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## Software Suite to Support In-Flight Characterization of Remote Sensing Systems

*Stennis Space Center, Mississippi*

A characterization software suite was developed to facilitate NASA's in-flight characterization of commercial remote sensing systems. Characterization of aerial and satellite systems requires knowledge of ground characteristics, or ground truth. This information is typically obtained with instruments taking measurements prior to or during a remote sensing system overpass. Acquired ground-truth data, which can consist of hundreds of measurements with different data formats, must be processed before it can be used in the characterization. Accurate in-flight characterization of remote sensing systems relies on multiple field data acquisitions that are efficiently processed, with minimal error.

To address the need for timely, reproducible ground-truth data, a characterization software suite was developed to automate the data processing methods. The characterization software suite is engineering code, requiring some prior

knowledge and expertise to run. The suite consists of component scripts for each of the three main in-flight characterization types: radiometric, geometric, and spatial. The component scripts for the radiometric characterization operate primarily by reading the raw data acquired by the field instruments, combining it with other applicable information, and then reducing it to a format that is appropriate for input into MODTRAN (MODerate resolution atmospheric TRANsmission), an Air Force Research Laboratory-developed radiative transport code used to predict at-sensor measurements. The geometric scripts operate by comparing identified target locations from the remote sensing image to known target locations, producing circular error statistics defined by the Federal Geographic Data Committee Standards. The spatial scripts analyze a target edge within the image, and produce estimates of Rel-

ative Edge Response and the value of the Modulation Transfer Function at the Nyquist frequency.

The software suite enables rapid, efficient, automated processing of ground-truth data, which has been used to provide reproducible characterizations on a number of commercial remote sensing systems. Overall, this characterization software suite improves the reliability of ground-truth data processing techniques that are required for remote sensing system in-flight characterizations.

*This work was done by Thomas Stanley of Stennis Space Center; Robert Ryan, Mary Pagnutti, Slawomir Blonski, Kenton Ross, Kara Holekamp, Gerald Gasser, and Wes Tabor of Lockheed Martin; and Ronald Vaughan of CSC.*

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## Visual Image Sensor Organ Replacement

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This innovation is a system that augments human vision through a technique called "Sensing Super-position" using a Visual Instrument Sensory Organ Replacement (VISOR) device. The VISOR device translates visual and other sensors (i.e., thermal) into sounds to enable very difficult sensing tasks.

Three-dimensional spatial brightness and multi-spectral maps of a sensed image are processed using real-time image processing techniques (e.g. histogram normalization) and transformed into a two-dimensional map of an audio

signal as a function of frequency and time. Because the human hearing system is capable of learning to process and interpret extremely complicated and rapidly changing auditory patterns, the translation of images into sounds reduces the risk of accidentally filtering out important clues.

The VISOR device was developed to augment the current state-of-the-art head-mounted (helmet) display systems. It provides the ability to sense beyond the human visible light range, to increase human sensing resolution, to use

wider angle visual perception, and to improve the ability to sense distances. It also allows compensation for movement by the human or changes in the scene being viewed.

*This work was done by David A. Maluf of Ames Research Center. 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 1-855-NASA-BIZ (1-855-6272-249) or sumedha.garud@nasa.gov. Refer to ARC-15578-2.*