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BOOK REVIEWS

QUANTITATIVE REMOTE SENSING OF LAND SURFACES. By S. LIANG. *John Wiley & Sons Inc., Hoboken, New Jersey, USA*, 2004. ISBN 0 471 28166 2. 160 × 243 mm. xxvi + 534 pages, plus CD-ROM. Illustrated. Price £82·50 hardback.

THIS NEW BOOK presents the principles of optical remote sensing and selected algorithms for quantitatively estimating land surface variables from remotely sensed observations. According to the author, it evolved from lecture notes he prepared for a graduate course on remote sensing. The structure, content and style of the book reflect this. It has an explicit structure: it contains neat descriptions of context, terms, concepts, principles and complex models; it cites relevant scientific literature, and the style facilitates and encourages the study of quantitative methods of optical remote sensing of land surfaces.

The book is essentially in two parts, with introductory and concluding chapters. The first part covers Chapters 2 to 4, and the second part Chapters 5 to 12.

In Chapter 1, the author explains concepts of optical remote sensing of land surface variables. Quantitative models for estimating land surface variables from remotely sensed data fall into three categories: statistical, physical and hybrid. A concise review of concepts of optical remote sensing of land surfaces describes digital numbers, radiance and its directional dependence through solid angles, irradiance, bi-directional reflectance, albedo and extra-terrestrial solar irradiance. The components of modelling systems for remote sensing include scene generation, scene radiation modelling, atmospheric radiative transfer modelling, navigational modelling, and mapping and locating the results of modelling on the earth's surface. A forward modelling system predicts what remote sensing data will be, under a given set of remote sensing and environmental conditions. A physically-based inversion scheme determines various land surface geophysical and biophysical variables. The author aptly lays the foundation for the rest of the book.

The first part of the book describes methods of physical modelling of the earth's atmosphere, vegetative canopies, soil and snow. Chapter 2 introduces radiative transfer in the atmosphere. It describes the radiative transfer equation in the solar spectrum, outlines analytical models of the bi-directional reflectance distribution function (BDRF) of land surfaces, to specify the lower boundary conditions of the radiative transfer equation, and links the quantities in this equation to atmospheric properties. It includes various numerical and approximate solutions, and approximate forms of radiative interactions between atmosphere and surface. Chapter 3 introduces physically-based canopy reflectance models for linking canopy properties with radiance measured by a remote sensor. It describes canopy radiative transfer formulae that are appropriate for dense vegetative canopies, introduces leaf-optical models that provide necessary leaf-optical properties for most canopy reflectance models, outlines geometric optical models that are used for sparse vegetative canopies, and discusses

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Monte Carlo ray tracing and radiosity simulation models. Chapter 4 introduces soil and snow reflectance models, including radiative transfer and geometric optical models and highlighting similarities between modelling BDRFs for snow and ice. It introduces the scattering properties of single particles of snow and soil, optical properties of soil, multiple scattering solutions for angular reflectance from snow and soil, including approximate and numerical solutions, geometric optical modelling and inversion of snow parameters, and discusses practical issues. The systematic analytical presentation of key concepts, theories and methods is impressive, for both its clarity and its brevity.

