Remote Sensing Digital Image Analysis

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An Introduction

Fifth Edition

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Preface

The first edition of this book appeared 25 years ago. Since then there have been enormous advances in the availability of computing resources for the analysis of remote sensing image data, and there are many more remote sensing programs and sensors now in operation. There have also been significant developments in the algorithms used for the processing and analysis of remote sensing imagery; nevertheless, many of the fundamentals have substantially remained the same. It is the purpose of this new edition to present material that has retained value since those early days, along with new techniques that can be incorporated into an operational framework for the analysis of remote sensing data.

This book is designed as a teaching text for the senior undergraduate and postgraduate student, and as a fundamental treatment for those engaged in research using digital image processing in remote sensing. The presentation level is for the mathematical non-specialist. Since the very great number of operational users of remote sensing come from the earth sciences communities, the text is pitched at a level commensurate with their background. That is important because the recognised authorities in the digital image analysis literature tend to be from engineering, computer science and mathematics. Although familiarity with a certain level of mathematics and statistics cannot be avoided, the treatment here works through analyses carefully, with a substantial degree of explanation, so that those with a minimum of mathematical preparation may still draw benefit. Appendices are included on some of the more important mathematical and statistical concepts, but a familiarity with calculus is assumed.

From an operational point of view, it is important not to separate the techniques and algorithms for image analysis from an understanding of remote sensing fundamentals. Domain knowledge guides the choice of data for analysis and allows algorithms to be selected that best suit the task at hand. Such an operational context is a hallmark of the treatment here. The coverage commences with a summary of the sources and characteristics of image data, and the reflectance and emission characteristics of earth surface materials, for those readers without a detailed knowledge of the principles and practices of remote sensing. The book then progresses though image correction, image enhancement and image analysis, so that digital data handling is properly located in its applications domain.

While incorporating new material, decisions have been taken to omit some topics contained in earlier editions. In particular, the detailed compendium of satellite programs and sensor characteristics, included in the body of the first three editions and as an appendix in the fourth, has now been left out. There are two reasons for that. First, new satellite and aircraft missions in optical and microwave remote sensing are emerging more rapidly than the ability for a book such as this to maintain currency and, notwithstanding this, all the material is now readily obtainable through Internet sources. A detailed coverage of data compression in remote sensing has also been left out.

Another change introduced with this edition relates to referencing conventions. References are now included as footnotes rather than as end notes for each chapter, as is more common in the scientific literature. This decision was taken to make the tracking of references with the source citation simpler, and to allow the references to be annotated and commented on when they appear in the text. Nevertheless, each chapter concludes with a critical bibliography, again with comments, containing the most important material in the literature for the topics treated in that chapter. One of the implications of using footnotes is the introduction of the standard terms *ibid*, which means the reference cited immediately before, and *loc. cit.,* which means cited previously among the most recent set of footnotes.

I am indebted to a number of people for the time, ideas and data they have contributed to help bring this work to conclusion. My colleague and former student, Dr Xiuping Jia, was a co-author of the third and fourth editions, a very welcome contribution at the time when I was in management positions that left insufficient time to carry out some of the detailed work required to create those editions. On this occasion, Dr Jia's own commitments have meant that she could not participate in the project. I would like to place on record, however, my sincere appreciation of her contributions to the previous editions that have flowed through to this new version and to acknowledge the very many fruitful discussions we have had on remote sensing image analysis research over the years of our collaboration.

Dr Terry Cocks, Managing Director of HyVista Corporation Pty Ltd, Australia, very kindly made available HyMap hyperspectral imagery of Perth, Western Australia to allow many of the examples contained in this edition to be generated. Dr Larry Biehl of Purdue University was enormously patient and helpful in bringing me up to an appropriate level of expertise with MultiSpec. That is a valuable and user-friendly image analysis package that he and Professor David Landgrebe have been steadily developing over the years. It is derived from the original LARSYS system that was responsible for much digital image processing research in remote sensing carried out during the 1960s and 1970s. Their transferring that system to personal computers has brought substantial and professional processing capability within reach of any analyst and application specialist in remote sensing.

Finally, it is with a great sense of gratitude that I acknowledge the generosity of spirit of my wife Glenda for her support during the time it has taken to prepare this

new edition, and for her continued and constant support of me right through my academic career. At times, a writing task is relentless and those who contribute most are friends and family, both through encouragement and taking time out of family activities to allow the task to be brought to conclusion. I count myself very fortunate indeed.

Canberra, ACT, Australia, February 2012 John A. Richards

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