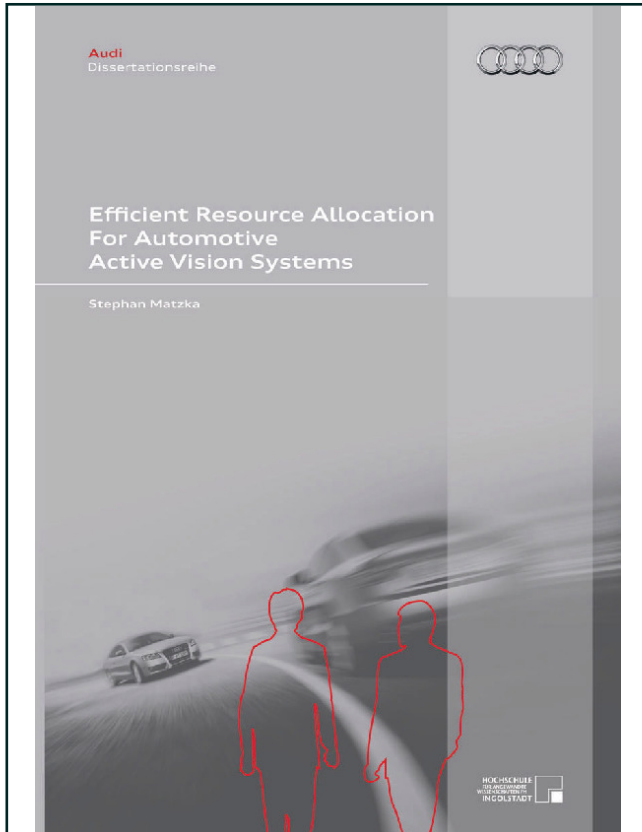




Stephan Matzka (Autor)

Efficient Resource Allocation for Automotive Active Vision Systems



<https://cuvillier.de/de/shop/publications/852>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Table of Contents

Front Matter	i
Abstract	i
Dedication	iii
Acknowledgements	v
Table of Contents	xi
List of Figures	xiii
List of Tables	xix
List of Publications	xxv
Symbols	xxvii
1 Introduction	1
1.1 Motivation	1
1.2 Initial situation	4
1.2.1 Environment	4
1.2.2 Goal	5
1.2.3 Sensor Configuration of the Test-Vehicle	7
1.3 System Overview	8
1.4 Contribution	10
1.5 Thesis Outline	12
2 Literature Review	13
2.1 Automotive Sensor Systems	14
2.1.1 Autonomous Driving Systems	14
2.1.2 Driver Assistance Systems	19
2.1.3 Discussion of Automotive Sensor Systems	20
2.2 Object Detection and Object Classification	21
2.2.1 2-D Object Detection and Classification	21

2.2.2	3-D Object Detection and Classification	27
2.2.3	Discussion of Object Detection and Object Classification	31
2.3	Decision Making	32
2.3.1	Moral Theories on Risk	32
2.3.2	Pareto Efficiency	35
2.3.3	Multiobjective Resource Allocation	36
2.3.4	Multiagent Resource Allocation	42
2.3.5	Discussion of Decision Making	44
2.4	Active Vision Systems	45
2.4.1	Human Visual System	45
2.4.2	Bottom-Up Saliency Driven Vision Systems	51
2.4.3	Top-Down Saliency Driven Vision Systems	60
2.4.4	Combined Bottom-Up and Top-Down Vision Systems	63
2.4.5	Utility-Based Vision Systems	67
2.4.6	Discussion of Active Vision Systems	70
3	Sensor Level	73
3.1	Differential Global Positioning System	73
3.2	Video Cameras	74
3.3	Laser Scanner	75
3.4	Photonic Mixer Device	75
3.5	Discussion of Sensors	76
3.5.1	Sensor Modalities	76
3.5.2	Sensor Ranges	77
4	Data Level	79
4.1	Coordinate Systems	79
4.1.1	Plan View	79
4.1.2	Perspective View	80
4.1.3	Coordinate Transformation	81
4.2	Position and Velocity of Ego-Vehicle	82
4.3	Luminance	83
4.4	Range	84
4.5	Motion	84

