

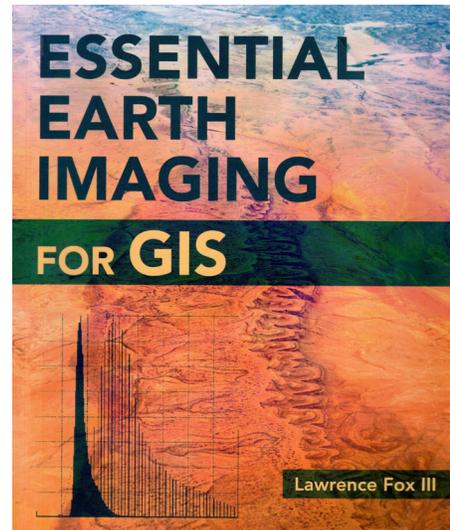
In the GIS world, imagery has been used for geoprocessing for decades. Imagery has always been a very important component of Geospatial applications. With continually advancing imagery technology, it becomes even more so. GIS software provides various functionalities and tools for processing, displaying, and interpreting imagery and extracting the features from it. Understanding how the software works to process the imagery becomes a normal, required task for geospatial professionals to do the work efficiently. The book *Essential Earth Imaging for GIS* written by Lawrence Fox III provides rich information and guidelines in GIS imagery technology not only for geospatial professionals but also for the college student, as a reference for introductory GIS courses that include multi-spectral imagery display and analysis.

Essential Earth Imaging for GIS provides a basic education in imaging technology and management, promoting the effective use of imaging tools in GIS software. This book includes concepts and methods of image formation and manipulation that enable the user to efficiently and effectively display, co-register, enhance, interpret and delimit features from earth imagery.

The book opens with a short but thorough introduction that orients the book's audience, the goals of the book, and explains how and why the book is organized as it is. The outline of each chapter is provided. It is a slim book with eight chapters, references, and index.

Chapter 1, "Overview of Imaging GIS," briefly describes the earth imagery history while it summarizes the types of imagery used in GIS based on the sensor systems that include satellites, aircraft, and unmanned aerial systems (UAS). The chapter identifies the structure of the two-dimensional digital imagery in which the value of each cell or pixel represents the brightness of imagery. With this important concept, the author points out that "*the interpreter can use the geographic pattern of relative brightness values to help correctly interpret Earth features....*" Right after this important perspective, another fundamental but crucial concept of color imagery is introduced: "...all colors can be formed from various shades of three additive primary colors: red, green and blue. Every color image is actually three images superimposed in various shades of those three colors. In the same chapter, the author also discusses the Three-dimensional data that is used for three-dimensional visualization of terrain in GIS software.

Chapter 2, "The Physical Basis and General Methods of Remote Sensing," presents the most important learning point of the book. The author uses straightforward language to explain the principles of electromagnetic (EM) radiation, the engine of image formation in virtually all earth imaging systems. The author covers the complex science of imaging systems, the capabilities, and limitations of various remote sensing methods, the aerial and spaceborne platforms and how their characteristics influence the attributes of the imagery collected from



Essential Earth Imaging for GIS

Lawrence Fox III

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them with simple diagrams, pictures, and detailed explanations. This is one of the longest chapters in the book. The author invests much effort in demonstrating the theories and the advanced level science behind the remote sensing technology, which the reader should appreciate.

Chapter 3 "Effects of the Atmosphere on Image Quality" is equally important for the user to understand. In this chapter, the user will learn how atmosphere and cloud cover affects the electromagnetic (EM) radiation detected by remote sensing systems. The author clearly presents for the reader very important concepts and facts related to the topic by using numbers, diagrams, and pictures in addition to the detailed explanations. One example of the easy to understand statements but very important concepts in the chapter is "When mapping surface features with imaging GIS, the reflected or emitted radiation is the *signal*, and the atmospheric contribution is the *noise*."

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Chapter 4 “Creating Two-dimensional Images with Sensors” educates the user to understand how sensors work to effectively use the two-dimensional images generated by remote sensors. The chapter covers the details of instruments that generate two-dimensional images, including cameras, multispectral sensors, and imaging radar. In this chapter, the most fascinating section would be “General image attributes: The Four Rs.” The author explains the imagery attributes in great detail because *“an understanding of four attributes of images allows practitioners to evaluate different types of remote sensing images for many applications regardless of the sensor technology used to produce them.”* The four Rs are the characteristics of the imagery resolution. They all exist in our daily practice when we, as geospatial professionals, produce imagery or use it in our GIS analysis. Accordingly, understanding these four Rs and applying this knowledge in our work will help us do our work efficiently and deliver the best results possible to our customers.

