

Contents

Part I Introduction

1	The Research Initiative UR:BAN	3
	Eberhard Hipp, Klaus Bengler, Ulrich Kressel, and Stefan Feit	
1.1	Motivation	3
1.2	The UR:BAN Research Initiative	5
1.3	Relation of UR:BAN to National Research Strategies	7
1.4	Work Program	8
1.5	Human Factors in Traffic (MV)	8
1.6	Cognitive Assistance (KA)	13
1.7	Networked Traffic System (VV)	19

Part II Urban Driving

2	A Meta-perspective on Research Activities in UR:BAN Human Factors in Traffic	29
	Matthias Graichen, Verena Nitsch, and Berthold Färber	
2.1	Introduction to the Project “Urban Driving”	29
2.2	Methodological Approach	32
2.3	Evaluation of Project Results	36
2.4	Summary and Conclusion	44
	References	45

Part III Human-Machine Interaction for Urban Environments

3	Introduction of Human-Machine Interaction for Urban Environments . .	49
	Julia Drüke	

4	The “HMI tool kit” as a Strategy for the Systematic Derivation of User-Oriented HMI Concepts of Driver Assistance Systems in Urban Areas . . .	53
	Julia Drücke, Carsten Semmler, and Lennart Bendewald	
4.1	Introduction	53
4.2	HMI Tool Kit	54
4.3	Applications of Urban HMI Concepts	69
4.4	Conclusion	72
	References	73
5	HMI Strategy – Warnings and Interventions	75
	Susann Winkler, Matthias Powelleit, Juela Kazazi, Mark Vollrath, Wolfgang Krautter, Andreas Korthauer, Julia Drücke, Daniel Töpfer, Carsten Semmler, and Lennart Bendewald	
5.1	Background	75
5.2	Concepts for Warnings and Urgent Warnings (Technische Universität Braunschweig)	77
5.3	Detecting and Warning of Visually Distracted Drivers (Robert Bosch GmbH)	88
5.4	Collision Avoidance by Autonomous Evasive Manoeuvre (Volkswagen AG and Technische Universität Braunschweig)	95
5.5	Conclusion	101
	References	102
6	HMI Strategy – Lateral and Longitudinal Control	105
	Sonja Hofauer, Britta Michel, Sigrun Weise, Anna Julia Karmann, Frank Diermeyer, Amelie Stephan, Julia Drücke, Carsten Semmler, and Lennart Bendewald	
6.1	Introduction	105
6.2	Theoretical Background	106
6.3	Implementing the HMI Strategy	108
6.4	Conclusion	117
	References	118
7	HMI Strategy – Recommended Action	119
	Lena Rittger and Martin Götze	
7.1	Introduction	119
7.2	Definition	119
7.3	HMI Concept for a Traffic Light Assistant (Adam Opel AG)	121
7.4	Generic, Integrative HMI Concept for Multiple ADAS (Technical University of Munich)	138
	References	148

Part IV Behaviour Prediction and Intention Detection

8	Behaviour Prediction and Intention Detection in UR:BAN VIE – Overview and Introduction	153
	Dietrich Manstetten	
8.1	Introduction	153
8.2	Working Steps in UR:BAN VIE	154
8.3	Summary of Results and Outlook Towards Automated Driving	158
8.4	Outline of Following Chapters	160
	References	161
9	Analysing Behavioural Data from On-Road Driving Studies: Handling the Challenges of Data Processing	163
	Matthias Graichen, Verena Nitsch, and Berthold Färber	
9.1	Introduction	163
9.2	Driving at Urban Intersections	164
9.3	Exploring Behavioural Data from On-Road Driving Studies: Challenges and Solutions	167
9.4	Summary and Conclusion	179
	References	180
10	Predicting Strategies of Driving in Presence of Additional Visually Demanding Tasks: Inverse Optimal Control Estimation of Steering and Glance Behaviour Models	183
	Felix Schmitt, Andreas Korthauer, Dietrich Manstetten, and Hans-Joachim Bieg	
10.1	Introduction	183
10.2	Distraction and Additional Tasks in Driving	184
10.3	Approaches to Mitigate Distraction	184
10.4	Modelling Driver Strategies for Allocation of Visual Attention	186
10.5	Experiment in Real Traffic	194
10.6	Numerical Evaluation	197
10.7	Conclusion	202
	References	202
11	Lane Change Prediction: From Driver Characteristics, Manoeuvre Types and Glance Behaviour to a Real-Time Prediction Algorithm	205
	Matthias Beggiato, Timo Pech, Veit Leonhardt, Philipp Lindner, Gerd Wanielik, Angelika Bullinger-Hoffmann, and Josef Krems	
11.1	Introduction	205
11.2	Methods	208

