

A segmentation strategy was tested based on the “Felzenszwalb” algorithm for its simplicity and computational efficiency. This approach represents the hyperspectral image as an 8-connected grid of pixels that can begin as independent segments. Edges between nodes represent the distance between neighboring spectra, and each is weighted according to a measure of distance between pixels. The algorithm iteratively joins neighboring pixels together into larger segments, and describes each segment by the minimum spanning tree of edges that joins all segments in the cluster.

Hyperspectral segmentation algorithms partition images into spectrally homogenous regions. However, the exact definition of homogeneity is dependent on the chosen similarity metric. The segmentation algorithm is augmented with a task-specific distance metric. Here, a Mahalanobis distance metric is used, learned from training data. By leveraging a (small) set of labeled pixels with known mineralogical interpretations, the metric suppresses uninformative spectral content. Multiclass linear discriminant analysis (LDA) is used to maximize the ratio of between-class vs. within-class separation, defined by the

Rayleigh quotient computed over labeled training data. Other distance metrics and segmentation strategies are possible, and can be substituted for these choices in modular fashion as different applications demand.

This work was done by David R. Thompson and Rebecca Castano of Caltech, Brian Bue of Rice University, and Martha S. Gilmore of Wesleyan University for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-48092.

Basic Operational Robotics Instructional System

Lyndon B. Johnson Space Center, Houston, Texas

The Basic Operational Robotics Instructional System (BORIS) is a six-degree-of-freedom rotational robotic manipulator system simulation used for training of fundamental robotics concepts, with in-line shoulder, offset elbow, and offset wrist. BORIS is used to provide generic robotics training to aerospace professionals including flight crews, flight controllers, and robotics instructors. It uses forward kinematic and inverse kinematic algorithms to simulate joint and end-effector motion,

combined with a multibody dynamics model, moving-object contact model, and X-Windows based graphical user interfaces, coordinated in the Trick Simulation modeling environment.

The motivation for development of BORIS was the need for a generic system for basic robotics training. Before BORIS, introductory robotics training was done with either the SRMS (Shuttle Remote Manipulator System) or SSRMS (Space Station Remote Manipulator System) simulations. The unique construc-

tion of each of these systems required some specialized training that distracted students from the ideas and goals of the basic robotics instruction.

This work was done by Brian Keith Todd of Johnson Space Center, James Fischer of Titan Systems Corp., and Jane Falgout and John Schweers of L-3 Communications. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24850-1