3rd International Symposium on Future Active Safety Technology Toward zero traffic accidents

FAST-zero’15

September 9-11, 2015 Gothenburg, Sweden

Program & Abstracts
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Dear Colleagues,

On behalf of the organizing committee, it is our pleasure to welcome you to Gothenburg, Sweden and the third FAST-zero symposium.

We are happy to have been trusted with the responsibility to organize FAST-zero’15, first time outside Japan, after the two successful events FAST-zero’11 in Tokyo, and FAST-zero’13 in Nagoya. The symposium takes place at Chalmers Conference Centre at Campus Johanneberg, where a major part of the Swedish academic research on traffic safety is carried out. The symposium is co-organized by Chalmers and SAFER - Vehicle and Traffic Safety Centre at Chalmers, which is a competence centre including 34 partners from the academy, society and industry. From this joint competence platform the symposium has been organized in close collaboration with partners in Japan guaranteeing a continuation of the traditions from the earlier symposia.

The quality of the symposium builds on important contributions from many people. To all symposium participants who have submitted technical papers, keynote speakers, International Scientific Committee, and the Organizing Committee - you have done a great job. We want to highlight the invaluable work by the Japanese team and particularly mention Pongsathorn Raksincharoensak and Yasutoshi Horii who have been the bridge between the organizers in Sweden and in Japan.

We hope you will enjoy the symposium!

General Chairs

Jonas Sjöberg, Professor, Department of Signals and Systems Chalmers

Dr. Anna Nilsson-Ehle, Director of SAFER
Welcome message from International Scientific Committee Chair

Innovation in the field of active safety is the key driving force towards the ultimate goal of realizing zero traffic-accidents. On behalf of the members of international scientific committee of FAST-zero’15, I am very pleased to welcome you to the 3rd symposium in Gothenburg, Sweden and thank you for your great contribution to the symposium. Following the tradition of FAST-zero symposia born in Japan, we organize technical sessions together with excellent keynote lectures by internationally renowned researchers, in order to bring together researchers and engineers to present the current state-of-the art and progress in research and development of active safety technologies.

In this symposium, 96 papers are accepted as technical papers in the technical sessions. I would like to thank all members of ISC committee who spend their precious time to review and select high-quality papers for the symposium as well as best paper awards. I would like to express my sincere thanks to Cristina Olaverri-Monreal (Austrian Institute of Technology), Benedikt Schonlau (IAV), Andreas Lie (Swedish Transport Administration) and Erik Coelingh (Volvo Cars) as renowned keynote speakers. Especially, besides regular contributions, I would like to thank Cristina Olaverri-Monreal, Keisuke Suzuki, Motoki Shino and Roman Henze for their great cooperation in organizing the invited sessions on special interest topics. For overall arrangement, I would like to thank Balázs Adam Kulcsár and Jonas Fredriksson for the session program arrangement, and Tomas Mckelvey for the symposium award selection process support. Finally, I would like to thank Björn Peters (VTI) for his effort in the technical visit organization.

Without your contributions and active participation, FAST-zero symposium philosophy would not be possible to realize. During the event, I wish that all of you learn a lot of new findings, have fruitful discussions and also build up networks of active safety researchers. Finally, I wish you a pleasant journey and interesting days during FAST-zero’15 symposium in Gothenburg.

Pongsathorn Raksincharoensak,
FAST-zero’15 International Program Committee Chair
In 2015, the Symposium on Future Active Safety Technology Towards zero traffic accidents has been taken place in Gothenburg, Sweden, triggering lot of research attention from both academia and industry.

The Symposium program is a good synergy of diversified traffic safety topics. Plenary sessions construct the backbone of the technical program, including selected topics on automated driving and human behavior. These two main trends can be observed in the topic selection of the accepted papers. Moreover, novel ideas have been communicated on crash and naturalistic data analysis, active and passive vehicular safety systems, simulator based studies, just to name a few of them. Four invited sessions have been organized, out of which one was on industrial track.

107 presentations can be found in the conference program (number of papers are a bit less due to the fact that industrial submission does not require papers), from 15 countries all around the World. Full Symposium papers have been accepted on the basis of reviewed extended abstracts by using the regular paper format of International Federation of Automatic Control (IFAC). Reviewing extended abstracts gave us the possibility to mobilize the traffic safety research community in order to ensure the quality standards of the Symposium. From paper submission till proceeding creation, an electronic database (www.easychair.org) has been used facilitating the review and program edition process a lot.

Outstanding papers have been nominated to best paper award. Finally, the high level technical program was accompanied by exciting social and technical visits.

We hope that this community will have many more occasion to meet in order to exchange scientific information, to build network, and to contribute to our joint vision: zero-traffic accident.

Balazs Kulcsar, Pongsathorn Raksincharoensak, Chiyomi Miyajima & Jonas Fredriksson
FAST-zero’15 Program Co-Chair
Organizers

FAST-zero’15 is organized by SAFER Vehicle and Traffic Safety Centre and Chalmers University of Technology, in co-operation with Swedish Vehicular Engineering Association.

Co-sponsors

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IAV automotive engineering is the gold sponsor of the symposium. www.iav.de

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  - This bimonthly Newsletter contains information about IFAC’s technical activities and forthcoming IFAC events all over the world.

- **Automatic inclusion of your name in our mailing lists for forthcoming events in your areas of interest**
  - IFAC organizes about 40 technical meetings all over the world each year

- **Subscription to the IFAC Journals and IFAC Affiliated Journals at a reduced Affiliate rate**
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Anna Nilsson-Ehle
Director, SAFER, Sweden.

Program Chair

Balázs Adam Kulcsár
Assistant Professor, Signals and Systems, Chalmers University of Technology, Sweden

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Professor, Kagawa University, Japan

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Chair, Swedish Vehicular Engineering Association (SVEA), Sweden

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Yasutoshi Horii
Senior Manager, DENSO SALES SWEDEN, Sweden

Yoshiki Miichi
Project Manager, Product Planning Div., Toyota Motor Corporation, Japan

Technical Visit Chair

Björn Peters
Research leader, VTI, Sweden
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<td>Hidehisa Yoshida</td>
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**Symposium Information**

**Date & Venue**
- **Date:** September 9-11, 2015
- **Venue:** Chalmers Conference Centre, Chalmersplatsen 1, Chalmers Campus Johanneberg, Gothenburg.
- **Nearest bus/tram stop:** Chalmers
- **Website:** [www.chalmerskonferens.se](http://www.chalmerskonferens.se)

**Registration & badges**
Pick up your name badge either at the Welcome Reception on Tuesday September 8 at 18:30-20:00, or at the Registration desk at the venue on Wednesday September 9 at 08:00-17:30.

**Technical Visits**
Pre-registration to the technical visits are mandatory.

**Lunch and coffee breaks**
Lunch and coffee/green tea are served in the mingle/exhibition area outside the main conference room Runan.

**Internet access - Wifi**
Wireless internet is available at the conference venue. Please contact the Registration desk for login details.

**Exhibition**
The exhibition is located outside the main conference room. Please visit our exhibitor’s booths in the breaks.

**FAST-zero’15 Awards**
FAST-zero’15 Best Paper Awards will be announced at the closing session.

**Information for speakers**
Symposium language is English. Each speaker has 25 minutes. Please, leave 5 minutes for questions and discussion. The Session Chair will notify you when a couple of minutes remain. Speakers must download their presentations 30 minutes before session in their session room with their session chair. A technician will help out if something does not work.

**Proceedings**
At the conference website, [www.fastzero15.net](http://www.fastzero15.net) you find electronic versions of:
- Conference proceedings (pdf)
- This document, Symposium program as pdf
- Online version of the program with abstracts
Gothenburg Information

From/To Landvetter Airport (GOT)

Airport busses “Flygbussarna Airport Coaches” depart from Landvetter Airport every 15 minutes. It takes 20 minutes to/from Korsvägen/Svenska Mässan, and 30 minutes to/from the central station “Nils Ericson Terminalen”. The fee is SEK 105 single, SEK 195 return, and tickets can be bought on the bus with credit card.

