Technology Focus: Data Acquisition

Measurement and Controls Data Acquisition System

Marshall Space Flight Center, Alabama

Measurement and Controls Data Acquisition System (MCDAS) is an application program that integrates the functions of two stand-alone programs: one for acquisition of data, the other for controls. MCDAS facilitates and improves testing of complex engineering systems by helping to perform calibration and setup of test systems and acquisition, dissemination, and processing of data. Features of MCDAS include an intuitive, user-friendly graphical user interface, a capability for acquiring data at rates greater than previously possible, cooperation between the data-acquisition software subsystem and alarm-checking and analytical components of the control software subsystem, and a capability for dissemination of data through fiber optics and virtual and wide-area networks, including networks that contain hand-held display units. The integration of the data acquisition and control software offers a safety advantage by making alarm information available to the control software in a more timely manner. By enabling the use of hand-held devices, MCDAS reduces the time spent by technicians asking for screen updates to determine effects of setup actions. Previously recorded data can be processed without interruption to current acquisition of data. Analysts can continue to view test parameters while test-data files are being generated.

This program was written by Rick Hall of **Marshall Space Flight Center**, *Alice Daniel formerly of UNITes (NTSI), and Frank E. Batts, Sr. of Langley Research Center. Further information is contained in a TSP (see page 1). MFS-32014-1*

IMU/GPS System Provides Position and Attitude Data

Stennis Space Center, Mississippi

A special navigation system is being developed to provide high-quality information on the position and attitude of a moving platform (an aircraft or spacecraft), for use in pointing and stabilization of a hyperspectral remote-sensing system carried aboard the platform. The system also serves to enable synchronization and interpretation of readouts of all onboard sensors. The heart of the system is a commercially available unit, small enough to be held in one hand, that contains an integral combination of an inertial measurement unit (IMU) of the microelectromechanical systems (MEMS) type, Global Positioning System (GPS) receivers, a differential GPS subsystem, and ancillary data-processing subsystems. The system utilizes GPS carrier-phase measurements to generate time data plus highly accurate and continuous data on the position, attitude, rotation, and acceleration of the platform. Relative to prior navigation systems based on IMU and GPS subsystems, this system is smaller, is less expensive, and performs better. Optionally, the system can easily be connected to a laptop computer for demonstration and evaluation. In addition to airborne and spaceborne remote-sensing applications, there are numerous potential terrestrial sensing, measurement, and navigation applications in diverse endeavors that include forestry, environmental monitoring, agriculture, mining, and robotics.

This work was done by Ching Fang Lin of American GNC Corp. for **Stennis Space Center**.

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Refer to SSC-00225, volume and number of this NASA Tech Briefs *issue, and the page number.*

Using Artificial Intelligence to Inform Pilots of Weather

Weather awareness is increased; workload is reduced.

Ames Research Center, Moffett Field, California

An automated system to assist a General Aviation (GA) pilot in improving situational awareness of weather in flight is now undergoing development. This development is prompted by the observation that most fatal GA accidents are attributable to loss of weather awareness. Loss of weather awareness, in turn, has been attributed to the difficulty of interpreting traditional preflight weather briefings and the difficulty of both obtaining and interpreting traditional in-flight weather briefings. The developmental automated system not only improves weather awareness but also substantially reduces the time a pilot must spend in acquiring and maintaining weather awareness.

The automated system includes computer hardware and software, a speech-based hardware/software user interface, and hardware interfaces between the computer and aircraft radio-communication equipment. The heart of the system consists of artificial-intelligence software, called Aviation Weather Environment (AWE), that implements a

Current Weather and Winds Aloft are shown alongside a pilot-selected route. Wind velocity at the pilot-selected altitude is depicted graphically with black arrows. The current weather is shown using symbolic and textual representations.

human-centered methodology oriented towards providing the weather information (1) that the pilot needs and/or wants, (2) at the appropriate time, and (3) in the appropriate format.

AWE can be characterized as a context-aware, domain-and-task knowledgeable, personalized, adaptive assistant. AWE automatically monitors weather reports for the pilot's flight route and warns the pilot of any weather conditions outside the limits of acceptable weather conditions that the pilot has specified in advance. AWE provides textual and/or graphical representations of important weather elements overlaid on a navigation map (see figure). The representations depict current and forecast conditions in an easy-to-interpret manner and are geographically positioned next to each applicable airport to enable the pilot to visualize conditions along the route. In addition to automatic warnings, the system enables the pilot to verbally request (via the speech-based user interface) weather and airport information.

AWE is context-aware in the following sense: From the location of the aircraft (as determined by a Global Positioning System receiver) and the route as specified by the pilot, AWE determines the phase of flight. In determining the timing of warnings and the manner in which warnings are issued, AWE takes account of the phase of flight, the pilot's definition of acceptable weather conditions, and the pilot's preferences for automatic notification. By noting the pilot's verbal requests for information during the various phases of flight, the system learns to provide the information, without explicit requests, at the corresponding times on subsequent flights under similar conditions.

This work was done by Lilly Spirkovska of **Ames Research Center** *and Suresh K. Lodha of the University of California. 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 Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14970-1.

Fast Lossless Compression of Multispectral-Image Data

A low-complexity adaptive-filtering algorithm is used.

NASA's Jet Propulsion Laboratory, Pasadena, California

An algorithm that effects fast lossless compression of multispectral-image data is based on low-complexity, proven adaptive-filtering algorithms. This algorithm is intended for use in compressing multispectral-image data aboard spacecraft for transmission to Earth stations. Variants of this algorithm could be useful for lossless compression of three-dimensional medical imagery and, perhaps, for compressing image data in general.

The main adaptive-filtering algorithm on which the present algorithm is based is the sign algorithm (also known as the sign-error algorithm and as the binary reinforcement algorithm). The sign algorithm is related to the least-mean-square (LMS) algorithm. Both algorithms are briefly described in the following two paragraphs.

Consider a sequence of image data (or any other data) that one seeks to compress. The sequence is specified in terms of a sequentially increasing index (k) and the value (d_k) of the kth sample. An estimated value of the kth sample, $\hat{d}_k$, is calculated by the equation

$$\hat{d}_k = \mathbf{w}_k^T \mathbf{u}_k,$$

where $\mathbf{w}_k$ is a filter-weight vector at index k and $\mathbf{u}_k$ is an input vector that can be defined in any of a number of different ways, depending on the specific application. Once the estimate $\hat{d}_k$ has been calculated, the error between the estimate and the exact value is calculated as

$$e_k = \hat{d}_k - d_k.$$

When the LMS algorithm or sign algorithm is used as part of a predictive compression scheme, the sequence of e_k values is encoded in the compressed bitstream.

The error value is also used to update the filter weights in either of two ways, de-