Advanced Methods for Classification of Hyperspectral Data

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Accurate land cover classification that ensures robust mapping under diverse conditions is important in environmental studies where the identification of the land cover changes and its quantification have critical implications for management practices, ecosystem health, and the impact of climate. Hyperspectral data provide enhanced capability for more accurate discrimination of land cover, but significant challenges remain for classification, including highly correlated spectral bands, high dimensionality, and nonlinear spectral response in nonstationary environments. Advanced methods in machine learning, including nonlinear manifold learning, semi-supervised learning, and active learning are promising for classification of hyperspectral data.

Nonlinear global and local manifold learning methods provide natural capability to both accommodate nonlinear scattering and practical, robust feature extraction methods in dynamic environments. Adaptive semi-supervised approaches train the classifier with labeled samples in one location/time and adapt supervised classifiers to samples in spatially disjoint areas or at different times where samples exhibit significantly different distributions [Kim and Crawford 2010]. Active learning techniques that focus on developing informative training sets with minimal redundancy have been demonstrated to promote greater exploitation of the information in both labeled and unlabeled data, while significantly reducing the cost of data collection [Di and Crawford 2011]. New developments for feature extraction via manifold learning, semi-supervised classification, and active learning of hyperspectral data are outlined and demonstrated using airborne and space-based hyperspectral data.

Hyperspectral Remotely Sensed Data: Opportunities and Challenges

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Hyperspectral data provide new opportunities for exploiting chemistry specific features to characterize targets, perform atmospheric correction, cross calibrate sensors, and accomplish improved land cover mapping. Significant challenges remain due to correlated spectral bands, high dimensionality, and nonlinear spectral responses, as well as the quantity of data that is generated. Advanced methods in machine learning, including nonlinear feature extraction and active learning, are promising for analysis of hyperspectral data. Nonlinear manifold learning methods provide natural capability to both accommodate nonlinear scattering and practical, robust feature extraction methods in dynamic environments. Active learning techniques, that focus on developing informative training sets with minimal redundancy, promote greater exploitation of the information in both labeled and unlabeled data, while significantly reducing the cost of data collection. New developments for feature extraction via global and local manifold learning and strategies for active learning for classification and unmixing of hyperspectral data are presented, and the impact is demonstrated using testbed hyperspectral data from airborne platforms and the NASA Hyperion sensor.

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Melba Crawford is a Professor of Engineering and Agriculture at Purdue University, where she is Director of the Laboratory for Applications of Remote Sensing and the Chair of Excellence in Earth Observation. She also serves as the Associate Dean for Research of the College of Engineering. Previously, she was a faculty member at the University of Texas at Austin, where she founded an interdisciplinary research and applications development program in space-based and airborne remote sensing. Dr. Crawford received the B.S. and M.S. degrees in Civil Engineering from the University of Illinois, Urbana, and the Ph.D. degree in Systems Engineering from Ohio State University, Columbus.

Dr. Crawford's research focuses on methods for analysis of hyperspectral and LIDAR data, including classification, active learning, and knowledge transfer, and in the application of these methodologies. Her research includes collaborative studies in land cover mapping and monitoring, topographic mapping, hydrologic modeling, and characterization of vegetation structure. She has more than 150 publications in scientific journals, conference proceedings, and technical reports.

Dr. Crawford's professional activities include service to the IEEE Geoscience and Remote Sensing Society, where she is an elected member of the Administrative Committee. As Education Director (1998-2000), she had responsibility for K-12, undergraduate, graduate, and professional educational outreach programs. She served as Vice President for Professional Activities (1999-2001) and Vice President for Meetings and Symposia (2002-2011), and is currently the Executive Vice President of the GRSS Society. Dr. Crawford is an Associate Editor of the IEEE Transactions on Geoscience and Remote Sensing. She was also a member of the NASA Earth System Science and Applications Advisory Committee (ESSAAC), the NASA EO-1 Science Validation team for the Advanced Land Imager and Hyperion, and the advisory committee to the NASA Socioeconomic Applications and Data Center (SEDAC). In 2004-2005, Dr. Crawford was a Jefferson Senior Science Fellow at the U.S. Department of State, where she coordinated Science Sector activities within the U.S. National Commission to UNESCO and served as an advisor to the U.S. Ambassador to UNESCO.