11.3	Results	211
11.4	Discussion and Conclusions	218
	References	220
12	Fusion of Driver Behaviour Analysis and Situation Assessment for Probabilistic Driving Manoeuvre Prediction	223
	Veit Leonhardt, Timo Pech, and Gerd Wanielik	
12.1	Introduction	223
12.2	Preliminary Considerations	224
12.3	Recognition of an Intention to Perform a Manoeuvre	226
12.4	Real-Time Application	236
12.5	Experimental Results	238
12.6	Summary and Conclusions	242
	References	243
13	Human Focused Development of a Manoeuvre Prediction in Urban Traffic Situations Based on Behavioural Sequences	245
	Jens Heine, Ingmar Langer, and Thomas Schramm	
13.1	Motivation and Goal	245
13.2	Method of Development and State of the Art	247
13.3	Experimental Study	249
13.4	Development of an Algorithm for Manoeuvre Prediction	252
13.5	Integration in Demonstrator Vehicle	259
13.6	Use of Driving Manoeuvre Prediction	261
13.7	Conclusion and Outlook	262
	References	263
14	Application of a Driver Intention Recognition Algorithm on a Pedestrian Intention Recognition and Collision Avoidance System . .	267
	Frederik Diederichs, Nina Brouwer, Horst Klöden, Peter Zahn, and Bernhard Schmitz	
14.1	Driver Intention Recognition for Pedestrian Collision Avoidance Systems	267
14.2	Theoretical Concepts of Intention Recognition and their Measurement Potential	270
14.3	Measure Driver Intention to Brake	272
14.4	Application and Demonstration for Pedestrian Collision Avoidance System in the Vehicle	278
14.5	Outlook: Acceptance and Safety	282
	References	283

Part V Simulation and Modelling of Road Users' Behaviour

15	Simulation and Modelling Within the UR:BAN Project	287
	Silja Hoffmann and Fritz Busch	
16	Methodology and Results for the Investigation of Interactions Between Pedestrians and Vehicles in Real and Controlled Traffic Conditions	291
	Jens Kotte and Andreas Pütz	
	16.1 Research Questions and Overall Methodology	291
	16.2 Interaction Study Under Real Traffic Conditions	293
	16.3 Static Traffic Observation Under Real Traffic Conditions	300
	16.4 Interaction Study Under Controlled Traffic Conditions	304
	16.5 Summary	308
	References	310
17	Understanding Interactions Between Bicyclists and Motorists in Intersections	311
	Mandy Dotzauer, Sascha Knake-Langhorst, and Frank Köster	
	17.1 Introduction	311
	17.2 AIM Research Intersection	315
	17.3 Observation of Bicyclist-Motorist Interactions in Intersections	319
	17.4 Findings and Implications	320
	17.5 Further Research	322
	References	323
18	Analysis and Modelling of the Operational and Tactical Behaviour of Bicyclists	325
	Heather Twaddle	
	18.1 Motivation	325
	18.2 Data Collection and Processing	328
	18.3 Data Analysis	330
	18.4 Behaviour Modelling	339
	18.5 Discussion and Conclusions	342
	References	343
19	Urban Interaction – Getting Vulnerable Road Users into Driving Simulation	347
	Christian Lehsing and Ilja T. Feldstein	
	19.1 Motivation and Goals – The Situation in 2012	347
	19.2 Social Interaction at a Glance	348
	19.3 Pedestrian Simulators – A Global but Divergent Approach	349
	19.4 Implementing the VRU – The UR:BAN Approach	350
	19.5 The Multiple-Simulator Setting – Enabling Social Interaction	353

