oratories, and tests in a two-way ground-to-spacecraft communication link were planned. Although the modulator board was conceived for original use in spacecraft-to-spacecraft and spacecraft-to-ground communications, there are potential terrestrial uses in microwave tower-to-tower links and aircraft remote sensing systems.

By making it possible to implement many different high-rate modulators in the same piece of hardware, the underlying design concepts of this modulator can be expected to afford economies of scale: It would cost less to manufacture many identical modulator hardware units to satisfy market demands for many types of modulators than to manufacture smaller numbers of specialized modulator units having different designs.

This work was done by Andrew Gray, Dennis Lee, Norman Lay, and Craig Cheetham of Caltech; Wai Fong, Pen-Shu Yeh, Robin King, and Parminder Ghuman of Goddard Space Flight Center; and Scott Hoy and Dave Fisher of Lockheed-Martin for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-2240
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-40807, volume and number of this NASA Tech Briefs *issue, and the page number.*

Some Improvements in Utilization of Flash Memory Devices

Lyndon B. Johnson Space Center, Houston, Texas

Two developments improve the utilization of flash memory devices in the face of the following limitations: (1) a flash write element (page) differs in size from a flash erase element (block), (2) a block must be erased before its is rewritten, (3) lifetime of a flash memory is typically limited to about 1,000,000 erases, (4) as many as 2 percent of the blocks of a given device may fail before the expected end of its life, and (5) to ensure reliability of reading and writing, power must not be interrupted during minimum specified reading and writing times.

The first development comprises interrelated software components that regulate reading, writing, and erasure operations to minimize migration of data and unevenness in wear; perform erasures during idle times; quickly make erased blocks available for writing; detect and report failed blocks; maintain the overall state of a flash memory to satisfy real-time performance requirements; and detect and initialize a new flash memory device.

The second development is a combination of hardware and software that senses the failure of a main power supply and draws power from a capacitive storage circuit designed to hold enough energy to sustain operation until reading or writing is completed.

This work was done by Thomas K. Gender, James Chow, and William E. Ott of Honeywell, Inc., for Johnson Space Center. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)}, to Honeywell. Inquiries concerning licenses for its commercial development should be addressed to:

Satellite Systems Operation
Honeywell, Inc.
19019 N. 59th Avenue
Glendale, AZ 85308
Phone: (602) 313-5000

Refer to MSC-23465-1/6-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

GPS/MEMS IMU/Microprocessor Board for Navigation

Lyndon B. Johnson Space Center, Houston, Texas

A miniaturized instrumentation package comprising a (1) Global Positioning System (GPS) receiver, (2) an inertial measurement unit (IMU) consisting largely of surface-micromachined sensors of the microelectromechanical systems (MEMS) type, and (3) a microprocessor, all residing on a single circuit board, is part of the navigation system of a compact robotic spacecraft intended to be released from a larger spacecraft [e.g., the International Space Station (ISS)] for exterior visual inspection of the larger spacecraft. Variants of the package may also be useful in terrestrial collision-detection and -avoidance applications.

The navigation solution obtained by integrating the IMU outputs is fed back to a correlator in the GPS receiver to aid in tracking GPS signals. The raw GPS and IMU data are blended in a Kalman filter to obtain an optimal navigation solution, which can be supplemented by range and velocity data obtained by use of (1) a stereoscopic pair of electronic cameras aboard the robotic spacecraft and/or (2) a laser dynamic range imager aboard the ISS. The novelty of the package lies mostly in those aspects of the design of the MEMS IMU that pertain to controlling mechanical resonances and stabilizing scale factors and biases.

This work was done by Ching-Fang Lin of American GNC Corp. for Johnson Space Center. Further information is contained in a TSP (see page 1).

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:

American GNC Corporation
888 Easy Street
Simi Valley CA 93065
Phone No.: (866) 856-8686,
Fax No.: (805) 582-0098
E-mail: marketing@americangnc.com

Refer to MSC-23098-1, volume and number of this NASA Tech Briefs *issue, and the page number.*