
Table of Contents

| | |
|--|-----------|
| Summary | 9 |
| Zusammenfassung | 15 |
| 1. Introduction | 21 |
| 1.1 Background | 22 |
| 1.2 NMR – basic principles | 23 |
| 1.3 From NMR to MRI | 24 |
| 1.4 Dynamic field imperfections | 28 |
| 1.5 Static field imperfections | 31 |
| 1.6 Spatiotemporal field monitoring | 33 |
| 1.7 Thesis outline | 36 |
| 2. Gradient System Characterization by Impulse Response | |
| Measurements with a Dynamic Field Camera | 39 |
| 2.1 Introduction | 40 |
| 2.2 Theory and Methods | 43 |
| <i>Probing an LTI system</i> | 43 |
| <i>Dynamic field camera</i> | 47 |
| <i>GIRF measurements</i> | 48 |
| 2.3 Results | 51 |
| <i>GIRF measurements</i> | 51 |
| <i>GIRF-based predictions</i> | 56 |
| 2.4 Discussion | 60 |
| <i>Applications</i> | 60 |
| <i>Model limitations</i> | 61 |
| <i>Mechanical oscillations & cross-terms</i> | 62 |
| <i>Sensitivity and resolution</i> | 63 |
| <i>Measurement time</i> | 64 |
| 2.5 Conclusion | 64 |

| | |
|---|------------|
| 3. Field Camera Measurements of Gradient and Shim Impulse Responses Using Frequency Sweeps | 67 |
| 3.1 Introduction | 68 |
| 3.2 Theory | 70 |
| <i>Impulse response measurements</i> | 70 |
| <i>Linear frequency sweeps</i> | 71 |
| <i>Variable sweep speed</i> | 76 |
| 3.3 Methods | 79 |
| <i>Shim hardware</i> | 79 |
| <i>Field measurements</i> | 81 |
| <i>System characterization</i> | 83 |
| 3.4 Results | 85 |
| 4.5 Discussion | 96 |
| 5.6 Conclusion | 101 |
| 4. Digital broadband cross-term pre-emphasis for gradients and shims | 103 |
| 4.1 Introduction | 104 |
| 4.2 Theory | 107 |
| <i>Pre-emphasis by GIRF inverse</i> | 108 |
| <i>Cross-term pre-emphasis</i> | 111 |
| <i>Iterative optimization of input waveforms</i> | 114 |
| 4.3 Pre-emphasis implementations | 116 |
| <i>Frequency-domain fit</i> | 116 |
| <i>SIRF inverse</i> | 119 |
| <i>Cross-term pre-emphasis</i> | 122 |
| <i>Sequence-specific optimization</i> | 127 |
| 4.4 Discussion and Conclusion | 130 |
| 5. Image reconstruction using the gradient impulse response for trajectory prediction | 135 |
| 5.1 Introduction | 136 |
| 5.2 Methods | 138 |
| 5.3 Results | 140 |
| 5.4 Discussion | 145 |
| 5.5 Conclusion | 147 |

6. Retrospective correction of physiological field fluctuations in high-field brain MRI using concurrent field monitoring 149

6.1 Introduction 150

6.2 Methods 153

Concurrent field monitoring 155

Snapshot field monitoring 157

Image reconstruction 158

6.3 Results 158

6.4 Discussion 165

6.5 Conclusion 169

7. Outlook 171

References 175

List of Publications 189

Curriculum Vitae 195

Acknowledgments 197