

Preface

The story is told that young King Solomon was given the choice between wealth and wisdom. When he chose wisdom, God was so pleased that he gave Solomon not only wisdom but wealth also. So it is with science.

Arthur Holly Compton

Because of the unique function of our visual system for information gathering and processing, images or pictures play a central role in our daily lives. In fact, much of what we know about ourselves and the world around us has been derived from images produced by various imaging devices. Magnetic resonance imaging (MRI), in particular, can produce images from human or any biological system noninvasively that reveal the structure, metabolism, and function of internal tissues or organs, greatly extending the range of human vision into realms that would otherwise be inaccessible. The impact of this imaging technique on diagnostic radiology has been revolutionary in the last two decades because of its capability to produce anatomical images with unprecedented quality and safety to the patient. With the ever-improving technology to produce images at higher speed (ultra-fast imaging), higher resolution (microimaging), and higher information content (combined anatomical, metabolic, and functional imaging), MRI will likely have similar impact in biology and neuroscience in the years to come.

Functionally, MRI can be regarded as one of the tomographic imaging techniques that produce images of the interior of an object from data collected outside. What really makes it more fascinating and attractive scientifically than many other techniques are its versatility and flexibility. To quote a popular saying of Erwin Hahn, “there is nothing that nuclear spins will not do for you, as long as you treat them as human beings.”

This book is about MRI. Although its working principles are not the easiest to understand for beginning students, they are certainly fun to learn. This book is

our attempt to help your endeavor. In contrast to many existing books on this subject, our discussions will be based on a signal processing approach in which the descriptions of the fundamental concepts and principles center around a signal. This approach is motivated largely by the consideration that understanding how MR signals are generated, detected, manipulated, and processed into an image is essential. The book has ten chapters covering five major topics of MRI: (1) signal generation, detection, and characteristics, (2) spatial localization principles, (3) image reconstruction, (4) image resolution, contrast, noise, and artifacts, and (5) advanced concepts on data acquisition (fast-scan imaging) and processing (constrained reconstruction). The style of presentation is aimed at upper-level undergraduate and graduate engineering students for use as a textbook on this subject. Toward this end, we have included homework problems in each chapter to assist the instructors in teaching and the students in learning the material. In addition, we hope that the materials are covered at an appropriate level to be useful as a reference for medical imaging scientists in this field.

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