

List of Figures

1.1	Resource management context	2
1.2	Chatspace: people meet and communicate in cyberspace	5
1.3	Unicast source → sink transmissions: orphaned sources adopted by sinks	7
1.4	Helical Keyboard: an application	12
1.5	Multiple sources can be used to model complex radiation pattern	13
2.1	System schematic	22
2.2	Source sets for spatialization	24
2.3	Audible and intensity ranges for sound source and sound sink	28
3.1	Concept — Interface — Models	32
3.2	Source loudness amplification	35
3.3	Image-based rendering	36
3.4	Cone of confusion; locus of points with the same ITD and ILD	39
3.5	Horizontal and vertical unsigned localization errors for a broadband signal; ellipses axes denote error in azimuth and elevation	40
3.6	Sensitivity for elevation discrimination depends on content and direction: d' measures the sensitivity; stars (EXP) are the results for the explosion samples; circles (SPE) are the results for speech samples; full symbols (DRY) are results without reverberation	42
3.7	Time-domain responses at nine occluder angles	44
3.8	Filter model magnitude response for reflected and occluded sound	46
3.9	Reflector and occluder recording setup	48
3.10	Identification of reflector presence	51
3.11	Identification of occluder presence	52
3.12	Identification of occluder presence in reverberation	52
3.13	Processing element for one sound pass including control parameters	53

4.1	Clustering of sources in resolution cone with similar moving direction and speed: the cluster in the left upper corner shows two cars chasing each other in the distance in direction away from the sink; the cluster in the right upper corner represents a stationary group of people talking; the other sound sources cannot be clustered because of different motion direction, or because they do not fit into one resolution cone	60
4.2	Clustering reduces the number of required spatialization channels	61
4.3	Two sound sources A and B are clustered together within the resolution cone of the representative virtual sound source C .	62
4.4	Listener inside the cylindrical coordinate system	65
4.5	left: Cylindrical coordinate system; right: Representative source location	65
5.1	Scenegrph with sound objects	72
5.2	Sound source node specification	72
5.3	Sound sink node specification	74
5.4	Soundscape node specification	75
6.1	Spatialization device interface	78
6.2	Multimedia Center: Virtual Reality Zone	80
6.3	Multimedia Center: Pioneer Sound Field Controller	80
6.4	Early reflections and reverberation	82
7.1	A/B test for spatialization backends via dummy head	90
7.2	Dissimilarity for non-restricted (N), clustered (C), and ambient (A) processing	94
8.1	Resource allocation without reaching the limited number of spatialization channels	96
8.2	Only two spatialization channels are available; clustering process starts, along with source assignment to ambient channels	97
8.3	Enlargement of a section of Figure 8.2	97
8.4	Listener movement changes clustering	98
8.5	88 inactive sound sources and one sound sink	98
8.6	One sound source becomes active	99
8.7	Two sound source are requested	100
8.8	Three sound sources are requested; clustering algorithm becomes active	100
8.9	Four sound sources are requested	101
8.10	Rotation of the sound sink changes the cluster allocation . . .	101

8.11 Moving closer with the sound sink to all sound sources 102
8.12 Moving closer again; cones become smaller 103
8.13 Moving closer again; cones become smaller; clusters get split up 103
8.14 Besides on sound source, active sound sources are passed . . . 104
8.15 Side view shows that resolution cones to the back are larger . 104

9.1 Soundscape deformer 110
9.2 Soundscape deformer: flattening 111
9.3 Soundscape deformer: narrowing 112
9.4 Soundscape deformer: extreme diotic case 112
9.5 Sound spatialization resource manager panel 114
9.6 Test scene with sound source visualization 115
9.7 Sound node editor 116
9.8 Tool data-flow 117

List of Tables

1.1	${}^s\text{O}U_{\text{Tput}}^{\text{rce}}$ and ${}^s\text{I}N_{\text{put}}^{\text{k}}$	6
1.2	User and delegate	8
1.3	Deafening and muting one's own and others' avatars	9
1.4	Reflexive and transitive audio exclude and include operations	10
2.1	Resource management	26
3.1	Spatialization/localization taxonomy	34
3.2	Frequency band determines limits of spatial resolution	39
6.1	Abstract spatialization backend interface	84
6.2	Comparison between spatialization backend interfaces	84
6.3	Comparison between spatialization backend features	85
7.1	Stimuli use of spatialization resources	91
7.2	Stimuli source description (using the coordinate system of the CRE API)	92
7.3	Trial combinations	92
7.4	Dissimilarity between intervals: non-restricted (N), clustered (C), and ambient (A)	93

List of Algorithms

- 1 Simple filtering algorithm 25
- 2 Simple algorithm to calculate source processing priority . . . 28
- 3 Selecting occluder for sound sink path 54
- 4 Clustering algorithm for sound sources 63