of vision for both local and remote operations under what would otherwise be conditions of low or even zero visibility.

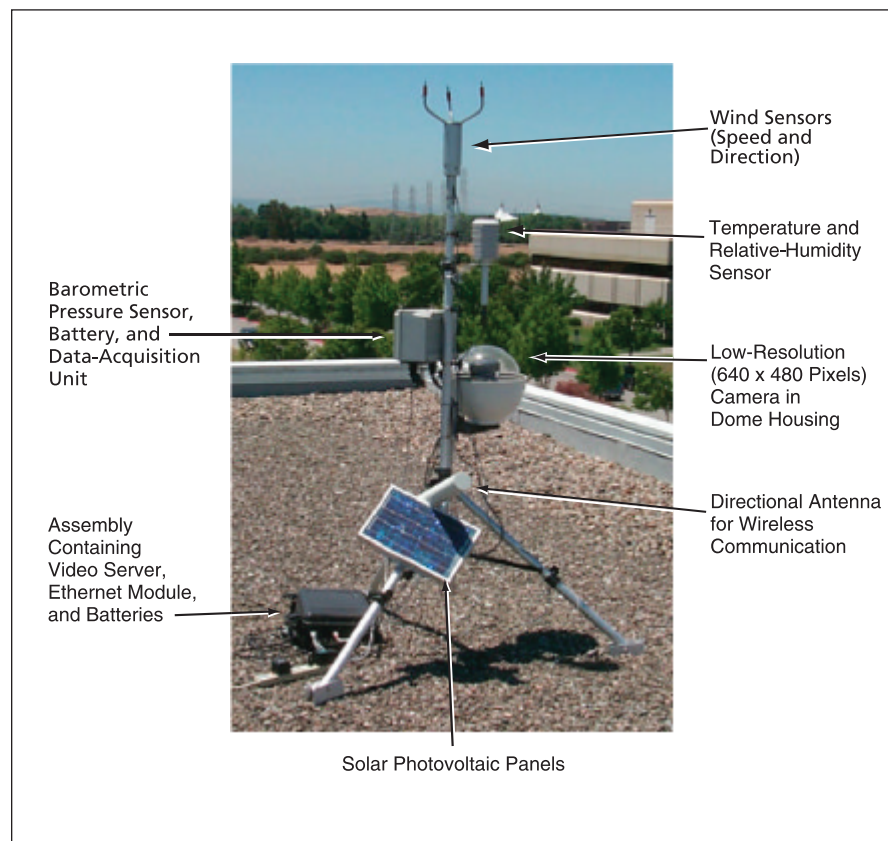
A prototype of a portable RTSS unit (see figure) includes a tripod, on which are mounted the following subsystems:

- A low-resolution pan/tilt/zoom color video camera in a dome housing;
- Ultrasonic sensors for measuring wind velocity;
- Temperature and relative-humidity sensors;
- A barometric pressure sensor;
- A data-acquisition (data-logging) subsystem for collecting sensor data;
- An embedded Web video-image-data server computer;
- A wireless Ethernet module;
- A battery power supply;
- Solar photovoltaic panels to charge the battery; and
- A directional antenna for wireless communication.

In addition to portable units like this one, the RTSS will include a high-resolution camera mounted on a pre-existing airport tower.

It is envisioned that future RTSSs will be parts of dynamic virtual tower systems, which will be air-traffic-control systems that will serve airports that lack control towers. In a virtual tower system, the information collected from a suite of RTSS units would be sent to a facility, located elsewhere than at an affected airport, where a team of air-traffic controllers could utilize the information in performing real-time tower operations. It is further envisioned that real-time integration of data among pilots, aircraft, and virtual tower stations will become feasible.

