

Preface

This book discusses the basic concepts of MRI leading to PC-MRA. An intuitive understanding of PC-MRA concepts is provided through simulation techniques using the extended form of Bloch equation. For completeness, quantitative flow measuring techniques and post-processing using statistical models are also included as separate chapters. Implementation details of important techniques discussed in this book are provided in the form of MATLAB codes.

PC-MRA is one of the non-contrast MRA techniques using the idea that blood flow velocities can be encoded by phase. This was first developed by Paul R. Moran in the early 1980s. Moran analyzed the phase effects on stationary and moving spins subjected to a pair of bipolar gradients. A stationary spin subjected to such a gradient pair will experience no net phase shift, but a moving spin will have a net phase shift proportional to its velocity. Two spins flowing at the same speed but in opposite directions will have equal but opposite phase shifts, and by measuring changes in phase, the velocity can be computed.

PC-MRA is based on use of bipolar gradients that create phase shifts of moving spins proportional to their velocities. The key applications include flow measurements, Cine CSF flow studies, and venography. The degree of sensitivity to slow or fast flows is determined by the amplitude, duration, and spacing of bipolar gradients, which is controlled by parameter VENC—velocity encoding. Simulation experiments outlined in this book provide a sound understanding of the encoding strategy and enable the reader to apply this knowledge in acquisition and post-processing methods.

Acknowledgments

Some sections of this book are based on previous articles: “Computer Simulation of Magnetic Resonance Angiography Imaging: Model Description and Validation,” Plos one 9. (2014) and “*In Silico* Modeling of Magnetic Resonance Flow Imaging in Complex Vascular Networks,” IEEE transactions on medical imaging, 33: 11 (2014).

Understanding Phase Contrast MR Angiography

A Practical Approach with MATLAB examples

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