

tion against overheating and thereby damaging nearby instrumentation leads through the use of conventional furnace brazing or any other technique that involves heating the entire BBS and its surroundings. The problem is further complicated by another application-specific prohibition against damaging the thin tantalum thermocouple sheaths through the use of conventional welding to join the thermocouples to the ring.

The first BBS rings were made of graphite. The tantalum-sheathed thermocouples were attached to the graphite rings by use of high-temperature graphite cements. The ring/thermocouple bonds thus formed were found to be weak and unreliable, and so graphite rings and graphite cements were abandoned.

Now, each BBS ring is made from one of two materials: either tantalum or a

molybdenum/titanium/zirconium alloy. The tantalum-sheathed thermocouples are bonded to the ring by laser brazing. The primary advantage of laser brazing over furnace brazing is that in laser brazing, it is possible to form a brazed connection locally, without heating nearby parts to the flow temperature of the brazing material. Hence, it is possible to comply with the prohibition against overheating nearby instrumentation leads. Also, in laser brazing, unlike in furnace brazing, it is possible to exert control over the thermal energy to such a high degree that it becomes possible to braze the thermocouples to the ring without burning through the thin tantalum sheaths on the thermocouples.

The brazing material used in the laser brazing process is a titanium-boron paste. This brazing material can with-

stand use at temperatures up to about 1,400°C. In thermal-cycling tests performed thus far, no debonding between the rings and thermocouples has been observed. Emissivity coatings about 0.001 in. (≈ 0.025 mm) thick applied to the interior surfaces of the rings have been found to improve the performance of the BBS sensors by raising the apparent emissivities of the rings. In thermal-cycling tests, the coatings were found to adhere well to the rings.

This work was done by Jeff Farmer and Chris Coppens of Marshall Space Flight Center and J. Scott O'Dell, Timothy N. McKechnie, and Elizabeth Schofield of Plasma Processes Inc. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32095-1.

Wrap-Around Out-the-Window Sensor Fusion System

Lyndon B. Johnson Space Center, Houston, Texas

The Advanced Cockpit Evaluation System (ACES) includes communication, computing, and display subsystems, mounted in a van, that synthesize out-the-window views to approximate the views of the outside world as it would be seen from the cockpit of a crewed spacecraft, aircraft, or remote control of a ground vehicle or UAV (unmanned aerial vehicle). The system includes five flat-panel display units arranged approximately in a semicircle around an operator, like cockpit windows. The scene displayed on each panel represents the view through the corresponding cockpit

window. Each display unit is driven by a personal computer equipped with a video-capture card that accepts live input from any of a variety of sensors (typically, visible and/or infrared video cameras).

Software running in the computers blends the live video images with synthetic images that could be generated, for example, from heads-up-display outputs, waypoints, corridors, or from satellite photographs of the same geographic region. Data from a Global Positioning System receiver and an inertial navigation system aboard the remote vehicle are used by the ACES soft-

ware to keep the synthetic and live views in registration. If the live image were to fail, the synthetic scenes could still be displayed to maintain situational awareness.

This work was done by Jeffrey Fox, Eric A. Boe, and Francisco Delgado of Johnson Space Center; James B. Secor II of Barrios Technology, Inc.; Michael R. Clark and Kevin D. Ehlinger of Jacobs Sverdrup; and Michael F. Abernathy of Rapid Imaging Software, Inc. Further information is contained in a TSP (see page 1).

Rapid Imaging Software, Inc. has requested permission to assert copyright for the software code. MSC-24020-1

Wide-Range Temperature Sensors With High-Level Pulse Train Output

John H. Glenn Research Center, Cleveland, Ohio

Two types of temperature sensors have been developed for wide-range temperature applications. The two sensors measure temperature in the range of -190 to $+200$ °C and utilize a thin-film platinum RTD (resistance temperature detector) as the temperature-sensing element. Other parts used in the fabrication of these sensors include NPO (negative-positive-zero) type ceramic capacitors for timing, thermally-stable film or wire-

wound resistors, and high-temperature circuit boards and solder.

The first type of temperature sensor is a relaxation oscillator circuit using an SOI (silicon-on-insulator) operational amplifier as a comparator. The output is a pulse train with a period that is roughly proportional to the temperature being measured. The voltage level of the pulse train is high-level, for example 10 V. The high-level output

makes the sensor less sensitive to noise or electromagnetic interference. The output can be read by a frequency or period meter and then converted into a temperature reading.

The second type of temperature sensor is made up of various types of multivibrator circuits using an SOI type 555 timer and the passive components mentioned above. Three configurations have been developed that were

based on the technique of charging and discharging a capacitor through a resistive element to create a train of pulses governed by the capacitor-resistor time constant.

Both types of sensors, which operated successfully over the wide temper-

ature range, have potential use in extreme temperature environments including jet engines and space exploration missions.

This work was done by Richard L. Patterson of Glenn Research Center and Ahmad Hammoud of ASRC Aerospace Corp. Further

information is contained in a TSP (see page 1). Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18350-1.

Terminal Descent Sensor Simulation

NASA's Jet Propulsion Laboratory, Pasadena, California

Sulcata software simulates the operation of the Mars Science Laboratory (MSL) radar terminal descent sensor (TDS). The program models TDS radar antennas, RF hardware, and digital processing, as well as the physics of scattering from a coherent ground surface. This application is specific to this sensor and is flexible enough to handle end-to-end design validation. Sulcata is a high-fidelity simulation and is used for performance evaluation, anomaly resolution, and design validation.

Within the trajectory frame, almost all internal vectors are represented in whatever coordinate system is used to

represent platform position. The trajectory frame must be planet-fixed. The platform body frame is specified relative to arbitrary reference points relative to the platform (spacecraft or test vehicle). Its rotation is a function of time from the trajectory coordinate system specified via dynamics input (file for open loop, callback for closed loop). Orientation of the frame relative to the body is arbitrary, but constant over time.

The TDS frame must have a constant rotation and translation from the platform body frame specified at run time. The DEM frame has an arbitrary, but

time-constant, rotation and translation with respect to the simulation frame specified at run time. It has the same orientation as sigma0 frame, but is possibly translated. Surface sigma0 has the same arbitrary rotation and translation as DEM frame.

This work was done by Curtis W. Chen 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 (626) 395-2322. Refer to NPO-46161.

A Robust Mechanical Sensing System for Unmanned Sea Surface Vehicles

NASA's Jet Propulsion Laboratory, Pasadena, California

The need for autonomous navigation and intelligent control of unmanned sea surface vehicles requires a mechanically robust sensing architecture that is watertight, durable, and insensitive to vibration and shock loading. The sensing system developed here comprises four black and white cameras and a single color camera. The cameras are rigidly mounted to a camera bar that can be re-configured to mount multiple vehicles, and act as both navigational cameras and application cameras. The cameras are

housed in watertight casings to protect them and their electronics from moisture and wave splashes.

Two of the black and white cameras are positioned to provide lateral vision. They are angled away from the front of the vehicle at horizontal angles to provide ideal fields of view for mapping and autonomous navigation. The other two black and white cameras are positioned at an angle into the color camera's field of view to support vehicle applications. These two cameras provide an overlap, as

well as a backup to the front camera. The color camera is positioned directly in the middle of the bar, aimed straight ahead. This system is applicable to any sea-going vehicle, both on Earth and in space.

This work was done by Eric A. Kulczycki, Lee J. Magnone, Terrance Huntsberger, Hrand Aghazarian, Curtis W. Padgett, David C. Trotz, and Michael S. Garrett of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46372