For tickets and information visit the website: [www.flygbussarna.se](http://www.flygbussarna.se)

Airport taxi costs approximately SEK 450. Ask for fixed price.

Public transportation

The Chalmers Conference Centre is located at Chalmers. Tram no. 6, 8 and 13 and bus no. 16 and 55 stop here. You can buy tickets in most convenience stores such as Pressbyrån, 7-eleven etc or pay with credit card on the trams. No cash is accepted on-board.

For information and travel planner visit the website: [www.vasttrafik.se](http://www.vasttrafik.se)

Taxi

There are several companies to choose from. You can phone for a taxi or hail one on the street. The driver should have a taxi ID card clearly displayed in the vehicle. Service is included in the taximeter price. Avoid unlicensed taxis.

Taxi Göteborg: +46 (0)31-650 000
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All major credits cards are accepted. If you go to/from Landvetter Airport, ask for the fixed price rate.

Bike rental: Styr & Ställ

Gothenburg is a bike friendly city. Throughout the city you will find bike stands with rental bikes. For only SEK 75 you can rent a bicycle as often as you wish. The first half hour of each journey is always free, regardless of the number of journeys per day. Short time visitors can choose the 3-Day Pass, which can be purchased from any of the credit card terminals for just SEK 25. It is also included in the Göteborg City Card.

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More information: [www.goteborg.com/citycard](http://www.goteborg.com/citycard)
Keynote speakers

Dr. Cristina Olaverri Monreal, AIT Austrian Institute of Technology GmbH
Innovation Systems Department Business Unit Technology Experience, Austria

Title: Road Users and Human Machine Interaction

Wednesday, September 9, 08:50, Room: Runan

Dr. Cristina Olaverri Monreal received the Ph.D. degree and M.Sc. degree in computer science, computational linguistics and phonetics in cooperation with BMW, from the Ludwig-Maximilians University in Munich, Germany, in 2002 and 2006, respectively. Currently, she is a senior scientist and research group lead with the Austrian Institute of Technology, where her focus is on innovative forms of mobile and ubiquitous interaction, and advanced approaches to human mobility also focusing on a vehicular context. Her experience in the areas of Human Factors and Human-Machine Interaction provides the foundation to minimize the barrier between users and technical systems focusing on the perception of the environment in complex, dynamic scenarios that are critical to decision-making processes. Her research interests lie in multi-functional systems for in-vehicle information and entertainment; overall efficiency of user and system utilization; driver behavior; simulation tools and research concerning Intelligent Transportation Systems (ITS). Dr. Olaverri has been engaged for several years as a member of technical committees, a referee for international conferences on ITS and a (co-)organizer of scientific events. She is the chair of the IEEE ITS Society’s Technical Activities Committee on Human Factors in Intelligent Transportation Systems and member of the IEEE ITS Society’s Technical Activities Committee on Artificial Transportation Systems and Simulation. She is also the program co-chair for the International IEEE Conference on Intelligent Transportation Systems (ITSC15) and the general chair and (co-)organizer of the Human Factors in Intelligent Vehicles Workshop (HFIV’12, HFIV’13, HFIV’14, HFIV’15) within the IEEE IV’12, IV’13, IV’14 and IV’15. Additionally, she is the general chair and (co-)organizer of the special session on Intelligent Cooperative Driving, and Autonomous Connected Vehicles (ICD & ACV 2014, ICD & ACV 2015), within the International Conference on Collaboration Technologies and Systems (CTS). Currently, Dr. Olaverri is Member of the Board of Governors (BoG) of the IEEE Intelligent Transportation Systems Society (ITSS) (Jan 1, 2015 to Dec 31, 2017), associate editor of the IEEE Transactions on Intelligent Transportation Systems and editor of the ITS Research Lab Spot Light column in the IEEE ITS Magazine. 2013-2014 she was guest editor of the special issue on “Human Factors in Intelligent Vehicles” (HFIV) of IEEE Transactions on Intelligent Transportation Systems (IEEE T-ITS).

Dipl.-Ing. Benedikt Schonlau, Head of Department Active Safety & Lighting Functions, IAV GmbH, Germany

Title: Highly automated driving: Whom can you trust?

Thursday, September 10, 08:30, Room: Runan

Benedikt Schonlau finished his degree in Mechatronics in 2005 at the Ostwestfalen-Lippe University of Applied Sciences (Germany). Starting in the field of function development for Driver Assistance and Active Safety he has been working for IAV in Chemnitz for over 10 years now. Between 2007 and 2011 Mr. Schonlau worked as project manager on the topic PreCrash. Since 2012 he is Head of Department Active Safety and Lighting Functions. In this role he is responsible for the worldwide establishment of IAV competencies in this field. He has a track record of fundamental research on these topics which is documented by numerous publications by IEEE, VDI and SAE. He is a member in Car2Car communication consortium as well as in ITS Niedersachsen.
Professor **Anders Lie**, PhD, Swedish Transport Administration, Sweden

**Title:** Road traffic safety, automated cars and infrastructure – potentials and possibilities

**Friday, September 11, 08:30, Room: Runan**

**Anders Lie**, Ph.D. in the field of medicine, is specialist in traffic safety working for the Swedish Transport Administration. He has held his position there since 1995. Anders Lie has been an active partner in the development of the Vision Zero. He has furthermore set-up in depth studies of all fatal crashes in Sweden starting from 1997. From the start he has been representing Sweden as a board member in the Euro NCAP crash test co-operation. Anders Lie has further been active in the development of a Management System Standard for Traffic Safety (ISO 39000).

Anders Lie has written over 50 scientific papers within the field of vehicle safety and is active in many international co-operations. His research is focused on evaluation of new vehicle safety technologies and Vision Zero. The research is also looking at how the introduction of new safety technologies can be followed and integrated in modern management systems such as ISO 39001. In September 2014 Anders Lie was appointed as adjunct professor at Chalmers University of Technology.

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**Dr. Erik Coelingh**, Volvo Cars, Sweden

**Title:** Drive Me – Self-driving cars for sustainable mobility

**Friday, September 11, 15:10, Room: Runan**

**Erik Coelingh**, Ph.D. is Senior Technical Leader for Safety and Driver Support Technologies with the Volvo Car Corporation and Adjunct Professor at Chalmers University of Technology in Gothenburg Sweden. He received the M.Sc. and Ph.D. degrees in electrical engineering from the University of Twente, Enschede, The Netherlands, in 1995 and 2000, respectively.

After his studies he joined Volvo Car Corporation and worked in several projects on vehicle control and active safety. He was responsible for the first application of collision mitigation by braking on the Volvo S80 in 2006 and led the advanced engineering activities for Pedestrian Detection with Full Auto Brake which was launched in 2010. Currently he is responsible for Volvo’s technical strategy for safety and driver support technologies and works actively on research and development of various collision avoidance and automated driving features, such as e.g. the Drive Me project.
Social Program

Welcome reception

**Date:** Tuesday September 8, 18:30–20:30  
**Place:** Dicksonska Palatset, Parkgatan 2  
**Fee:** Included in the full registration fee (pre-registration is mandatory)  
**Accompanying person:** SEK 150, incl VAT  
**Nearest bus/tram stop:** “Kungsportsplatsen” or “Valand”. From Kungsportsplatsen, walk up on Kungsportsavenyn and take left on Parkgatan. From Valand, walk down on Kungsportsavenyn and take left on Parkgatan.

The City of Gothenburg has the pleasure to invite you to attend the Welcome reception. Lord Mayor of Gothenburg Lena Malm will welcome you to the city of Gothenburg and you will find ample opportunity to meet old friends and make new acquaintances.