Yet another development is that of a real-time, automated visibility-image-management system that uses RTSSs to track changing airport and terminal



A **Prototype RTSS Portable Unit** includes sensor, power, and communication subsystems mounted on a 9-ft (=2.7-m) tripod.

conditions. More specifically, this system processes RTSS image data, by use of advanced algorithms, to predict trends in visibility. The image data are acquired, stored, and processed at 15-minute intervals. The processing of the data yields 15-minute updates of a

visibility-versus-time plot, on which visibility is quantified on a suggested scale of 0 to 1.

This work was done by David A. Maluf, Yuri Gawdiak, Christopher Leidichj, and Richard Papasin of Ames Research Center and Peter B. Tran and Kevin Bass of QSS

Group, Inc. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-15029-1.

Implantable Wireless MEMS Sensors for Medical Uses

Integrated Sensing Systems, Inc., Ypsilanti, Michigan

Sensors designed and fabricated according to the principles of microelectromechanical systems (MEMS) are being developed for several medical applications in outer space and on Earth. The designs of these sensors are based on a core design family of pressure sensors, small enough to fit into the eye of a needle, that are fabricated by a “dissolved wafer” process. The sensors are expected to be implantable, batteryless, and wireless. They would be both powered and interrogated by hand-held radio trans-

ceivers from distances up to about 6 in. (about 15 cm). One type of sensor would be used to measure blood pressure, particularly for congestive heart failure. Another type would be used to monitor fluids in patients who have hydrocephalus (high brain pressure). Still other types would be used to detect errors in delivery of drugs and to help patients having congestive heart failure.

This work was directed by Alexander Chimbayo of Integrated Sensing Systems, Inc. under a NASA Small Business Inno-

vation Research (SBIR) contract monitored by Langley Research Center. For further information, contact:

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Refer to SBIR-0010, volume and number of this NASA Tech Briefs issue, and the page number.

Embedded Sensors for Measuring Surface Regression

Electrical-resistance measurements are translated into real-time material thickness and surface regression data for hybrid fuels, solid propellants, and ablative materials.

Stennis Space Center, Mississippi

The development and evaluation of new hybrid and solid rocket motors requires accurate characterization of the propellant surface regression as a function of key operational parameters. These characteristics establish the propellant flow rate and are prime design drivers affecting the propulsion system geometry, size, and overall performance. There is a similar need for the development of advanced ablative materials, and the use of conventional ablatives exposed to new operational environments. The Miniature Surface Regression Sensor (MSRS) was developed to serve these applications. It is designed to be cast or embedded in the material of interest and regresses along with it. During this process, the resistance of the sensor is related to its instantaneous length, allowing the real-time thickness of the host material to be established. The time derivative of this data reveals the instantaneous surface regression rate.

The MSRS could also be adapted to perform similar measurements for a variety of other host materials when it is desired to monitor thicknesses and/or regression rate for purposes of safety, operational control, or research. For example, the sensor could be used to monitor the thicknesses of brake linings or racecar tires and indicate when they need to be replaced. At the time of this reporting, over 200 of these sensors have been installed into a variety of host materials.

An MSRS can be made in either of two configurations, denoted “ladder” and “continuous” (see Figure 1). A ladder MSRS includes two highly electrically conductive legs, across which narrow strips of electrically resistive material are placed at small increments of length. These strips resemble the rungs of a ladder and are electrically equivalent to many tiny resistors connected in parallel. A substrate material provides structural support for the legs and rungs. The instantaneous sensor

resistance is read by an external signal conditioner via wires attached to the conductive legs on the non-eroding end of the sensor. The sensor signal can be transmitted from inside a high-pressure chamber to the ambient environment, using commercially available feedthrough connectors. Miniaturized internal recorders or wireless data transmission could also potentially be employed to eliminate the need for producing penetrations in the chamber case.

The rungs are designed so that as each successive rung is eroded away, the resistance changes by an amount that yields a readily measurable signal larger than the background noise. (In addition, signal-conditioning techniques are used in processing the resistance readings to mitigate the effect of noise.) Hence, each discrete change of resistance serves to indicate the arrival of the regressing host material front at the known depth of the affected resistor rung. The average rate of regression between two adjacent resis-