Smart Mobile In-Vehicle Systems

Gerhard Schmidt • Huseyin Abut
Kazuya Takeda • John H.L. Hansen
Editors

Smart Mobile In-Vehicle Systems

Next Generation Advancements

Springer

Editors
Gerhard Schmidt
Christian-Albrechts-Universität
Kiel, Germany

Huseyin Abut
San Diego State University
San Diego, CA, USA

Kazuya Takeda
Nagoya University
Nagoya, Japan

John H.L. Hansen
The University of Texas at Dallas
Dallas, TX, USA

ISBN 978-1-4614-9119-4 ISBN 978-1-4614-9120-0 (eBook)
DOI 10.1007/978-1-4614-9120-0
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2013953325

© Springer Science+Business Media New York 2014
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

Part A: Interesting Facts About the Automobile and Its History

The adventure of the automobile and its place in our lives exhibit a long and fascinating history. Until the introduction of intelligence and information processing, milestones have included the invention of engines using different power sources: steam, electricity, and gasoline. Its roots, however, can be traced back to the end of the fifteenth century. At that time Leonardo Da Vinci was drawing a three-wheel vehicle. It was not really a motor-car because it was powered by strings. They had to be stretched by operators. The vehicle did not have seats and it is not entirely clear what application Da Vinci really had in mind [1].

The first car that did not need muscular strength was built in 1769 by a Frenchman named Joseph Cugnot. He took advantage of the invention of the steam engine and its further enhancements. His vehicle was bulky and consequently was very difficult to control. In fact, a "chauffeur"—the French word for fireman—was needed to heat the boiler [2]. Steam driven cars were still in use in the twenties of the last century.

January 29, 1886 is considered as the real birth day of the automobile as we know it today. On this date Carl Benz received the patent for a "car with a combustion engine". The vehicle had three wheels. The engine was placed under and behind the seats [2].

A dictionary printed in 1897 reports on the efficiency of gasoline engines in those days: One liter of gasoline was sufficient to transport two passengers over a distance of 16 km [3]. However, 1 h was needed to cover this distance. So, neglecting the low speed and the lack of comfort of the passengers, our "automobile-grandfathers" already developed 6 1/4-L-cars.

Electricity was used for powering automobiles even before the utilization of gasoline. Like the current plug-in electric vehicles, their cruising range was limited by the low capacity of available batteries [4]. Nevertheless, they gained popularity in cases, where only short distances had to be covered and where frequent stops

were needed as in the distribution of cargo in large metropolitan areas. The German postal service used some battery-powered trucks up to the sixties of the last century [5].

Approximately 1900, engineers accepted the challenge to combine the advantages of gasoline- and battery-powered engines. Ferdinand Porsche, at that time a young engineer at the Lohner-Factory in Vienna, has exhibited a gasoline-electric-powered car, (i.e. the first hybrid vehicle [6]) at the 1900 Exposition Universelle in Paris. During driving, two single-cylinder gasoline engines charged a battery. The car was then driven by electric motors tied to the front wheels. Because of its unreliability, heavy weight, and high cost the car was not a commercial success.

The automobile industry has experienced a remarkable growth during the past century interrupted only by two world wars. Cars with combustion engines became easier to operate and more comfortable for the passengers as well. The introduction of sensors and digital processors in cars offered mechanisms to further enhance their performance: engines have become more reliable, produced less exhaust, and consumed less gasoline—just to mention a few. In many countries the use of passenger cars outnumbered the use of railways. This continued even in times where gasoline becomes more and more expensive. One reason may be that people "feel at home" in their cars, and driver warning and assistance systems and car infotainment units help to create this feeling. The first group helps the driver to be more prudent and safe for all the persons in the vehicle. Whereas, the second provides valuable information concerning road, traffic, and weather conditions, keeping the driver in touch with the world as well as helping to turn the car into a virtual concert hall in the middle of heavy traffic during commuting hours.