The Welcome reception will take place at Dicksonska Palatset, a grandiose house dating from 1862. The house is located in the middle of the city close to the main street Avenyn. The Welcome reception includes a mingle plate with finger food and wine. The Welcome reception is included in the registration fee if marked upon registration (pre-registration is mandatory).

Banquet Dinner

**Date:** Thursday September 10, 18:30-23:00  
**Place:** Universeum, Södra Vägen 50  
**Fee:** Included in the full registration fee (pre-registration is mandatory)  
**Accompanying person:** SEK 800, incl VAT  
**Website:** [www.universeum.se](http://www.universeum.se)  
**Nearest bus/tram stop:** “Korsvägen”. Universeum is located just opposite the tram/bus stop.

The banquet dinner will be at Universeum, the largest science centre in the Nordic region. At Universeum, every day is an adventure. The wonderful building, in the heart of Gothenburg, brings together animals, nature, technology and a diversity of joyful experiments.

In just one day you can go on safari in the rainforest, head out into space, dive into the depths of the world’s oceans and walk through the Swedish wilderness.

During the evening we start with a welcome drink and then a tour to explore the exhibits. Finally you will end up at the fantastic Aquariums where you will be enjoying a great dinner!
Technical Visits

Technical visit at Lindholmen

**Date:** Thursday September 10, at 12:45-15:15, or 14:45-17:15  
**Place:** Lindholmen, Gothenburg  
**Fee:** included in the conference fee, pre-registration mandatory  
**Registration:** Please register on the website www.fastzero15.net  
**Gathering:** Outside the conference center.  
Please note that buses leave sharp, coffee/tea will be served during the visit.

On Thursday afternoon, as an alternative to the technical sessions at the conference venue, there will be two opportunities for technical visits at Lindholmen, on the other side of the river. VTI, Volvo Cars and AB Volvo will demonstrate various facilities and technologies. Buses will take you there and back. You can choose between 12:45-15:15 (Group 1), and 14:45-17:15 (Group 2), the program is the same at the two occasions. The number of places is limited and there is a booking system to reserve a place.

Technical demos at AstaZero

**Date:** Wednesday September 9, at 16:55-21:00  
**Place:** AstaZero Active Safety Test Area, Hällered  
**Fee:** SEK 500, incl VAT  
**Registration:** Please register on the website www.fastzero15.net before September 4, 2015. Limited number of seats and pre-registration is mandatory.  
**Gathering:** Outside the conference center.  
Please note that buses leave at 16:55, not later!  
Dinner sandwich and beverage will be provided on the bus and is included in the fee.

On Wednesday evening, directly after the end of the technical sessions, buses depart for a technical visit at AstaZero. AstaZero is a brand new proving ground for active safety testing with unique environments for road safety research. AstaZero’s facility is currently the only test facility in the world specifically developed for tests and research surrounding active safety. The proving ground contains a 5,7 km long rural road, a city area, a high speed area, and a multilane road. AstaZero is located 50 min from Gothenburg city.

You will be guided at the proving ground, and there will be several technical demos. Please note, the conference fee does not include this visit. You need to register separately.

**Schedule:**  
16:55 Departure from the Conference Center. Dinner sandwich will be provided on the bus  
18:00 Demonstrations of safety systems at the high speed area  
20:00 Bus back to Gothenburg, arriving at 21:00

For updated information, please visit www.fastzero15.net
Program at a glance

Tuesday, September 8, 2015

18:30-20:00
Welcome Reception & Registration

Location: Dicksonska Palatset, Parkgatan 2, Gothenburg

Wednesday, September 9, 2015

08:00
Registration & Coffee

08:30-08:50
Opening ceremony

Room: Runan

08:50-09:35
Keynote 1: Road Users and Human Machine Interaction
Dr. Cristina Olaverri Monreal, AIT Austrian Institute of Technology GmbH, Innovation Systems Department Business Unit Technology Experience, Austria

Room: Runan

09:35-10:00 Coffee & Green Tea Break

Room: Palmstedtsalen
10:00-11:40
Automated driving - safety and reliability I

Room: Scaniasalen
10:00-11:40
Pedestrian safety

Room: Runan
10:00-11:40
Traffic systems

11:40-12:40 Lunch Break

12:40-14:45
Safety analysis

12:40-14:45
Automated driving - driver behaviour

12:40-14:45
Safety oriented driver modelling and analysis

14:45-15:10 Coffee & Green Tea Break

15:10-16:55
Driver analysis

15:10-16:55
Driver analysis and support systems

15:10-16:55
Risk assessment

16:55-21:00
Technical Demos at AstaZero (Pre-registration mandatory)
**Thursday, September 10, 2015**

<table>
<thead>
<tr>
<th>Time</th>
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<tr>
<td>08:00</td>
<td>Coffee &amp; Green Tea</td>
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<tr>
<td>08:30-09:15</td>
<td>Keynote 2: Highly automated driving: Whom can you trust?</td>
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<td></td>
<td>Dipl.-Ing. Benedikt Schonlau, Head of Department Active Safety &amp; Lighting Functions, IAV GmbH , Germany</td>
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<td>Room: Runan</td>
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<tr>
<td>09:15-09:40</td>
<td>Coffee &amp; Green Tea Break</td>
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<tr>
<td>09:40-11:45</td>
<td>Detection, sensing and localization</td>
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<td>09:40-11:45</td>
<td>Safety on crossing</td>
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<td>09:40-11:45</td>
<td>Automated driving</td>
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<tr>
<td>11:45-13:00</td>
<td>Lunch Break</td>
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<tr>
<td>13:00-14:40</td>
<td>Estimation techniques for active and passive safety</td>
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<td>13:00-14:40</td>
<td>Automated driving - vehicle platoons</td>
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<tr>
<td>13:00-14:40</td>
<td>Autonomous driving and crash analysis</td>
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<tr>
<td>12:45-15:15</td>
<td>Technical Visit at Lindholmen (Group 1)</td>
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<td>Pre-registration mandatory</td>
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<tr>
<td>14:40-15:20</td>
<td>Coffee &amp; Green Tea Break</td>
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<tr>
<td>15:20-17:00</td>
<td>Traffic safety</td>
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<td>15:20-17:00</td>
<td>Driving dynamics</td>
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<td>15:20-17:00</td>
<td>Crash and naturalistic data</td>
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<td>18:30-23:00</td>
<td>Banquet dinner</td>
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*Location: Universeum, Södra Vägen 50, Gothenburg*
**Friday, September 11, 2015**

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<thead>
<tr>
<th>Time</th>
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<th>Room</th>
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<tbody>
<tr>
<td>08:00</td>
<td>Coffee &amp; Green Tea</td>
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<tr>
<td>08:30-09:15</td>
<td>Keynote 3: Road traffic safety, automated cars and infrastructure – potentials and possibilities &lt;br&gt;Prof. Anders Lie, Swedish Transport Administration, Sweden.</td>
<td>Runan</td>
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<tr>
<td>09:15-09:40</td>
<td>Coffee &amp; Green Tea Break</td>
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<tr>
<td>11:20-12:40</td>
<td>Lunch Break</td>
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<tr>
<td>12:40-14:45</td>
<td>Analysis and Modeling for Driver Performance II &lt;br&gt;12:40-14:45 Safety system evaluation &lt;br&gt;12:40-14:45 Safe driving and simulators</td>
<td>Palmstedtsalen</td>
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<tr>
<td>14:45-15:10</td>
<td>Coffee &amp; Green Tea Break</td>
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<tr>
<td>15:10-15:55</td>
<td>Keynote 4: Drive Me – Self-driving cars for sustainable mobility &lt;br&gt;Dr. Erik Coelingh, Volvo Cars, Sweden</td>
<td>Runan</td>
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<tr>
<td>15:55-16:20</td>
<td>Prize and closing ceremony</td>
<td>Runan</td>
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</table>
08:00-08:30 Registration & Coffee