4.5.1	Range Profile Differentiation	84
4.5.2	2-D and 3-D Motion Vector Maps	86
4.6	Discussion of Data Level Modules	97
5	Semantic Level	99
5.1	Road Type	100
5.2	2-D Traffic Participant Detection and Classification	101
5.2.1	Training and Evaluation of Cascades	102
5.2.2	Pedestrian Classifier Cascades	103
5.2.3	Car Classifier Cascades	107
5.2.4	Lorry Classifier Cascades	109
5.2.5	Human Detector Cascade and Vehicle Detector Cascades	112
5.2.6	Validation of detected Traffic Participants	115
5.3	3-D Traffic Participant Classification	118
5.3.1	Spin Image Generation with sparse Input Data	119
5.3.2	Regression of Scan Pattern Features	122
5.3.3	Generating efficient Scan patterns	127
5.4	Saliency Detection	129
5.4.1	Implemented Saliency Detectors	129
5.4.2	Evaluation of Saliency Detection	131
5.5	Time-to-collision	136
5.6	Discussion of Semantic Level Modules	139
6	Reasoning Level	141
6.1	Traffic Participant Probability Determination	141
6.1.1	Statistical Information	142
6.1.2	Dynamic Information	143
6.1.3	Fusion of Statistical and Dynamic Information	146
6.2	Candidate Region Determination	150
6.2.1	Use of Saliency	151
6.2.2	Use of Traffic Participant Detection	152
6.2.3	Use of Statistically Optimal Regions	154
6.2.4	Evaluation of Candidate Region Determination	154
6.2.5	Comparison of Strategies for Candidate Region Determination	159

6.3	Discussion of Reasoning Level Modules	162
6.3.1	Traffic Participant Probability Determination	162
6.3.2	Candidate Region Quality	163
7	Contextual Resource Allocation	165
7.1	Resource Allocation Concept	165
7.1.1	Influences on Decision Making	166
7.1.2	Forms of Decision Making	168
7.1.3	Formalisation of Resource Allocation Problem	170
7.1.4	Proposed Resource Allocation Concept	171
7.2	Determination of Combined Utility	173
7.2.1	Introduction of Example Scene	174
7.2.2	Objectives for Utility Optimisation	176
7.2.3	Evaluation of Combined Utility	187
7.3	Sensor Resource Allocation Heuristics	190
7.3.1	Exhaustive Search Method	191
7.3.2	Best-First Search Method	192
7.3.3	Pre-Sorted Search Method	192
7.3.4	Sensor Model for Utility Calculation	195
7.3.5	Evaluation of Sensor Resource Allocation Heuristics	199
7.4	Computational Resource Allocation Heuristics	205
7.4.1	Scaling of Computational Costs	205
7.4.2	Queue Scheduling	206
7.4.3	Determination of Classifiers and Priorities	209
7.4.4	Evaluation of Computational Resource Allocation Heuristics	211
7.5	Evaluation of Contextual Resource Allocation	215
7.5.1	Evaluation of Contextual Sensor Resource Allocation	215
7.5.2	Evaluation of Contextual Computational Resource Allocation	218
7.5.3	Resulting Allocations for Test Sequences	222
7.6	Discussion of Contextual Resource Allocation	222
7.6.1	Severity Determination	222
7.6.2	Resource Allocation Concept	224
7.6.3	Discussion of Resulting Allocations for Test Sequences	225

8	Conclusions and Future Work	227
8.1	Conclusion	227
8.2	Future Work	229
A	Test Sequences	233
B	Resulting Allocations	239
B.1	Allocation for Traffic Calmed Sequence (TRC)	241
B.2	Allocation for Urban Sequence (URB)	248
B.3	Allocation for Motorway Sequence (MWY)	255
	Bibliography	277