As with the widespread deployment of driver warning and assistance systems becoming the norm, passive and active control systems are emerging and finding their way in a number of applications. One example is the driver-free auto parking, available now in many mid-level to high-end cars. Along with these, the first long distance competition of driverless cars sponsored by DARPA in the US took place in 2004 [7]. Recently, Google intelligent vehicles have traveled both in metropolitan areas and long-haul trips without a single accident. In a number of states in the US and in Europe, cars without drivers are legalized and already permitted to be on the road. Many US states are moving forward with specialized laws to governing who is responsible for safety and operation of "driverless" vehicles.

The real enthusiasts of cars, however, fear that electronically loaded cars will disappear from the streets when they reach the age of old-timers because electronic components to repair them will not be available. They are also concerned that too many tools and schemes for their assistance may take away their "fahrvergnügen" (fun of driving) [8].

In addition to the electronics that go into cars, "how" we drive says a lot about who we are, and how our society incorporates personal transportation within the economic infrastructure, as well as issues of both personal and public safety. The recent best seller by Vanderbilt: "TRAFFIC: Why we drive the way we do, and what is says about us" is an interesting view of our society and the automobile. In particular, emerging countries such as India and China, in comparison to

countries in Europe and North America, have fundamentally different views of personal transportation and changing views of what is acceptable in terms of safety and convenience. In spite of this, in-vehicle technology continues to progress forward with new advances appearing in high-end vehicles, as well as down to the most affordable entry level vehicles in many of these countries.

Part B: Things We Do When We Drive a Car Today

As people spend more time in their vehicles, and commuting time to and from work continues to increase as urban populations grow in this age of high-tech, drivers are attempting to perform many more tasks than simply driving their vehicle from point A to point B, which was the case in the twentieth century. The introduction of wireless technology, digital audio/music players, mobile Internet access, advanced entertainment/multimedia systems, and smart navigation technologies into the car has placed increased cognitive demands on drivers. Yet, the typical driving test all over the world continues to focus exclusively on the logistics of operating the vehicle itself and does not include the management of these outside technologies as part of the driver assessment for issuing a license.

Many countries including the US have therefore instituted laws that restrict the use of cell phones and text messaging while operating a vehicle. For instance, large, bright, and illuminated road signs saying “Click it & Ticket it,” are posted along the highways in California. USA State Legislative groups and Governors have come together to bring better consistency within the US for laws addressing cell phone use and texting while driving [11, 12]. Restrictions on the use of cell phones while driving have reached worldwide acceptance at various levels (see [13] for a summary). Again, the recent book by Vanderbilt “Traffic: Why We Drive the Way We Do” offers a number of perspectives on society, culture, and government engagement on driving and drivers [10].

Driver distractions in the car are many and have been documented by countless research studies. On the average, drivers attempt to adjust their radio 7.4 times per hour of driving, turn their attention to infants 8.1 times/hour, and are generally searching for something (e.g., sunglasses, coins, etc.) 10.8 times/hour. It is further observed that the average driver looks away from the road 0.06 s every 3.4 s, i.e., 64 s/h. Mobile devices with “intense displays” such as the iPod, other smart phones, and tablets require more mental concentration to perform secondary tasks like searching for songs, pausing, or skipping a song.

While there are some differences of opinion, researchers have noted that any task that requires a driver to divert his/her attention (typically visual) away from the road for more than 1.5 s is viewed as a distraction. However, some scholars believe that this threshold is around 3.0 s. Irrespective of the exact time figure, such a guideline is important as a general rule. But it should be clear that not all drivers are equally skilled, and even advanced/experienced drivers go through periods of fatigue,

or they can be unfamiliar with the vehicle they are operating at the time. As a consequence, even for brief periods of time, these could alter their driving abilities and could result incostly and fatal accidents.

Part C: Workshops on Signal Processing in Present and Future Cars

In 2011, the 5th Biennial Workshop for In-Vehicle Systems took place in Kiel, Germany. This meeting served to bring together researchers from diverse research areas to consider advancements in digital signal processing within vehicles to improve safety, comfort, and potentially contribute to reduce driver distraction. A total of 27 peer-reviewed conference papers were presented with researchers from academia, automotive and technology companies, as well as government research laboratories. The workshop included two tutorials, held by highly recognized and experienced speakers from both industry and academia:

Silvia Schuchardt and Anne Theiß at the registration desk of the workshop

First tutorial on Kalman filtering with applications to automotive speech enhancement was presented by Prof. Dr.-Ing. Eberhard Hänsler from Technische Universität Darmstadt, Germany, and Dr.-Ing. Gerald Enzner, Ruhr-Universität Bochum, Germany.

