Technology Focus: Data Acquisition

Medical Signal-Conditioning and Data-Interface System

Lyndon B. Johnson Space Center, Houston, Texas

A general-purpose portable, wearable electronic signal-conditioning and data-interface system is being developed for medical applications. The system can acquire multiple physiological signals (e.g., electrocardiographic, electroencephalographic, and electromyographic signals) from sensors on the wearer's body, digitize those signals that are received in analog form, preprocess the resulting data, and transmit the data to one or more remote location(s) via a radio-communication link and/or the Internet. The system includes a computer running data-object-oriented software that can be programmed to configure the system to accept almost any analog or digital input signals from medical devices. The computing hardware and software implement a general-purpose data-routing-and-encapsulation architecture that supports tagging of input data and routing the data in a standardized way through the Internet and other modern packet-switching networks to one or more computer(s) for review by physicians. The architecture supports multiple-site buffering of data for redundancy and reliability, and supports both real-time and slower-than-real-time collection, routing, and viewing of signal data. Routing and viewing stations support insertion of automated analysis routines to aid in encoding, analysis, viewing, and diagnosis.

This work was done by Jeffrey Braun, Charles Jacobus, Scott Booth, Michael Suarez, Derek Smith, Jeffrey Hartnagle, and Glenn LePrell of Cybernet Systems Corp. for **Johnson Space Center**. *For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-22969, volume and number of this NASA Tech Briefs *issue, and the page number.*

Instruments for Reading Direct-Marked Data-Matrix Symbols

Contrast is enhanced through oblique viewing and illumination.

Marshall Space Flight Center, Alabama

Improved optoelectronic instruments (specially configured digital cameras) for reading direct-marked data-matrix symbols on the surfaces of optically reflective objects (including specularly reflective ones) are undergoing development. Data-matrix symbols are two-dimensional binary patterns that are used, like common bar codes, for automated identification of objects. The first data-matrix symbols were checkerboardlike patterns of black-and-white rectangles, typically existing in the forms of paint, ink, or detachable labels. The major advantage of direct marking (the marks are more durable than are painted or printed symbols or detachable labels) is offset by a major disadvantage (the marks generated by some marking methods do not provide sufficient contrast to be readable by optoelectronic instruments designed to read black-and-white data-matrix symbols). Heretofore, elaborate lighting, lensing, and software schemes have been tried in efforts to solve the contrast problem in direct-mark matrix-symbol readers. In comparison with prior readers based on those schemes, the readers now undergoing development are expected to be more effective while costing less.

All of the prior direct-mark matrix-symbol readers are designed to be aimed perpendicularly to marked target surfaces, and they tolerate very little angular offset. However, the reader now undergoing development not only tolerates angular offset but depends on angular offset as a means of obtaining the needed contrast, as described below.

The prototype reader (see Figure 1) includes an electronic camera in the form of a charge-coupled-device (CCD) image detector equipped with a telecentric lens. It also includes a source of collimated visible light and a source of collimated infrared light for illuminating a target. The visible and infrared illumination complement each other: the visible illumination is more useful for aiming the reader toward a target, while the infrared illumination is more useful for reading symbols on highly reflective surfaces. By use of beam splitters, the visible and

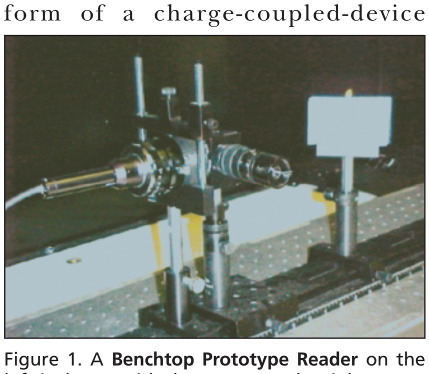

Figure 1. A **Benchtop Prototype Reader** on the left is shown with the target on the right.