19.6	Interaction in Numbers – A Methodological Overview	354
19.7	Conclusions and Outlook	360
	References	360
20	Encounters Between Drivers with and Without Cooperative Intelligent Transport Systems	363
	Katharina Preuk, Mandy Dotzauer, Frank Köster, and Meike Jipp	
20.1	Cooperative Intelligent Transport Systems	363
20.2	Why Research Encounters Between Drivers with and Without C-ITS?	365
20.3	How to Research Encounters Between Drivers	367
20.4	Encountering Drivers with Traffic Light Assistance Systems: Overview of a Study	369
20.5	Encounters Between Drivers with and Without C-ITS: Open Questions	370
	References	374
21	The Multi-Driver Simulation: A Tool to Investigate Social Interactions Between Several Drivers	379
	Dominik Muehlbacher	
21.1	Need for Multi-Driver Simulation?	379
21.2	The WIVW Multi-Driver Simulation	381
21.3	Study 1: Driver Models vs Human Drivers	382
21.4	Study 2: Single-Driver Simulation vs Multi-Driver Simulation	385
21.5	Conclusion	389
	References	390
22	A New Approach to Investigate Powered Two Wheelers' Interactions with Passenger Car Drivers: the Motorcycle – Car Multi-Driver Simulation	393
	Sebastian Will	
22.1	Abstract	393
22.2	Introduction	393
22.3	Simulator Setup: The Motorcycle-Car Multi-Driver Simulation	394
22.4	Study Example: Intersection Support	396
22.5	Conclusion	401
	References	401
23	Multi-Road User Simulation: Methodological Considerations from Study Planning to Data Analysis	403
	Dominik Muehlbacher, Katharina Preuk, Christian Lehsing, Sebastian Will, and Mandy Dotzauer	
23.1	Introduction	403
23.2	Planning Studies	404
23.3	Conducting Studies	406

23.4 Analyzing Data	409
23.5 Conclusion	415
References	417
Part VI Controllability and Safety in Use Assessment of Advanced Driver Assistance Systems	
24 Development and Evaluation of Methods to Assess Controllability and Safety in Use Within the UR:BAN Project	421
Alexandra Neukum and Norbert Schneider	
25 Validity of Research Environments – Comparing Criticality Perceptions Across Research Environments	423
Christian Purucker, Norbert Schneider, Fabian Ruger, and Alexander Frey	
25.1 Introduction	423
25.2 Theoretical Background: Validity of Research Environments	424
25.3 Methodology	430
25.4 Results	436
25.5 Discussion	442
References	444
26 Emergency Steering Systems – Controllability Investigations with the Vehicle in the Loop	447
Fabian Ruger and Berthold Farber	
26.1 Introduction	447
26.2 Emergency Steering Interventions at Occupied Opposite Lanes	449
26.3 Emergency Steering Seen from Oncoming Traffic	452
26.4 Summary	458
References	459
27 Consideration of the Available Evading Space for the Evaluation of the Driver Reaction to Emergency Steering Interventions	461
Andreas Putz	
27.1 Introduction and Motivation	461
27.2 Existing Knowledge on the Influence of the Driving Context in the Controllability Assessment	462
27.3 Deduction of Related Research Questions and Hypothesis for the Experiment	463
27.4 Experimental Design for the Evaluation of the Influence of the Available Evading Space	464
27.5 Reaction Patterns to System Initiated Emergency Steering Interventions .	466
27.6 Influence of the Available Evading Space on the Driver Reaction	470

27.7 Influence of a Retraction Possibility on the Driver Reaction 473

27.8 Design of an Exemplary Override Criterion 475

27.9 Conclusions 476

 References 477

**28 Designing Emergency Steering and Evasion Assist to Enhance Safety
in Use and Controllability 479**

Norbert Schneider, Guy Berg, Svenja Paradies, Peter Zahn, Alexander
Huesmann, and Alexandra Neukum

28.1 Introduction 479

28.2 Intervention Concepts 480

28.3 Actuators 481

28.4 Design Implications Based on Experimental Studies 483

 References 492

**29 Integrating Different Kinds of Driver Distraction
in Controllability Validations 495**

Rico Auerswald, Alexander Frey, and Norbert Schneider

29.1 Introduction 495

29.2 Methodological Implications & Recommendations 496

29.3 Case Studies 499

29.4 Conclusion 516

 References 517