The second tutorial on car hands-free testing and optimization was presented by Dr.-Ing. Hans-Wilhelm Gierlich, head of the Telecom Division of HEAD acoustics, Germany.

Highlights of the workshop have been the four keynote addresses, two of which coming from industry, the other two from academia:

The first keynote was delivered by Dr.-Ing. Luis Arévalo, Vice President, Division of Car Multimedia, Automotive Navigation and Infotainment Systems at Robert Bosch GmbH, Germany. The title of his speech was "Navigation Systems Interacting with Other Vehicle Electronic Control Units."

Professor John H.L. Hansen, from the University of Texas at Dallas, USA, gave the second high-class keynote about "UTDrive: Advances in Human-Machine Systems to Reduce Driver Distraction for In-Vehicle Environments."

Third keynote address with the title “Intelligence in Vehicles,” which was presented by Dr. Arne Bartels from the Volkswagen Group Research in Wolfsburg, Germany.

Professor Tim Fingscheidt from Technische Universität Braunschweig, Germany, gave the last keynote on “"Speech Enhancement in Car Applications—Any Specifics?”

In addition to these keynotes and 27 excellent oral presentations, which had been the basis for this book, two panel sessions were organized on “Multi-Sensor and Data Fusion” and “Driver Distraction.” Several highly respected panelists from industry and academia have participated and guided the panels. Along with these panels, talks, and keynotes the workshop participants were able to have a look at the latest publications from Springer, the publisher of this book and its four predecessors, at their exhibit booth.

Dr. Baumann at the Springer booth

Following the kick-off of the workshop with tutorials on the first day, the participants were invited to a welcome reception in the “Landeshaus” of Kiel—the Parliament House of the State of Schleswig-Holstein. The welcome addresses were given by Dr. Cordelia Andreßen, Undersecretary, Ministry of Science, Economics, and Transport and by Dr. Hans-Wilhelm Gierlich, Head of the Telecom Division, HEAD acoustics, Germany, the main sponsor of this workshop. After these talks, attendees were given a tour the all parliament building of the State of Schleswig-Holstein.

The participants in the plenary hall of the parliament of Schleswig-Holstein

After the sessions on the second day there was an organized visit to the Leibniz Institute of Marine Sciences (IFM-GEOMAR). The tour was followed by a dinner on the boat "Stadt Kiel" cruising on the Baltic Sea. The captain has organized a tour of the boat including the engine room. As it can be seen from the photo below on the right, Professor John Hansen, in particular, has really enjoyed this and had a long chat with the crew. Fortunately for the sake of other guests and the crew, John did not attempt to steer the ship. The dinner was served on the two decks and the guests had discussions on automotive topics and, of course, about matters beyond that.

Motorship "Stadt Kiel" cruising on the Baltic Sea and her engine room

Best student paper award

At the end of the workshop the best student paper—based on its originality, professional merit, contribution, and presentation quality—was awarded to Philipp Heidenreich and his coauthor Professor Abdelhak Zoubir for their contribution "Computational Aspects of Maximum Likelihood Direction-of-Arrival Estimation of Two Targets with Applications to Automotive Radar." An extended version of

this contribution can be found in Chap. 1 of this book. On the right you see Philipp Heidenreich (right) together with Dr. Bernd Iser (left) from SVOX who sponsored the award.