08:30-08:50 Session 1: Opening ceremony
CHAIR: Jonas Sjöberg
LOCATION: Runan

08:50-09:35 Session 2: Keynote 1: Road Users and Human Machine Interaction
Dr. Cristina Olaverri Monreal, AIT Austrian Institute of Technology GmbH, Innovation Systems Department Business Unit Technology Experience, Austria
CHAIR: Jonas Sjöberg
LOCATION: Runan

09:35-10:00 Coffee & Green Tea Break

10:00-11:40 Session 3A: Automated driving - safety and reliability I
CHAIR: Robin van der Made
LOCATION: Palmstedtsalen
10:00 Sehyun Tak and Hwasoo Yeo
Asymmetric Collision Risk Spacing Policy for Longitudinal Control of Autonomous Driving Vehicle
10:25 Gabriel Rodrigues de Campos, Paolo Falcone and Jonas Sjöberg
Traffic safety at intersections: a priority based approach for cooperative decision-making
10:50 Hossein Tehrani, Quoc Huy Do, Masumi Egawa, Kenji Muto, Keisuke Yoneda and Seiichi Mita
Distance Constraint Model for Automated Lane Change to Merge or Exit
11:15 Rene Molenaar, Raymond de Vries and Robin van der Made
Full Spectrum Camera Simulation for Development of Automated Driving Applications

10:00-11:40 Session 3B: Pedestrian safety
CHAIR: Björn Peters
LOCATION: Scaniasalen
10:00 Shun Taguchi and Takayoshi Yoshimura
Driving Behavior Prediction for Natural Driving
10:25 Kazuhiro Ezawa and Pongsathorn Raksincharoensak
2-D Pedestrian Motion Prediction Modeling in Urban Driving Scenario Based on Potential Field
10:50 Tokihiko Akita
Pedestrian detection system while turning at intersection by surround monitor camera
11:15 Keisuke Suzuki, Takuya Kakihara and Yasutoshi Horii
Investigation of brake timing of drivers for design of pedestrian collision-avoidance systems

10:00-11:40 Session 3C: Traffic systems
CHAIRS: Tadjine Hadj Hamma and Ichiro Kageyama
LOCATION: Runan
10:00 Eijiro Takeuchi, Yoshihiko Ninomiya and Shinpei Kato
Lane Visibility Check Methods based on High Precision Maps and 3D LiDAR for Traffic Prediction
10:25 Hadji Hamma Tadjine and Daniel Goerhing
Acoustic/Lidar Sensor Fusion for Car Tracking in City Traffic
10:50 Tetsuya Kaneko, Ichiro Kageyama, Yukio Kuriyagawa and Tetsunori Haraguchi
Micro-Scale Traffic Simulator for Analyzing Mutual Interference between Personal Mobility Vehicles and Traffic Flow
11:15 Adrian Sonka, Louisa Liesner, Torben Pawellek, Florian Krauns, Roman Henze and Ferit Küçükay
Environment Perception and Event Detection for Object Prediction in Traffic

11:40-12:40 Lunch Break
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<tr>
<th>Time</th>
<th>Session</th>
<th>Chair</th>
<th>Location</th>
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<tbody>
<tr>
<td>12:40</td>
<td>Session 4A: Safety analysis</td>
<td>Bengt Jacobson</td>
<td>Palmstedtsalen</td>
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<td></td>
<td>12:40 Jens Schmuedderich, Sven Rebhan, Thomas Weisswange, Marcus Kleinehagenbrack, Robert Kastner, Morimichi Nishigaki, Shunsuke Kusuhara, Hiroyuki Kamiya, Naoki Mori and Shinnosuke Ishida</td>
<td>A novel approach to driver behavior prediction using scene context and physical evidence for intelligent Adaptive Cruise Control (I-ACC)</td>
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<td></td>
<td>13:05 Julian Eggert, Stefan Klingelschmitt and Florian Damerow</td>
<td>The Foresighted Driver: Future ADAS Based on Generalized Predictive Risk Estimation</td>
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<td></td>
<td>13:30 Yoshitaka Marumo, Takashi Nakano, Yohei Michitsujii and Hiroyuki Kobayashi</td>
<td>Driver’s Judgment Assistance System at Signalized Intersection by Indicating GO/NOGO Indices</td>
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<td>13:55 Derong Yang, Xiaoli Xie, Fredrik Bruzelius, Bruno Augusto, Bengt Jacobson and Mats Jonasson</td>
<td>Evaluation of Post Impact Control Function with Steering and Braking Superposition in High-fidelity Driving Simulator</td>
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<td>14:20 Nils Lube and Maminirina Ranovona</td>
<td>Simulation of lane departure accidents in Germany</td>
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<tr>
<td>12:40</td>
<td>Session 4B: Automated driving - driver behaviour</td>
<td>Svenja Scherer and Jonas Sjöberg</td>
<td>Scaniaosalen</td>
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<td></td>
<td>12:40 Marie-Pierre Pacaux-Lemoine, Philippe Simon and Jean-Christophe Popieul</td>
<td>Human-Machine Cooperation principles to support driving automation systems design</td>
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<td></td>
<td>13:05 Patrick Roßner, Svenja Scherer, Katharina Simon, Martin Jentsch and Angelika C. Bullinger</td>
<td>Join the joyride before it’s too late! Effects of autonomous driving on perceived driving enjoyment</td>
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<td></td>
<td>13:30 Malin Sundbom and Jonas Sjöberg</td>
<td>A study of appropriate model complexity for estimation of car-following behavior</td>
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<td></td>
<td>13:55 Roissa Pokam, Christine Chauvin and Serge Debernard</td>
<td>Augmented Reality Interface Design for Autonomous Driving</td>
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<td></td>
<td>14:00 Yoshiaki Furukawa, Kazuaki Takeya, Daisaku Senoo, Hiroshi Hasegawa and Toshio Ito</td>
<td>Development of Motor-and-bicycle Anti Roll-down System</td>
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<tr>
<td>12:40</td>
<td>Session 4C: Safety oriented driver modelling and analysis</td>
<td>Selpi</td>
<td>Runan</td>
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<tr>
<td></td>
<td>12:40 Mustafa Anwar Taie</td>
<td>New Trends in Automotive Software Design for the Challenges of Active Safety and Autonomous vehicles</td>
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<td></td>
<td>13:05 Ichiro Kageyama and Yukiyo Kuriyagawa</td>
<td>On Construction of Driver Model for Analysing Driver Characteristics</td>
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<tr>
<td></td>
<td>13:30 Andréa Palmberg, Jakob Imberg, Selpi Selpi and Robert Thomson</td>
<td>The effect of curve geometry on driver behaviour in curves by using naturalistic driving data</td>
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<td></td>
<td>13:55 Toru Kumagai</td>
<td>What Determines Where Drivers Press the Gas Pedal When Crossing an Unsignalized Intersection?</td>
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<tr>
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<td>14:20 Le Anh Son, Hirofumi Aoki, Tatsuya Suzuki and Hiroto Hamada</td>
<td>Parameters Optimization Using Genetic Algorithm Technique for Vestibulo-ocular Reflex model</td>
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<tr>
<td>14:45</td>
<td>Coffee &amp; Green Tea Break</td>
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<tr>
<td>15:10</td>
<td>Session 5A: Driver analysis</td>
<td>Chiyomi Miyajima</td>
<td>Palmstedtsalen</td>
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<tr>
<td></td>
<td>15:10 Marcus Mai, Thomas Tüschen and Günther Prokop</td>
<td>A physiological based Driver Model for longitudinal Vehicle Guidance and its Challenges in Validation</td>
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<td></td>
<td>15:35 Ekim Yurtsever, Chiyomi Miyajima, Selpi and Kazuya Takeda</td>
<td>Driving Signature Extraction</td>
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<td></td>
<td>16:00 Henrik Eriksson, Josef Nilsson, Jan Jacobson, Peter Janevik and Håkan Andersson</td>
<td>AstaZero – an Open Facility for Active Safety Research</td>
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</tbody>
</table>
### 15:10-16:55 Session 5B: Driver analysis and support systems

