

5.3.2	Optimized sound source for broadband excitation	94
5.3.3	Using measured directivity patterns for the synthesis	97
5.4	Applications of directivity synthesis	100
5.4.1	Directivity synthesis of musical instruments radiation patterns: Simultaneous approach using a dodecahedron loudspeaker	100
5.4.2	Directivity synthesis for RIR measurements: Sequential approach using tilted dodecahedron loudspeaker	105
5.4.3	Directivity synthesis for high resolution radiation patterns: Sequential approach using an optimized spherical loudspeaker array	110
5.5	Summary directivity patterns in room acoustic measurements	114
6	Including directivity patterns in room acoustic simulations	115
6.1	Directivity in wave based room simulation	116
6.1.1	Spatial sampling of the eigenfunctions of a room	116
6.1.2	Radiation of monopoles and physical multipoles	117
6.1.3	Spherical wave spectrum of physical multipoles	118
6.1.4	Verification of the algorithm	120
6.2	Directivity in particle based room simulation	123
6.2.1	Implementation for fixed source and receiver directivity patterns	124
6.2.2	Implementation for exchangeable directivity patterns	124
6.2.3	Efficient pre-processing for exchangeable receiver directivity patterns	125
6.3	Summary directivity patterns in room acoustic simulation	126
7	Conclusions and Outlook	129
A	Appendix	133
A.1	Geometry of the used measurement devices	133
A.1.1	Surrounding flexible array (turntable and arm)	133
A.1.2	Surrounding spherical LS array (HRTF arc)	134
A.1.3	Surrounding spherical microphone array (24 channels)	135
A.1.4	Surrounding spherical microphone array (32 channels)	136
A.1.5	Spherical loudspeaker array (12 channels, midrange device) .	137
A.1.6	Spherical loudspeaker array (28 channels, SLAYER)	138
A.2	Implementation of array measurements	139
A.2.1	Calibration of surrounding spherical microphone array	139
A.2.2	Optimizing the directivity of the array sensors	140

Contents

A.3	Spherical datasets	146
A.3.1	Musical instrument recordings (Berlin, 2009)	146
A.3.2	HRTFs measurement data at different ranges	147
A.3.3	SLAYER Radiation	147
A.4	Software tools, data processing and visualization	151
A.4.1	ITA-Toolbox for Matlab	151
A.4.2	Data formats (HDF5, OpenDAFF)	151
A.4.3	Implementation of Balloon plots	152
A.4.4	Visual quality assessment of spherical data	153
Glossary		155
Bibliography		159
List of Figures		171
Acknowledgments		175