October 2012 Eberhard Hänsler and Gerhard Schmidt

Literature

1. http://wn.com/Leonardo_Da_Vinci_Automovile_1495
2. http://www.leifiphysik.de/web_ph09/geschichte/08automobil/automobil.htm
3. Meyers Konversations-Lexikon. Bibliographisches Institut, 1897
4. http://de.wikipedia.org/wiki/Elektroauto
5. http://www.museumsstiftung.de/index.php?id=777
6. http://www.spiegel.de/auto/fahrkultur/porsche-semper-vivus-das-erste-hybridauto-der-welt-a-749168.html
7. http://en.wikipedia.org/wiki/DARPA_Grand_Challenge
8. "Fahrvergnügen" was used in a commercial by VW in the 1990th in California
9. T. Vanderbilt, *"TRAFFIC: Why we drive the way we do, and what is says about us"*, (Vintage Books, Random House, Inc., New York, 2008)
10. http://www.ghsa.org/html/stateinfo/laws/cellphone_laws.html, (USA's State Governors Highway Safety Association)
11. http://www.ncsl.org/issues-research/transport/cellular-phone-use-and-texting-while-driving-laws.aspx, (USA's National Conference on State Legislatures)
12. http://www.cellular-news.com/car_bans/(Cellular News listing of Countries Worldwide that ban cell phones while driving), (Contributing authors)

Preface

The *Fifth Biennial Workshop on Digital Signal Processing (DSP) for In-Vehicle Systems* took place in Kiel, Germany, on September 4–7, 2011. The workshop was organized by the *Digital Signal Processing and System Theory* research group at Kiel University, Germany. As mentioned above, this biennial is the fifth in a series. It was organized first in 2003 in Nagoya (Japan), followed by events in Sesimbra (Portugal) in 2005, in Istanbul (Turkey) in 2007 and in Dallas (Texas, USA) in 2009. World-class experts from a wide spectrum of research fields have participated and shared cutting-edge studies on driver behavior and in-vehicle technologies just as they did in earlier workshops.

The workshop at Kiel University formed a communication platform among researchers, automotive manufacturers, government foundations, and legislators for road safety and on future in-vehicle technologies as well as focusing on driver behavior. Contributions came from signal processing, control engineering, multimodal audio–video processing, biomechanics, human factors, and transportation engineering, which opened doors for fruitful discussions and information exchange in an exciting interdisciplinary area. The main focus areas were as follows:

- DSP technologies in automobiles,
- speech dialog, hands-free, and in-car communication systems (algorithms and evaluation),
- driver-status monitoring and distraction/stress detection,
- in-vehicle dialog systems and human–machine interfaces,
- challenges in video and audio processing for in-vehicle products,
- multisensor fusion for driver identification and robust driver monitoring,
- vehicle-to-vehicle and vehicle-to-infrastructure wireless technologies
- human factors and cognitive science in enhancing safety, and
- transportation engineering.

From this workshop, 15 papers and one additional contribution stemming from a tutorial, which was held at the start of the workshop, were selected and expanded with even newer material. These 16 chapters make up this book. Chapters are

grouped into five parts, each addressing key areas within in-vehicle digital signal processing arena:

Part I: Sensor and Data Fusion,
Part II: Speech and Audio Processing,
Part III: Driver Distraction,
Part IV: Driving Behavior and User Profiling,
Part V: Driving Scene Analysis.

First, Part I consists of four chapters that cover the fusion of sensor signals or data in general. The first chapter considers the estimation of the direction of arrival in automotive RADAR. Special emphasis is put here on computational aspects. The second chapter investigates stereo camera systems for estimating three-dimensional motion fields in real time for applications such as automotive driver assistance systems, robotics, or surveillance. It is followed by an overview on vehicle-assistance systems that acquire, process, and evaluate environmental data. Several state-of-the-art systems are described here. Chapter 4 addresses the design, the perception, and decision algorithms of the so-called unmanned ground vehicles. Special focus is put on the *Otonobil*, the first autonomously driven vehicle of Turkey.

The next five chapters make up Part II of the textbook which focuses on speech and audio processing for in-vehicle systems. Chapter 5 presents an overview about testing and optimization of hands-free equipment in cars and Chap. 6 focuses on combined fast-converging echo cancellation and residual echo and noise suppression schemes for wideband automotive hands-free systems. Chapter 7 deals with the systems that improve the (speech) communication within the passenger compartment. Next, Chap. 8 discusses the acoustic concept of a *room in a room*, which allows for recording and playback of sound fields with a multitude of microphones and loudspeakers. The last chapter in this second part of the book is about a novel post-processing scheme that can be applied after a conventional filterbank. It *refines* the original short-term spectra and allows for improved pitch estimation or improved convergence speed or complexity reduction of echo cancellation filters.