**CHAIR:** Jonas Fredriksson  
**LOCATION:** ScaniaSalen

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<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
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<tbody>
<tr>
<td>15:10</td>
<td>Shohei Kitazawa and Tetsuya Kaneko</td>
<td>Study on Difference of the Traveling Trajectory with Change in Vehicle Response Characteristics in the Lane Change Situation</td>
</tr>
<tr>
<td>15:35</td>
<td>Satoru Takenaka, Sayaka Nogami, Yukiyo Kuriyagawa, Hiroki Seto, Haruhiko Nakatsuji and Yosuke Tate</td>
<td>Driving support systems to encourage safe driving in complex situations: ways to provide information to the driver in a less distracting manner</td>
</tr>
<tr>
<td>16:00</td>
<td>Kei Sato, Hiroshi Mouri and Masao Nagai</td>
<td>Analysis of Drivers’ Behavior at Non-signalized Intersection Without Right-of-Way Using a Developed Simulation Program</td>
</tr>
<tr>
<td>16:25</td>
<td>Kazuto Yokoyama, Yukiyasu Akemi, Toshihide Satake, Ryotaro Suzuki and Michitoshi Azuma</td>
<td>Automatic Parking System for Electrified Vehicles Using Sonar Sensors</td>
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</tbody>
</table>

### 15:10-16:55 Session 5C: Risk assessment

**CHAIRS:** Tsukasa Shimizu and Takahiro Wada  
**LOCATION:** Runan

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>15:10</td>
<td>Yuichi Saito, Makato Itoh and Toshiyuki Inagaki</td>
<td>Detection of Drowsy Driving via a Dual Control Theoretic Driver Assistance</td>
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<tr>
<td>15:35</td>
<td>Kyuwon Kim, Beomjun Kim, Kyongsu Yi, Kyoungjun Lee, Hyokjin Chong and Bongchul Ko</td>
<td>Integrated Risk Assessment based Robust Vehicle Motion Control for Application to Automated Vehicles</td>
</tr>
<tr>
<td>16:00</td>
<td>Donghoon Shin, Beomjun Kim and Kyongsu Yi</td>
<td>Probabilistic Threat Assessment of Vehicle States Using Wireless Communications for Application to Integrated Risk Management System</td>
</tr>
<tr>
<td>16:25</td>
<td>John Sullivan, Rini Sherony and Shan Bao</td>
<td>The influence of roadway features on observed lane departure warning response in a simulator</td>
</tr>
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</table>
### Thursday, September 10, 2015

**08:30-09:15 Session 6: Keynote 2: Highly automated driving: Whom can you trust?**

*Dipl.-Ing. Benedikt Schönlau*, Head of Department Active Safety & Lighting Functions, IAV GmbH, Germany

**CHAIR:** Pongsathorn Raksincharoensak  
**LOCATION:** Runan

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**09:15-09:40 Coffee & Green Tea Break**

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**09:40-11:45 Session 7A: Detection, sensing and localization**

**CHAIRS:** Tokihiko Akita and Johan Degerman  
**LOCATION:** Palmstedtsalen

- **09:40** Maryam Foroughi, Uri Iurgel, Alexander Ioffe and Wolfgang Doerr  
  *Free Space Grid for Automotive Radar Sensors*

- **10:05** Johan Degerman, Klas Alenljung and Yoshihiro Abe  
  *Simultaneous localization and mapping (SLAM) for automotive using forward looking radar*

- **10:30** Makoto Itoh, Ryo Ishikawa and Toshiyuki Inagaki  
  *Evaluating Body Movements of a Drowsy Driver with Pressure Distribution Sensors*

- **10:55** Megumi Suzuki, Kenichi Miyazaki, Takao Iwaki, Keisuke Shibuya, Junichi Fujita and Akihito Sawa  
  *The Development of High Sensitivity Uncooled Infrared Night Vision Sensors for driving assistance use*

- **11:20** Keisuke Kazama, Kei Sato, Yasuhiro Akagi, Pongsathorn Raksincharoensak and Hiroshi Mouri  
  *Localization Method Based on Road Boundary Detection*

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**09:40-11:45 Session 7B: Safety on crossing (invited session)**

**Organizer:** Cristina Olaverri Monreal, Austrian Institute of Technology, and Enrique Cabello, Rey Juan Carlos University

**CHAIR:** Cristina Olaverri  
**LOCATION:** Scaniaasalen

- **09:40** René Schönrock, Franziska Wolf, Jan Krause and Tim Ruß  
  *Smart Traffic Cone - Dynamic detection and localization of traffic disruptions*

- **10:05** Enrique Cabello  
  *Lessons learnt in non-supervised record of real crossings*

- **10:30** Tim Ruß, Sebastian Naumann and Juri Sidorenko  
  *Avoiding Collisions between Pedestrians/Cyclists and Vehicles at Signal Controlled Intersections using V2X*

- **10:55** Stephanie Schwarz, David Sellitsch, Manfred Tscheligi and Cristina Olaverri Monreal  
  *Safety in Pedestrian Navigation: Road Crossing Habits and Route Quality Needs*

- **11:20** Sebastian Naumann, Olaf Czagalla and Felix Kühner  
  *A Safety Index for Road Crossing*

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**09:40-11:45 Session 7C: Automated driving, motivations and challenges (invited session)**

**Organizer:** Ferit Küçükay and Roman Henze, TU Braunschweig

**CHAIR:** Roman Henze  
**LOCATION:** Runan

- **09:40** Hideo Inoue  
  *ADAS with Driving Intelligence for Future Innovation*

- **10:05** Pongsathorn Raksincharoensak  
  *Potential-Field Based Motion Planning and Control Algorithm for Autonomous Driving Intelligence System*

- **10:30** Bernd Hartmann  
  *Road Condition Estimation - the next step towards Vision Zero on its way to Automated Driving*

- **10:55** Tadjine Hadj Hamma, David Seidel, Schönlau Benedikt, Grimm Stephan and Pflug Robert  
  *Safe Driving Generation 1 – Cooperative Safety Functions*