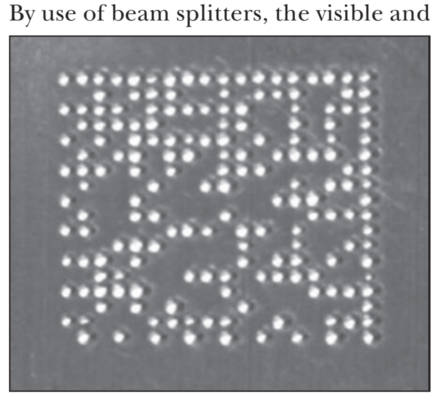

Figure 2. A **Data-Matrix Symbol** marked with no contrast using a dot peen process on a smooth aluminum target was imaged in the prototype reader at a viewing angle 15° off the perpendicular to the target surface.

infrared collimated lights are introduced along the optical path of the telecentric lens, so that the target is illuminated and viewed from the same direction.

The instrument is designed to be aimed at an angle up to 45° off the perpendicular to the surface. Depending on the target material and its surface finish, this arrangement gives rise to one or more of the following effects: (1) most of the light incident on the relatively flat portions of the target surface adjacent to marks is reflected away from the camera, making those portions appear dark, (2) the shadowed portions of the interior surfaces of the marks receive little illumination and therefore appear even darker, and/or (3) some of the light impinging on the non-shadowed portion of the concave interior surface of each mark is reflected toward the camera, making that portion of the mark appear bright (shown in Figure 2). The net result is that in the image formed in the camera, the contrast between the marks and the adjacent relatively flat target surface is increased, making it much easier for image-processing hardware and software to recognize a data-matrix symbol.

The telecentric lens is an important element of the innovation. A telecentric lens provides nearly constant magnification over a range of working distances, thereby nearly eliminating perspective angle error. In other words, tilting of the line of sight, curvature of the target surface, and relative movement of the camera and target cause little or no distortion and exert little or no effect on magnification, simplifying the task of image-processing hardware and software. A contemplated future advanced version of the reader would be equipped for automatic focus and would be able to read symbols at distances ranging from several centimeters to a few meters.

This work was done by Harry F. Schramm and Eric L. Corder of **Marshall Space Flight Center**.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Marshall Space Flight Center. Refer to MFS-31944-1.

Processing EOS MLS Level-2 Data

NASA's Jet Propulsion Laboratory, Pasadena, California

A computer program performs level-2 processing of thermal-microwave-radiance data from observations of the limb of the Earth by the Earth Observing System (EOS) Microwave Limb Sounder (MLS). The purpose of the processing is to estimate the composition and temperature of the atmosphere versus altitude from ≈8 to ≈90 km. "Level-2" as used here is a specialists' term signifying both vertical profiles of geophysical parameters along the measurement track of the instrument and processing performed by this or other software to generate such profiles. Designed to be flexible, the program is controlled via a configuration file that defines all aspects of processing, including contents of state and measurement vectors, configurations of forward models, measurement and calibration data to be read, and the manner of inverting the models to obtain the desired estimates. The program can operate in a parallel form in which one instance of the program acts a master, coordinating the work of multiple slave instances on a cluster of computers, each slave operating on a portion of the data. Optionally, the configuration file can be made to instruct the software to produce files of simulated radiances based on state vectors formed from sets of geophysical data-product files taken as input.

This work was done by W. Van Snyder, Dong Wu, William Read, Jonathan Jiang, Paul Wagner, Nathaniel Livesey, Michael Schwartz, Mark Filipiak, Hugh Pumphrey, and Zvi Shippony 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 (818) 393-2827. Refer to NPO-35188.

Ground Processing of Data From the Mars Exploration Rovers

NASA's Jet Propulsion Laboratory, Pasadena, California

A computer program implements the Earth side of the protocol that governs the transfer of data files generated by the Mars Exploration Rovers. It also provides tools for viewing data in these files and integrating data-product files into automated and manual processes. It reconstitutes files from telemetry data packets. Even if only one packet is received, metadata provide enough information to enable this program to identify and use partial data products. This software can generate commands to acknowledge received files and retransmit missed parts of files, or it can feed a manual process to make decisions about retransmission. The software uses an Extensible Markup Language (XML) data dictionary to provide a generic capability for displaying files of basic types, and uses external "plug-in" application programs to provide more sophisticated displays. This program makes data products available with very low latency, and can trigger automated actions when complete or partial products are received. The software is easy to install and use. The only system requirement for installing the software is a Java J2SE 1.4 platform. Several instances of the software can be executed simultaneously on the same machine.

This program was written by Jesse Wright, Kathryn Sturdevant, and David Noble 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 (818) 393-2827. Refer to NPO-42226.