Part III is on driver distraction with two chapters. Chapter 10 focuses on understanding how drivers react to various secondary tasks such as phone calls, and creating text messages. The CAN bus is used then for analyzing the distraction effect of such actions. The second chapter provides the definition of reference labels for perceptual evaluations from external evaluators, and the consistency and effectiveness of using a visual-cognitive space for subjective evaluations are investigated.

The next two chapters form Part IV concentrating on driver behavior and user profiling. Chapter 12 is about evaluation methods of save driving skills. The second chapter of this part is on the impact of emotions on driving behavior with special emphasis on pre- and post-accident situations.

The last portion of the book is Part V which addresses driving scene analysis. In Chap. 14 two driving scene analysis systems are proposed: The first system

measures the similarities between driving behavior signals in driving scenes involving stops, starts, and right and left turns. The second system measures the similarities between environmental driving signals, focusing on surrounding vehicles and driving road configuration. In Chap. 15 studies are presented on algorithms that use front cameras or, in particular, motion vectors of standard video encoding algorithms to detect various driving events. The detection results can be used to gain understanding of the driving dynamics, and eventually to support driver decisions and improve driving safety. In the last chapter of the book, in Chap. 16, automotive radar systems for estimation of target shapes are described. Special focus is put on a two-stage approach for combining high-resolution techniques with conventional Fourier-based methods.

We hope that this book provides an up-to-date perspective on automotive signal processing, with novel ideas for researchers, engineers, and scientists in the field. We wish to thank all those who participated in the 2011 workshop. We wish to express our continued appreciation of Springer Publishing for a smooth and efficient publication process for this book. Specifically, we would like to thank Alex Greene and Ms. Ania Levinson of Springer Publishing for their extensive efforts to enhance the structure and content of this book, as well as providing our community a high-quality and scholarly platform to stimulate public awareness, scientific research, and technology development in this field.

Kiel, Germany — Gerhard Schmidt
San Diego, CA, USA — Huseyin Abut
Nagoya, Japan — Kazuya Takeda
Dallas, TX, USA — John H.L. Hansen

Contents

Part I Sensor and Data Fusion

1 Computational Aspects of Maximum Likelihood DOA Estimation of Two Targets with Applications to Automotive Radar 3
Philipp Heidenreich and Abdelhak M. Zoubir

2 Dense 3D Motion Field Estimation from a Moving Observer in Real Time 19
Clemens Rabe, Uwe Franke, and Reinhard Koch

3 Intelligence in the Automobile of the Future 35
Arne Bartels, Thomas Ruchatz, and Stefan Brosig

4 Unmanned Ground Vehicle *Otonobil*: Design, Perception, and Decision Algorithms 47
Volkan Sezer, Pınar Boyraz, Ziya Ercan, Çagri Dikilitaş, Hasan Heceoğlu, Alper Öner, Gülay Öke, and Metin Gökaşan

Part II Speech and Audio Processing

5 Car Hands-Free Testing and Optimization: An Overview 59
Hans-Wilhelm Gierlich

6 A Wideband Automotive Hands-Free System for Mobile HD Voice Services 81
Marc-André Jung and Tim Fingscheidt

7 In-Car Communication 97
Christian Lüke, Gerhard Schmidt, Anne Theiß, and Jochen Withopf

8 Room in a Room: A Neglected Concept for Auralization 119
Markus Christoph

9 Refinement and Temporal Interpolation of Short-Term Spectra: Theory and Applications 139
Mohamed Krini and Gerhard Schmidt

Part III Driver Distraction

10 Effects of Multitasking on Drivability Through CAN-Bus Analysis 169
Amardeep Sathyanarayana, Pinar Boyraz, and John H.L. Hansen

11 Using Perceptual Evaluation to Quantify Cognitive and Visual Driver Distractions 183
Nanxiang Li and Carlos Busso

Part IV Driving Behavior and User Profiting

12 Evaluation Method for Safe Driving Skill Based on Driving Behavior Analysis and Situational Information at Intersections 211
Yosuke Yoshida, Matti Pouke, Masahiro Tada, Haruo Noma, and Masaru Noda

