Introduction to the Mathematics of Medical Imaging, Second Edition

Charles L. Epstein

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At the heart of every medical imaging technology is a sophisticated mathematical model of the measurement process and an algorithm to reconstruct an image from the measured data. This book provides a firm foundation in the mathematical tools used to model the measurements and derive the reconstruction algorithms used in most imaging modalities in current use. In the process, it also covers many important analytic concepts and techniques used in Fourier analysis, integral equations, sampling theory, and noise analysis.

This text uses X-ray computed tomography as a "pedagogical machine" to illustrate important ideas and incorporates extensive discussions of background material making the more advanced mathematical topics accessible to readers with a less formal mathematical education. The mathematical concepts are illuminated with over 200 illustrations and numerous exercises.

New to the second edition are a chapter on magnetic resonance imaging (MRI), a revised section on the relationship between the continuum and discrete Fourier transforms, a new section on Grangreat s formula, an improved description of the gridding method, and a new section on noise analysis in MRI.

Audience The book is appropriate for one- or two-semester courses at the advanced undergraduate or beginning graduate level on the mathematical foundations of modern medical imaging technologies. The text assumes an understanding of calculus, linear algebra, and basic mathematical analysis.

Contents Preface to the Second Edition; Preface; How to Use This Book; Notational Conventions; Chapter 1: Measurements and Modeling; Chapter 2: Linear Models and Linear Equations; Chapter 3: A Basic Model for Tomography; Chapter 4: Introduction to the Fourier Transform; Chapter 5: Convolution; Chapter 6: The Radon Transform; Chapter 7: Introduction to Fourier Series; Chapter 8: Sampling; Chapter 9: Filters; Chapter 10: Implementing Shift Invariant Filters; Chapter 11: Reconstruction in X-Ray Tomography; Chapter 12: Imaging Artifacts in X-Ray Tomography; Chapter 13: Algebraic Reconstruction Techniques; Chapter 14: Magnetic Resonance Imaging; Chapter 15: Probability and Random Variables; Chapter 16: Applications of Probability; Chapter 17: Random Processes; Appendix A: Background Material; Appendix B: Basic Analysis; Index.

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