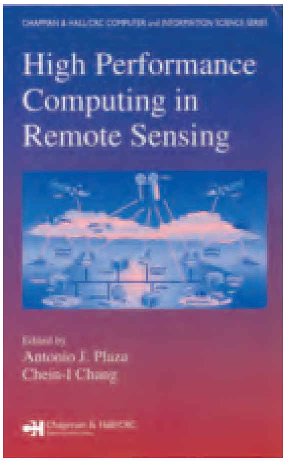
Book Review



High Performance Computing in Remote Sensing

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Chapman & Hall/CRC: Boca Raton, FL. 2008. xxvi and 466 pp., images, diagrams, index

ISBN 978-1-58488-662-4

Hardcover. $99.95

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High Performance Computing in Remote Sensing introduces the most recent advances in the incorporation of the high-performance computing (HPC) paradigm in remote sensing missions. Eighteen well-selected and organized chapters cover the entire spectrum of current and future data processing techniques in remote sensing applications, with a focus on the use of HPC techniques.

This book begins with an introduction chapter that describes the major innovative contributions covered by this book and its individual chapters. The book is divided into four parts. The first part describes basic concepts of HPC in remote sensing and provides a detailed review of existing and planned HPC systems in this area. Each of the remaining three parts illustrate a specific parallel computing paradigm, including multiprocessor (cluster-based) systems, large-scale and heterogeneous networks of computers, and specialized hardware architecture for analysis and interpretation of remotely-sensed data.

Part One begins with an extensive review of the state-of-art design of HPC systems for remote sensing missions. It also includes a case study in which the pixel purity index (PPI), a well-known processing algorithm, is implemented on three different HPC platforms: a massively parallel multiprocessor, a heterogeneous network of distributed computers, and a specialized field programmable gate array (FPGA) hardware architecture. Analytical and experimental results are presented in the context of a real application, using hyperspectral data collected by the NASA Jet Propulsion Laboratory's Airborne Visible Infra-Red Imaging Spectrometer (AVIRIS) over the World Trade Center area of New York City right after the 9/11 terrorist attacks. Another paper in this part covers multimedia and video data processing as another example of an HPC application that demands high computational power.

Part Two describes a compendium of algorithms and techniques for HPC-based remote sensing data analysis using multiprocessor systems such as clusters and networks of computers, including massively parallel facilities. A paper authored by Gillis *et al.* presents a parallel version of the Optical Real-Time Adaptive Spectral Identification System (ORASIS) developed at the Naval Research Laboratory for the analysis of remotely-sensed hyperspectral image data. A paper authored by Tilton describes a parallel implementation of a recursive approximation of the hierarchical image segmentation algorithm (HSEG) developed at NASA. The paper demonstrates the computational efficiency of the algorithm by testing the implementation on multispectral remotely-sensed data collected by the Landsat Thematic Mapper instrument. A paper authored by Asner *et al.* summarizes the major processing steps and challenges involved in collection and analysis of hyperspectral image data, and presents examples of how high-performance computing is used to meet these challenges. It also discusses the emerging use of other HPC techniques, such as data processing onboard aircraft and spacecraft platforms, and distributed Internet computing. A paper authored by Plaza *et al.* presents the use of parallel neural network architectures for solving remote sensing problems. Finally a paper by Valencia *et al.* presents the use of HPC-based remote sensing techniques to address wildland fires.

Part Three is devoted to large-scale and heterogeneous distributed computing by focusing on parallel techniques for remote sensing data analysis using large-scale distributed platforms, with a special emphasis on grid computing environments and fully heterogeneous networks of workstations. A paper by Lee begins with an introduction on the fundamental concepts of grid computing, Web services, and service-oriented architectures, and is followed by a survey of current grid infrastructure and science projects relevant to remote sensing. A paper authored by Gasster *et al.* presents the background, architecture, implementation and examples of remote sensing grids. A paper by Fusco *et al.* describes some European Space Agency (ESA) activities related to the use of grid technology for Earth Observation: ESA Grid Processing on-Demand environment, and several Earth Observation applications that have been plugged into the environment. A paper by Cafaro *et al.* presents an overview of grid computing environments and discusses their usefulness in the context of remote sensing. This part ends with a paper by Velez-Reyes *et al.* that describes the concept of a solutionware system for the solution of hyperspectral/multispectral remote sensing image processing problems. The paper presents

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the implementations of parallel processing in the Itanium architecture and a prototype version of a hyperspectral image processing toolbox over the grid.

Part Four is comprised of five chapters and is devoted to systems and architectures for at-sensor and real-time collection and analysis of remote sensing data using specialized hardware and embedded systems. It also includes specific aspects about current trends in the design and operation of remote sensing sensors. A paper by Green reviews the critical characteristics of an imaging spectrometer instrument and the corresponding characteristics of the measured spectra, and discusses the roles for the application of high-performance computing methods to AVIRIS. A paper by EI-Araby *et al.* discusses the roles of reconfigurable computing using FPGAs for onboard processing of remotely sensed data. A paper by Wang *et al.* descries an FPGA implementation of the constrained energy minimization (CEM) algorithm, which has been widely used for hyperspectrum-based object detection and classification. A paper by Du discusses the constrained linear discriminant analysis (CLDA) algorithm and its real-time implementation for processing of hyperspectral imagery for target detection and discrimination. The book closes with a paper by Setoain *et al.* that addresses the emerging use of graphic processing units (GPUs) for on-board processing of remotely sensed data.

In conclusion, this book provides a state-of-the-art summary of the HPC techniques – including cluster computers, workstation and grid networks, field programmable gate arrays, and graphics processing unites – used to solve remote sensing problems. It is a good reference for researchers and practitioners in remote sensing, computer engineering, and other related fields. The book is especially useful for design and implementation of high performance systems for collecting, storing, and analyzing hyperspectral remotely sensed data.