13 Pre- and Postaccident Emotion Analysis on Driving Behavior 225
Abdul Wahab, Norhaslinda Kamaruddin, Norzaliza M. Nor, and Hüseyin Abut

Part V Driving Scene Analysis

14 Content-Based Driving Scene Retrieval Using Driving Behavior and Environmental Driving Signals 243
Yiyang Li, Ryo Nakagawa, Chiyomi Miyajima, Norihide Kitaoka, and Kazuya Takeda

15 Driving Event Detection by Low-Complexity Analysis of Video-Encoding Features 257
Elias S.G. Carotti and Enrico Masala

16 Target Shape Estimation Using an Automotive Radar 271
Florian Engels

Index 291

Contributors

Hüseyin Abut San Diego State University, San Diego, CA, USA

Boğaziçi University, Istanbul, Turkey

Arne Bartels Volkswagen AG, Wolfsburg, Germany

Pınar Boyraz Istanbul Technical University, Istanbul, Turkey

Stefan Brosig Volkswagen AG, Wolfsburg, Germany

Carlos Busso The University of Texas at Dallas, Richardson, TX, USA

Elias S.G. Carotti Politecnico di Torino, Torino, Italy

Markus Christoph Harman/Becker Automotive Systems GmbH, Straubing, Germany

Çagri Dikilitaş Istanbul Technical University, Istanbul, Turkey

Florian Engels A.D.C. Automotive Distance Control Systems GmbH, Lindau, Germany

Ziya Ercan Istanbul Technical University, Istanbul, Turkey

Tim Fingscheidt Technische Universität Braunschweig, Braunschweig, Germany

Uwe Franke Daimler AG, Sindelfingen, Germany

Hans-Wilhelm Gierlich HEAD acoustics GmbH, Herzogenrath, Germany

Metin Gökaşan Istanbul Technical University, Istanbul, Turkey

John H.L. Hansen University of Texas at Dallas, Dallas, TX, USA

Hasan Heceoğlu Istanbul Technical University, Istanbul, Turkey

Philipp Heidenreich ADC Automotive Distance Control Systems GmbH, Lindau, Germany

Marc-André Jung Technische Universität Braunschweig, Braunschweig, Germany

Norhaslinda Kamaruddin Universiti Teknologi Mara, Selangor Darul Ehsan, Malaysia

Norihide Kitaoka Nagoya University, Nagoya, Japan

Reinhard Koch Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Mohamed Krini Nuance Communications, Ulm, Germany

Nanxiang Li The University of Texas at Dallas, Richardson, TX, USA

Yiyang Li Nagoya University, Nagoya, Japan

Christian Lüke Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Enrico Masala Politecnico di Torino, Torino, Italy

Chiyomi Miyajima Nagoya University, Nagoya, Japan

Ryo Nakagawa Nagoya University, Nagoya, Japan

Masaru Noda Nara Institute of Science and Technology, Nara, Japan

Haruo Noma Advanced Telecommunications Research Institute International, Kyoto, Japan

Norzaliza M. Nor International Islamic University, Kuala Lumpur, Malaysia

Gülay Öke Istanbul Technical University, Istanbul, Turkey

Alper Öner Istanbul Technical University, Istanbul, Turkey

Matti Pouke Oulu University, Oulu, Finland

Clemens Rabe Daimler AG, Sindelfingen, Germany

Thomas Ruchatz Volkswagen AG, Wolfsburg, Germany

Amardeep Sathyanarayana University of Texas at Dallas, Dallas, TX, USA

Gerhard Schmidt Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Volkan Sezer Istanbul Technical University, Istanbul, Turkey

Masahiro Tada Advanced Telecommunications Research Institute International, Kyoto, Japan

Kazuya Takeda Nagoya University, Nagoya, Japan

Anne Theiß Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Abdul Wahab International Islamic University, Kuala Lumpur, Malaysia

Jochen Withopf Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Yosuke Yoshida Nara Institute of Science and Technology, Nara, Japan

Abdelhak M. Zoubir Technische Universität Darmstadt, Darmstadt, Germany