The second part of the book describes selected algorithms for estimating land surface variables from optical remotely sensed data. It provides a synthesis of a wealth of scientific information and forms the heart of the book. Chapter 5 explains the importance of radiometric calibration of satellite sensors, presents concepts and principles, describes current post-launch methods of sensor calibration, and shows calibration results from Landsat 4 and 5 Thematic Mapper and NOAA AVHRR. Chapter 6 presents algorithms for atmospheric correction of optical remote sensing images, describing the context, representative algorithms for correcting single- and multiple-viewing angle images, and presenting selected algorithms for estimating water vapour content of the atmosphere. Chapter 7 is on applying topographic corrections to remotely sensed images. It explains semi-empirical and physically-based methods, and reviews current methods for generating digital elevation models, because of their critical importance in applying topographic corrections. Chapter 8 is on estimating land surface biophysical variables from optical remote sensing. It presents concisely and informatively selected vegetative indices, and their functional relationships with biophysical and biochemical models, both for multispectral and hyperspectral remote sensing systems. It explores spatial signatures, in terms of variograms, and outlines procedures for estimating leaf-area index and fractional photosynthetically active radiation from AVHRR and techniques for physical inversion, using traditional optimisation methods in conjunction with a canopy radiative transfer model, generic algorithms, table lookup and hybrid algorithms. Chapters 9 and 10 neatly describe methods of estimating surface radiation budgets, using broadband albedo and long-wave radiation, respectively. Chapter 11 is on four-dimensional data assimilation, a relatively new technique for providing physically consistent estimates of spatially distributed environmental variables. The estimates are derived by using a dynamic model from heterogeneous, irregularly distributed and temporally inconsistent observation data, acquired by different optical remote sensing systems, with different levels of spatial, spectral and temporal resolution. After presenting basic concepts and mathematical descriptions of dynamic models for data assimilation, representative algorithms are briefly outlined from meteorology and oceanography, hydrology and crop-growth models. Chapter 12 describes methods of calibrating models, and validating products derived from models by field measurement on the ground. As spatial resolution becomes coarser, advanced methods of spatial scaling must be developed to determine the accuracy of products. The author summarises background information, then explains the need for, and explores methods of validating, land surface products, as well as comparing different algorithms and products.

Earth observation is driven by scientific questions and practical applications, according to the author. Having reviewed techniques for estimating land surface variables, the author sets out, in the final chapter, to show how the derived products can be used to solve practical problems, by reviewing ways in which to integrate remote sensing with ecological models, agriculture, urban-heat islands, global carbon cycles, and improving our understanding of land–atmosphere interactions.

This book represents a tour de force by Liang. It provides a systematic and contemporary review of the theory and methods of estimating land surface variables from optical remote sensing. The concise synthesis of concepts, theories, methods and applications is not only stimulating to read, but also invaluable as a comprehensive reference on the subject. Written in an economical style and without much discussion, the structure and argument is coherent and commendably clear, the illustrations are helpful and the compact disc contains relevant computer programs and sets of data. With over 1300 references to the scientific literature, readers can delve further into most topics. The book is extremely well produced, with a good layout, clear type, a useful list of acronyms and a comprehensive index. It is timely and refreshing, fills a gap in the market, will make a valuable addition to university libraries, and is highly recommended to students, academics and scientists.

J. Hogg

AN INVITATION TO 3-D VISION: FROM IMAGES TO GEOMETRIC MODELS. By Y. Ma, S. Soatto, J. Košecká and S. S. Sastry *Springer-Verlag, New York, USA*, 2004. ISBN 0 387 00893 4. 162 × 242 mm. xx + 526 pages. 170 illustrations. Price £61·50 hardback.

This is primarily a textbook of core principles, taking the reader from the most basic concepts of machine vision, such as image formation, to detailed applications, such as autonomous vehicle navigation. Perhaps, most importantly, it begins by explaining why machine vision is "hard", in the sense that any mathematical model of a real image by necessity must be a crude one, making the matching of features between two images even more problematic, at least on the surface. This serves to put the book in its proper context, as one dealing primarily with the geometric principles of machine vision and, to a lesser extent, with photometry and basic image processing techniques. Thus, the emphasis is on camera calibration and scene reconstruction and their applications. It is a clearly written book, and assumes no previous knowledge of machine vision. Everything that is required is introduced, particularly in the first of the three parts of the book, with main appendices covering topics such as optimisation and Kalman filtering. Each chapter also has its own set of appendices, which serve to develop certain topics in greater detail, so as not to detract from the flow of discussion in the chapter itself, along with exercises that allow the reader to develop certain details. The treatment is mathematically rigorous and consistent, but not impenetrable, as most things are introduced quite clearly. Everything you need to know to get started in machine vision is here, in an entirely self-contained work.

The first part of the book contains necessary background material on rigid-body motion, image formation and some basic image processing, such as feature matching. This also serves to develop some of the mathematical background used in later chapters.

The second part of the book presents many of the classical results from the projective geometry of two views, for example the properties of the essential matrix and its decomposition into four pose solutions, and just why this ambiguity arises. As this is a book of core principles, one will not see some topics that are covered in other books, such as those by Hartley and Zisserman (2001) and Kanatani (1993). There is

