

Remote Sensing Technology and Applications

Joan Lurie, FELLOW SPIE

BAE SYSTEMS

Remote Sensing Business Development

30 West 61st Street, Apt. 9A

New York, New York 10023

E-mail: Drjoan@gte.net

Edward M. Irvin, Jr.

Lockheed Martin Space Systems

Commercial Remote Sensing

1111 Lockheed Martin Way

O/D#01, B/107

Sunnyvale, California 94089

E-mail: ed.irvin@lmco.com

A long anticipated new era in remote sensing has begun with data now being acquired by commercially-owned satellites and airplanes as well as (as in the past) government-owned satellites. The advent of this era is marked by new imaging sensors and platforms including the first commercial high-resolution satellites. These provide better than 1 meter ground sample distance. There are several commercial systems, including IKONOS, Quickbird and EROS, providing an unprecedented quality and quantity of earth observation data in a very short time after acquisition! In addition, data can be readily purchased commercially from many other systems. The timely availability of this data opens up exciting new application areas including disaster management, urban planning and many others. For the first time in the history of remote sensing, there are systems and data currently in the commercial marketplace which, previously, were unavailable or available only to governments. The industry is maturing and this Remote Sensing special section of *Optical Engineering* includes papers addressing many aspects of the current state of remote sensing.

This special section begins with an overview of the global emergence of commercial earth observation satellites and their impact on current and future availability of digital remote sensing imagery data. This impact is synergistic with the rapidly expanding field of geospatial information systems (GIS) applications. Subsequent papers focus on: 1) image collection, 2) image processing tools, and 3) applications using both aerial and satellite collection platforms.

In their overview paper, Baker, O'Connor, and Venzor provide observations from their unique position at RAND on the emergence of commercially-operated high-resolution imaging satellites. Although capable of providing continuous earth coverage of great information value to GIS analysts, the high initial cost of satellites and com-

petition with government-sponsored systems present challenges for the private investor. Chief among these challenges are the policies of world governments that permit free public access to commercial imagery, as well as clear rules governing competition from government-sponsored competitors. The chief benefit of a financially healthy international commercial remote sensing satellite industry is nothing less than a significant increase in global transparency, with attendant benefits of timely environmental monitoring and common datasets accessible to all governments, non-government organizations (NGOs), and academic and commercial value-added services groups.

The group of papers on image collection includes Martin's paper describing the image collection optimization process. This optimization is crucial to maximize use of expensive remote sensing satellites. Gorin and Sharp each present important enabling techniques for hyperspectral imaging (HSI), an exciting remote sensing image dataset that promises significant increase in information content. Gorin's paper deals with the optimization, for object detection and recognition, of atmospheric correction of hyperspectral data in the thermal wave bands. His technique uses a new image assessment measure, the spectral similarity scale, to quantify the "goodness of fit" for spectral emissivity output from atmospheric correction. Sharp describes a data compression technique to greatly reduce the vast amounts of data to be stored and transmitted from HSI sensors having 200+ sensor bands recorded in each image pixel. She demonstrates the technique's effectiveness on datasets from a number of operational HSI sensors.

The image processing papers describe automated approaches to extract information from imagery data and a technique to protect the intellectual property rights of a digital image by embedding a digital watermark. Cheng and Toutin describe an automated process of extracting

digital elevation models (DEMs) from stereo images of a ground area of interest. The process, using a satellite geometry model developed at the Canadian Center for Remote Sensing, is used to compare the accuracy of automatically-extracted DEMs from the SPOT and ASTER imaging sensors with a USGS DEM of the same ground area of interest. Haverkamp describes a fully automated process that extracts and marks straight roads on images of urban environments captured by the 1-meter resolution commercial satellite IKONOS. Barni, Bartolini, Magli, and Olmo assess existing digital watermarking techniques when applied to remote sensing imagery and show how modification of these techniques can have minimal impact on an important image processing analysis: unsupervised classification.