- **11:20** Gunnar Tornmalm and Tony Sandberg  
  *Scania Autonomous Transport Solutions*
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<td>11:45-13:00</td>
<td>Lunch Break</td>
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<tr>
<td>13:00-14:40</td>
<td>Session 8A</td>
<td>Estimation techniques for active and passive safety</td>
<td>John Hansen</td>
<td>Palmstedtsalen</td>
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<td><strong>CHAIR:</strong> John Hansen</td>
<td><strong>LOCATION:</strong> Palmstedtsalen</td>
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<tr>
<td>13:00</td>
<td></td>
<td>Yang Zheng and John Hansen</td>
<td>MobileUTDrive: An Android Portable Device Platform for In-vehicle Driving Data Collection and Display</td>
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<tr>
<td>13:25</td>
<td></td>
<td>Hisashi Imanaga and Shigeru Kashima</td>
<td>Estimation methods of Number of Accident Considering quality of active and passive safety performance</td>
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<tr>
<td>13:50</td>
<td></td>
<td>Shohei Ueda and Takahiro Wada</td>
<td>Modeling Driver’s Skill of Merging Operation toward Its Assistance System</td>
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<tr>
<td>14:15</td>
<td></td>
<td>Hiroyumi Yotsutsui, Takahide Matsumoto, Keiichiro Yonemura and Hideyuki Kita</td>
<td>An Experimental Study on the Effect of Sequential Transverse and Lateral Markings on Perceived Speed in Curved Road</td>
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<tr>
<td>13:00-14:40</td>
<td>Session 8B</td>
<td>Automated driving - vehicle platoons</td>
<td>Yoshitaka Marumo</td>
<td>Scania salen</td>
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<td><strong>CHAIR:</strong> Yoshitaka Marumo</td>
<td><strong>LOCATION:</strong> Scania salen</td>
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<td>13:00</td>
<td></td>
<td>Dongwook Kim, Taeyoung Chung and Kyongsu Yi</td>
<td>Lane-level Localization using Around View Monitoring Camera for Automated Urban Driving</td>
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<tr>
<td>13:25</td>
<td></td>
<td>Jeffrey Too Chuan Tan and Yoshihiro Suda</td>
<td>Automatic Vehicle Following of Personal Mobility Vehicles for Autonomous Platooning</td>
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<td>13:50</td>
<td></td>
<td>Alon Tuchner and Jack Haddad</td>
<td>Vehicle Platoon Formation Using Interpolating Control with Integral Action</td>
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<td>14:15</td>
<td></td>
<td>Takuma Ito, Masahiro Mio, Kyoichi Tohriyama and Minoru Kamata</td>
<td>Novel map platform based on primitive elements of traffic environments for automated driving technologies</td>
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<tr>
<td>13:00-14:40</td>
<td>Session 8C</td>
<td>Autonomous driving and crash analysis</td>
<td>Balazs Kulcsar</td>
<td>Runan</td>
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<td><strong>CHAIR:</strong> Balazs Kulcsar</td>
<td><strong>LOCATION:</strong> Runan</td>
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<td>13:00</td>
<td></td>
<td>Sehyun Tak and Hwasoo Yeo</td>
<td>The Study on the Risk Proactive Cooperative Cruise Control System with Different Market Penetration Rate Scenarios</td>
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<tr>
<td>13:50</td>
<td></td>
<td>Shigeyoshi Tsutsumi, Kei Sato and Masao Nagai</td>
<td>Analysis of Vehicle Accident Involving Bicycle at Non-signalized Intersection by Near-Crash Incident Database</td>
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<tr>
<td>14:15</td>
<td></td>
<td>Kristofer Kusano, Rong Chen and Hampton Gabler</td>
<td>Effect of Driving Context on Time to Collision at Brake Application during Car Following</td>
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<tr>
<td>14:40-15:20</td>
<td>Coffee &amp; Green Tea Break</td>
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<td>15:20-17:00</td>
<td>Session 9A</td>
<td>Traffic safety</td>
<td>Hidehisa Yoshida</td>
<td>Palmstedtsalen</td>
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<td><strong>CHAIR:</strong> Hidehisa Yoshida</td>
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<td>15:45</td>
<td></td>
<td>Takuma Ito, Tatsuya Shino and Minoru Kamata</td>
<td>Improvement of Elderly Drivers’ Acceptability for Proactive Collision Avoidance Using Passive Information Sharing</td>
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<td>16:10</td>
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<td>Roissa Pokam, Serge Debernard and Christine Chauvin</td>
<td>Towards autonomous driving: an Augmented Reality Interface Design for lane change</td>
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<td>16:35</td>
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<td>Georgios Chrysakis, Helen Monkhouse and Stratis Kanarachos</td>
<td>Vehicle Controllability Assessment Using Detailed Multibody Vehicle Simulations</td>
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<td>Time</td>
<td>Session 9B: Driving dynamics</td>
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<td>15:20</td>
<td>Florian Spitzhüttl, Henrik Liers and Marcus Petzold</td>
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<td>Creation of pre-crash simulations in global traffic accident scenarios based on the iGLAD database</td>
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<td>15:45</td>
<td>Shuguang Li, Toshiyuki Sugimachi, Kimihiko Nakano, Yoshihiko Tabuchi, Yoshihiro Suda, Kouji Yamamoto, Hideki Takahashi, Yoshitomo Orino, Noriyuki Oka, Kayoko Yoshino and Toshinori Kato</td>
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<td>Driving operations and parietal lobe activity correlate with driving skill during curve driving</td>
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<td>16:10</td>
<td>Daniel Lechner, Claire Naude, Thierry Serre, Maxime Dubois-Lounis, Michèle Guilbot, Jean-Yves Fournier and Vincent Ledoux</td>
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<td>Characterization of Driving Dynamics on road incidents collected by EDR</td>
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<td>16:35</td>
<td>Hironori Suzuki and Takaya Ishikura</td>
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<td>Green Phase Countdown Timer for Reducing Drivers’ Dilemma at Signalized Intersection</td>
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<tr>
<th>Time</th>
<th>Session 9C: Crash and naturalistic data</th>
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<tr>
<td>15:20</td>
<td>Ryo Oga, Kenshiro Kato, Takaaki Terashima and Nabuaki Takubo</td>
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<td>Characteristics of Crash Data Collected by Event Data Recorders in Airbag Control Modules during Collision with a Tubular Metal Guardrail</td>
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<td>15:45</td>
<td>Rong Chen, Kristofer D. Kusano and Hampton C. Gabler</td>
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<td>Age and Gender Difference in Braking Behaviour from the 100-Car Naturalistic Driving Study: The Implication for Autonomous Braking System Design</td>
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<td>16:10</td>
<td>Irene Isaksson Hellman and Magdalena Lindman</td>
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<td>Evaluation of Rear-End Collision Avoidance Technologies based on Real World Crash Data</td>
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<td>16:35</td>
<td>Esteban R. Gelso and Jonas Sjöberg</td>
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<td>Towards a consistent threat assessment at traffic junctions using road information and naturalistic data: A test example</td>
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**Friday, September 11, 2015**

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<tr>
<th>Time</th>
<th>Session 10: Keynote 3: Road traffic safety, automated cars and infrastructure – potentials and possibilities</th>
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<tr>
<td>08:30-09:15</td>
<td>Prof. Anders Lie, Swedish Transport Administration, Sweden</td>
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<td>CHAIR:</td>
<td>Anna Nilsson-Ehle</td>
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<tr>
<th>Time</th>
<th>Session 11A: Analysis and Modeling for Driver Performance I (invited session)</th>
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<tr>
<td>09:15-09:40</td>
<td>Coffee &amp; Green Tea Break</td>
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<td>09:40-11:20</td>
<td>Organizer: Motoki Shino, The University of Tokyo</td>
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<td>CHAIR:</td>
<td>Motoki Shino</td>
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<td>LOCATION:</td>
<td>Palmstedtsalen</td>
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<td>09:40</td>
<td>Ryo Iwaki, Kenji Sato, Takashi Wakasugi and Nobuyuki Uchida</td>
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<td>10:05</td>
<td>Nobuyuki Uchida, Takashi Tagawa and Kenji Sato</td>
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<td>10:30</td>
<td>Motoki Shino, Yuta Shimazu, Takashi Tagawa and Minoru Kamata</td>
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<th>Time</th>
<th>Session 11B: Safety and driver assistant systems</th>
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<tr>
<td>09:40-11:20</td>
<td>Tania Dukic Willstrand and Hironori Suzuki</td>
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<td>CHAIRS:</td>
<td>Scaniasalen</td>
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<td>09:40</td>
<td>Takashi Nakano, Yoshitaka Marumo and Hironori Suzuki</td>
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<td>10:05</td>
<td>Gökrem Büyükyıldız, Olivier Pion, Roman Henze and Ferit Küçükay</td>
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<td>10:30</td>
<td>Raphael Pfeffer, Tobias Leichsenring and Sebastian Schwab</td>
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<td>10:55</td>
<td>Tania Dukic Willstrand, Thierry Bellet, Thomas Broberg, Christina Stave, Jean-Christophe Paris, Björn Peters and Claude Marin-Lamellé</td>
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<tr>
<th>Time</th>
<th>Session 11C: Vehicle Automation and Connected Safety (invited session)</th>
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<tr>
<td>09:40-11:20</td>
<td>Organizer: Keisuke Suzuki, Kagawa University</td>
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<td>CHAIRS:</td>
<td>Jesper Sandin and Keisuke Suzuki</td>
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<td>09:40</td>
<td>Pongsathorn Raksincharoensak, Ko Iwano, Yuichi Saito, Hiroshi Mouri and Masao Nagai</td>
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<td>10:05</td>
<td>Jesper Sandin, Bruno Augusto, Peter Nilsson and Leo Laine</td>
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<td>10:30</td>
<td>Jesper Sandin, Bruno Augusto, Mats Petersson, Bo Svanberg and Regina Johansson</td>
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<td>10:55</td>
<td>Kentarou Hitomi, Hitoshi Terai, Hiroyuki Okuda, Takashi Bando, Chiyomi Miyajima, Takatsugu Hirayama, Yuki Shinohara, Masumi Egawa and Kazuya Takeda</td>
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<th>Time</th>
<th>Lunch Break</th>
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<td>11:20-12:40</td>
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12:40-14:45 Session 12A: Analysis and Modeling for Driver Performance II (invited session)
Organizer: Motoki Shino, The University of Tokyo