Chapter 5, “Displaying Digital Images with GIS Software” opens with a talk about human vision and the engineer’s ability to mimic human color perception to make color photography, television, and remote sensing imagery. In the section “True-color Images,” the author renders the history of “the tristimulus theory of color vision...key to the development of color imaging..” and reviews the theory with colorful diagrams. He provides examples of the application in image display and printing technology. In the section “Assigning spectral bands to colors,” the author leads us to an even broader knowledge base by teaching us to understand how spectral bands are assigned to colors and how to learn to assign them in effective ways to produce false colors to help us to gather more information in remote processing. The section “How Software Controls Contrast and Brightness of Color Displays” discusses the details and mathematics of histograms and presenting image brightness. The section “Stretching the Histogram of a Single-band Image to Enhance Contrast and Brightness” in GIS software provides important guidelines for practitioners to understand how to use the tools to achieve the best imagery display when working with the imagery. The last section of the chapter introduces “Pseudo Color Images” that should not be confused with false-color images, as pointed out by the author.

Chapter 6, “Generating Three-dimensional Data with Photogrammetric Measurements and Active Sensors”, introduces the audience to another important topic regarding earth imagery. The author overviews the technologies that generate three-dimensional data including photogrammetry, lidar, and interferometric radar technology. The section “Obtaining Vertical and Horizontal Positions from Aerial Photographs” includes subsections “Geometry of a Single Aerial Photography,” “Geometry of an Overlapping Pair of Aerial Photographs,” “Digital Surface Models and Orthophotos,” and “Incorporating Machine Vision into Photogrammetry” which cover important concepts, technologies, and methodologies of Photogrammetry.

The section “Obtaining Vertical and Horizontal Positions from Lidar Sensors” presents how the lidar systems work. The last section “Obtaining Vertical and Horizontal Positions from Interferometric Radar Sensors” briefly but precisely describes how interferometric radar works to produce three-dimension data.

Chapter 7, “Image Processing,” includes a typical workflow illustrating image processing procedures that are normally performed by imager providers, image analysts and GIS software users. The chapter provides the detailed technical knowledge and guidelines for Imager Restoration,” “Image Rectification,” and “Imager Enhancement.” It also discusses challenges and technology in the “Conversion to Radiance” and “Atmospheric Correction” in imaging processing. Toward the end of the chapter, the author briefly prescribes “Image Processing in the Cloud” that has been increasingly popular in the geospatial industry with advancing internet technology. In the last section of this chapter, “Typical Workflow for Image Processing,” a workflow chart demonstrates the procedures used in the image processing while the summary of each step in the flowchart is clearly stated.

Chapter 8, the final chapter, “Extracting Information from Images” provides very important and useful guidelines for GIS professionals to perform the tasks of imagery interpretation and delineation using GIS software. The user will also learn the advantages and disadvantages of automated image classification methods and how to evaluate maps generated using these methods. In the same chapter, the author points toward the future developments of the technology.

The book is well organized so that the user can follow along easily. The author explains the details of each technical topic with straightforward language and professionally. The book provides many useful examples, pictures, diagram and tables, which makes the book easy and fun to read. Moreover, the user can actually get hands on the GIS software and do the excises with real data. The exercises are thoughtfully designed and the data carefully selected. The step by step, easy follow instructions are included in the exercise materials. These exercises help the user to understand the book in the context of the professional industry.

The author provides detailed information in the Introduction of the book about how and where to download the 180-day trial of ArcGIS software and associated exercise instructions and data. The book is well written and provides very useful guidelines for GIS professionals, as well as great resources for students who are pursuing a geospatial career. Even if one is already familiar with GIS software, he/she can still derive great benefits from studying the book to get a better understanding of earth imagery, which should benefit them in their daily work. My only suggestion might be that it should be more convenient for the user if the Exercise Instructions were made part of the book as an appendix. Regardless, it is a great book and strongly recommended for geospatial professionals who are working with Earth imagery and students who want to understand Earth imaging in GIS processing and analysis.