Applications of remote sensing range from environmental management and planning to aiding in disaster response. The first two papers in the applications group describe how remote sensing can be used in disaster response. Rodarmel, Scott, Simerlink, and Walker relate how multiple remote sensing devices aboard an aerial platform were of significant value to the rescue and cleanup operations following the attack on the World Trade Center in New York City. They make the important point that in certain situations, imagery data from multiple parts of the electromagnetic spectrum are essential to extract the information needed. They also describe their rapid hardware integration and analysis accomplishments in achieving daily overflights of the WTC site and delivery of actionable information to people on the ground. Laben describes the integration of remote sensing data and GIS technology in order to produce and manage decision support products for disaster management at the Pacific Disaster Center on Maui, Hawaii. Gomez discusses the application of hyperspectral imaging to transportation systems analysis as well as the status and importance of the development of spectral libraries. Spectral libraries, relating spectrographic response to various surfaces and materials, are required for interpretation of HSI images, not only in transportation but in any application area. Almeida-Guerra describes the successful application of SPOT imagery data to study change in land use along the Colombian Caribbean coast and the development of coastal management policy.

Based upon the broad interest from potential contributors who were unable to complete papers in time for this issue, we believe this special section can be repeated in the future. We thank all the authors contributing to this special section, the reviewers for their timely reviews of the papers selected here, and the *Optical Engineering* staff for their patient guidance and support.



Joan Lurie's current position is in business development for remote sensing at BAE SYSTEMS. The application areas include all aspects of remote sensing imagery systems with emphasis on data exploitation and utility of hyperspectral imagery. She has also been an imagery systems consultant in the same area. Her recent assignments have concentrated on applications of commercial remote sensing to several vertical markets including agriculture, timber, and geology. Dr. Lurie has over twenty

years experience in industry and academia in technical management, market analysis, and strategic planning for use of satellite imagery data of the earth. She was the Director of Strategic Marketing at Datron/Transco, Inc. Before joining Datron, Dr. Lurie was Remote Sensing Applications Manager at TRW with emphasis on business acquisition in the areas of commercial, government, and environmental applications. One of her principal responsibilities was the development of commercial and civil applications of remotely sensed data in US and international markets. She and her staff developed hyperspectral data analysis systems focused on applications in agriculture, mineral exploration, and timber assessment. In 1994, 1995, 1996, 1999, 2000 and 2001 Dr. Lurie was a conference chairperson and proceedings editor at international symposia entitled Satellite Remote Sensing and cosponsored by SPIE and the European Optical Society. In 1996 and 1997 she acted as chair of the Terrestrial Applications of Multispectral Data conference at the SPIE Annual meeting. Dr. Lurie has been active on several SPIE committees including Publications and Symposium. She was a founding member and chair of Women in Optics. In 2002, she will chair the Engineering, Science and Technology Policy Committee. Dr. Lurie spent nine years as a physics professor at Rider College in Lawrenceville, NJ. She held two postdoctoral appointments, at Rutgers University in New Jersey and University College, London, UK. She received doctorate and master's degrees in physics from Rutgers University after completing a BS in physics, summa cum laude, at the City University of New York.



Edward M. Irvin, Jr., has been the Director of Commercial Remote Sensing/IKONOS programs at Lockheed Martin Space Systems Company—Sunnyvale Operations since Fall of 1999. From 1994–1999, he was a System Engineering Manager for the IKONOS Remote Sensing System. As Capture Manager for the Commercial Remote Sensing System from 1991–1994, he was one of the founders and architects of the CRSS/IKONOS business plan and the IKONOS concept of operations. He began his career as a Remote Sensing Analyst intern for the U.S. Government in 1980. He joined Lockheed in 1983, starting as a Senior Research Engineer, Special Programs from 1983–1985; Project Leader, Image Processing Laboratory from 1985–1990; and Manager, Advanced Technology Development, Special Programs 1991. During this time, he was involved in the research, design, and development of multi-sensor algorithms, large scale digital processing systems, and advanced satellite imaging system concepts developments. He graduated with highest honors from the University of California at Santa Barbara with bachelor's and master's degrees in geography/remote sensing. He also was awarded a one year academic fellowship in 1982 for postgraduate work in remote sensing/geographic information systems at the University of Hamburg, West Germany.