CHAIR: Nobuyuki Uchida
LOCATION: Palmstedtsalen
12:40 Kenji Sato, Ryo Iwaki, Takashi Wakasugi and Nobuyuki Uchida
Analysis and modeling of driver behavior on pedestrian crossing situation (2nd report: Analysis of a crossing diagonally situation using JARI-ARV)
13:05 Vachirawat Lertsilpachalearn, Yasuhiro Akagi and Pongsathorn Raksincharoensak
Motion Planning Method for Overtaking Bicycles in Urban Driving Scenario Based on Potential Field Framework
13:30 Takayuki Kondoh, Shane McLaughlin, Tomohiro Yamamura, Nobuyuki Kuge, Miguel Perez and Takashi Sunda
Detailed Investigation of Real-time Steering Entropy Sensitivity in Calling Events
13:55 Tsukasa Shimizu, Masayuki Okuwa and Pongsathorn Raksincharoensak
Analysis of Driver Behavior for Joint Human-Machine Systems Design of Intelligent Driving System
14:20 John M. Scanlon, Kristofer D. Kusano and Hampton C. Gabler
The Influence of Roadway Characteristics on Potential Safety Benefits of Lane Departure Warning and Prevention Systems in the U.S. Vehicle Fleet

12:40-14:45 Session 12B: Safety system evaluation
CHAIR: Robert Thomson
LOCATION: Scaniasalen
12:40 Marvin Rabben, Dr.-Ing. Roman Henze and Prof. Dr.-Ing. Ferit Küçükay
Dynamic Crash Target for the Assessment, Evaluation and Validation of ADAS and Safety Functions
13:05 Shin Tanaka
Simulation of reconstructing accidents for developing active safety system
13:30 Hidehisa Yoshida and Hideya Yamaguchi
Primitive Modelling of Driver’s Steering Torque using Front Field of View and Reaction Torque
13:55 Toshihiro Hiraoka, Keita Nozaki, Shota Takada and Hiroshi Kawakami
Safe Driving Evaluation System to Enhance Motivation for Safe Driving
14:20 Jonathan Jonsson, Nils Lubbe, Johan Strandrath and Robert Thomson
The Effect of Advanced Automatic Collision Notification (AACN) on Road Fatality Reduction in Sweden

12:40-14:45 Session 12C: Safe driving and simulators
CHAIRS: Jan Schröder and Birgitta Thorslund
LOCATION: Runan
12:40 Ahsan Ud-Din Qazi
Extending Vehicle Linear Behaviour: A Retrospective Approach through Design and Simulation Strategies
13:05 Birgitta Thorslund and Jonas Jansson
Effects of hearing loss shown in both driving simulator and real traffic
13:30 Jan Schröder, Christian Berger and Thomas Herpel
A Methodology for Simulation and Validation of a Safety-Critical Electronic Control Unit for Integration Testing in Connected Hardware-in-the-Loop Environments
13:55 Marcus Kleinehagenbrock, Morimichi Nishigaki, Robert Kastner, Jens Schmuedderich, Sven Rebhan, Thomas Weisswange, Hiroyuki Kamiya, Naoki Mori, Shunsuke Kusuhara and Shinnosuke Ishida
Introduction of Intelligent Adaptive Cruise Control (i-ACC) – a predictive safety system
14:20 Beom Jun Kim, Dong Wook Kim, Jun Young Lee, Kyu Won Kim, Young Seop Son and Kyong Su Yi
High-level Automated Driving on Complex Urban Roads with LiDAR, Vision, and GPS/map based Environment Representation

14:45-15:10 Coffee & Green Tea Break

15:10-15:55 Session 13: Keynote 4: Drive Me – Self-driving cars for sustainable mobility
Dr. Erik Coelingh, Volvo Cars, Sweden
CHAIR: Jonas Sjöberg
LOCATION: Runan
15:55-16:20 Session 14: Prize and closing ceremony
CHAIR: Jonas Sjöberg
LOCATION: Runan
08:00-08:30 Registration & Coffee

08:30-08:50 Session 1: Opening ceremony
CHAIR: Jonas Sjöberg
LOCATION: Runan

08:50-09:35 Session 2: Keynote 1: Road Users and Human Machine Interaction
Dr. Cristina Olveroni Monreale, AIT Austrian Institute of Technology GmbH, Innovation Systems Department Business Unit Technology Experience, Austria
CHAIR: Jonas Sjöberg
LOCATION: Runan

This presentation gives an overview of the impact of such technologies on traffic awareness for the driver towards improving driving performance and reducing road accidents. Furthermore, the benefits and potential problems regarding vehicle automation will be outlined.

ABSTRACT. With the number of in-vehicle information systems and the complexity of their tasks growing at a very high rate in near future, we need a clear understanding of their related distraction or mental workload and its impact on driver performance as these systems do not always comply with the intended driver safety enhancement. The advent of vehicle automation promotes a reduction of the driver workload. However, depending on the automation grade; consequences for the passengers such as out-of-the-loop states can be foreseen. This presentation gives an overview of the impact of such technologies on traffic awareness for the driver towards improving driving performance and reducing road accidents. Furthermore, the benefits and potential problems regarding vehicle automation will be outlined.

09:35-10:00 Coffee & Green Tea Break

10:00-11:40 Session 3A: Automated driving - safety and reliability I
CHAIR: Robin van der Made
LOCATION: Palmstedtsalen

10:00 Sehyun Tak and Hwasoo Yeo
Asymmetric Collision Risk Spacing Policy for Longitudinal Control of Autonomous Driving Vehicle

SPEAKER:
ABSTRACT: Spacing policy for autonomous vehicles is one of the important issues because it is highly related to the safety on the roads, efficiency of vehicles, and user satisfaction of autonomous vehicles. Many researchers have developed several spacing policies for autonomous vehicle control. Most of the spacing policies are mainly focused on the control scheme such as string stability and safety. So, the issues related to user satisfaction and possible effect of autonomous vehicles on manual vehicles are less considered especially in the mixed traffic situation of autonomous and manual vehicles. In this study, we propose an Asymmetric Collision Risk (ACR)-based spacing policy based on the analysis on collision risk and driving behavior. The proposed spacing policy is compared with other spacing policies by simulating with trajectories of human drivers. Based on the simulation results, the performance of each spacing policy is compared in terms of vehicle operation, CO2 emission and safety. The results show that ACR spacing policy has similar pattern with the human driver with smoother trajectory and less acceleration/deceleration actions. In terms of road efficiency and environment, the proposed ACR spacing policy shows the second best performance next to Safety Spacing policy. However, in terms of safety in mixed situation of manual and autonomous vehicles, ACR spacing policy is superior to other spacing policies with zero occurrence of critical event. By considering overall performance, the proposed ACR spacing policy is expected to generally show good performance in the mixed traffic situation of manual and autonomous vehicles.

10:25 Gabriel Rodrigues de Campos, Paolo Falcone and Jonas Sjöberg
Traffic safety at intersections: a priority based approach for cooperative decision-making

SPEAKER:
ABSTRACT. In this paper, we consider the coordination problem of multiple autonomous vehicles at traffic intersections. In particular, we exploit a cooperative, sequential conflict resolution approach based on a pre-defined decision order. Using an optimal control formulation, we show how coordination can be ensured by solving two local problems where collision avoidance is enforced as time-dependent state constraints. We will analyse the feasibility of a given sequence with respect to different decision criteria and present simulation results supporting our results.
10:50 Hossein Tehrani, Quoc Huy Do, Masumi Egawa, Kenji Muto, Keisuke Yoneda and Seiichi Mita

**Distance Constraint Model for Automated Lane Change to Merge or Exit**

**SPEAKER:** Quoc Huy Do

**ABSTRACT.** Lane change is a complicated maneuver and a reason for many severe highway accidents. Automatic lane change has great potentials to reduce the number of accidents. Previous researches mostly tried to find an optimal trajectory that can be applied for simple lane change. They do not consider time/distance constraints for doing the lane change during the merging/exiting. Through analysis of human driver lane change data, we propose a multi segments behavior and motion model to mimic the human driver operation. We developed a simulation platform in PreScan and evaluated proposed automatic lane change model for challenging scenario in the merging/exiting.

11:15 Rene Molenaar, Raymond de Vries and Robin van der Made

**Full Spectrum Camera Simulation for Development of Automated Driving Applications**

**SPEAKER:** Robin van der Made

**ABSTRACT.** Cameras are an essential component of many Advanced Driver Assistance Systems (ADAS) such as Lane Departure Warning, Lane Keeping Assistance, Automatic Emergency Braking, Traffic Sign Recognition and Night Vision. With the ongoing evolution of ADAS towards Automated Driving, the amount of cameras within vehicles as well as the performance of these cameras is only expected to grow. Nowadays automotive cameras are typically sensitive beyond the visual range (i.e. into the near infrared range) They may also use up to 20 bits precision for their internal signal. In order to support the development process of ADAS and Automated Driving Systems by means of simulation, it is required to have detailed physically correct simulation models of these automotive cameras. This paper describes the implementation and validation of a new spectral camera sensor model in the ADAS simulation platform PreScan. The traditional RGB-based camera implementation created images limited to the visual spectrum. In contrast, the new PreScan spectral camera sensor model allows for high color depth, broad spectrum and physically correct image generation. The model provides a real-time simulation of light in the 320-1500nm spectral range which traverses through the various media and lenses before the sensor produces the final image signal. Other important features of this new detailed camera model are a depth resolution of 20 bit per waveband as well as an increased dynamic range.

**10:00-11:40 Session 3B: Pedestrian safety**

**CHAIR:** Björn Peters

**LOCATION:** ScaniaSalen

10:00 Shun Taguchi and Takayoshi Yoshimura

**Driving Behavior Prediction for Natural Driving**

**SPEAKER:**

**ABSTRACT.** This paper proposes a method that uses a state-space model to predict vehicle behavior. It incorporates a proposed model of a generic driver, who is described by a simple feedback model with various constraints corresponding to general traffic rules and the physical limits of the vehicle. In addition, data assimilation is used to estimate the state and the model parameters on-line. By being able to predict natural driving data in unknown situations, the prediction error of the proposed model is significantly reduced compared to constant prediction, since data assimilation can be used to adapt the model to new situations. The data assimilation makes this model universal and robust against any new road-traffic situations. Furthermore, it is confirmed that this ability to predict can improve the fuel efficiency of adaptive cruise control systems.

10:25 Kazuhiro Ezawa and Pongsathorn Raksincharoensak

**2-D Pedestrian Motion Prediction Modeling in Urban Driving Scenario Based on Potential Field**

**SPEAKER:**

**ABSTRACT.** This paper presents 2-D pedestrian motion prediction model based on potential field for a hazard-anticipatory collision avoidance braking system to enhance the collision avoidance performance. 1-D pedestrian motion prediction reaches its limit under the situation that a pedestrian walks towards a parked vehicle as the prediction is conducted based on the current position and velocity of pedestrian within a finite time horizon. If the change of pedestrian motion can be predicted, the vehicle maneuver to avoid collision with pedestrian can be executed in advance. 2-D pedestrian motion prediction model based on potential field is constructed. The effectiveness of the proposed prediction model is verified by comparing the measured trajectory with the calculated data based on 1-D prediction and 2-D prediction.

10:50 Tokihiko Akita

**Pedestrian detection system while turning at intersection by surround monitor camera**

**SPEAKER:** Tokihiko Akita

**ABSTRACT.** Recently, demand for active safety systems has been increasing toward zero traffic accident fatality, thus an automated emergency brake system to avoid pedestrian accidents will be commercialized corresponding to Euro-NCAP. However, an effective assistance system for pedestrian accidents while turning at an intersection has not been proposed, though number of the accidents is the second largest after crossing pedestrian accident. We
propose the driving assistance system utilizing the surround monitor camera system which is getting popular. Stereo camera configuration utilizing front and side fish eye cameras has been considered to improve detection reliability. However, particular concerns for this configuration are existed, thus we are trying to develop the solution applying machine-learning feature amount in this research. They were preliminarily verified utilizing computer graphics, and then experimented for actual images captured in the real world.

11:15 Keisuke Suzuki, Takuya Kakihara and Yasutoshi Hori
Investigation of brake timing of drivers for design of pedestrian collision-avoidance systems
SPEAKER: Tadjine Hadj Hamma
ABSTRACT. The braking behaviors of drivers when a pedestrian steps out from a sidewalk and into the street were analyzed using a driving simulator. Based on drivers' braking behavior, a braking control timing for a system for avoiding collisions with pedestrians was proposed. In this study, the subject drivers started braking at almost the same time in terms of time to collision (TTC), regardless of the velocity of the subject vehicle and the crossing velocity of the pedestrian. The results of our experiments showed that, to minimize the degree of interference between the driver and the system, the optimum timing at which to apply the braking was at a TTC of 1.3 s. Next, the drivers' braking behavior was investigated when the system controlled the braking to avoid a collision with this timing. The drivers did not exhibit any change in their braking behavior, while there was no excessive interference between the braking control system and the drivers when attempting to avoid a collision with a pedestrian, indicating that the drivers were not becoming excessively dependent on the system.

10:00-11:40 Session 3C: Traffic systems
CHAIRS: Tadjine Hadj Hamma and Ichiro Kageyama
LOCATION: Runan
10:00 Eijiro Takeuchi, Yoshiki Ninomiya and Shinpei Kato
Lane Visibility Check Methods based on High Precision Maps and 3D LiDAR for Traffic Prediction
SPEAKER: Hadj Hamma Tadjine
ABSTRACT. This paper proposes fast lane visibility check methods for traffic prediction using traffic lane information and measurement information given by range sensor. Especially, this paper describes high accurate positioning method using high density point cloud map, competing lane search method, and fast visibility check method using high precision vector map and 3D LiDAR (Light Detection and Ranging). Finally, this paper illustrates experimental results in urban environments. In this experiment, the proposed method can detect occluded traffic lanes at crossing points, behind of vehicle and slopes.

10:25 Hadj Hamma Tadjine and Daniel Goehring
Acoustic/Lidar Sensor Fusion for Car Tracking in City Traffic
SPEAKER: Hadj Hamma Tadjine
ABSTRACT. In this paper we describe an approach which combines data from lidar sensors and acoustic sensory data for an improved object tracking accuracy in the setting of an autonomous car. After explaining the sensory setup we chose, we will show how acoustic data from two Kinect cameras, i.e., multiple microphones, which were mounted on top of a car, can be combined to derive an object's direction and distance. Part of this work will focus on a method to handle non-synchronized sensory data between the multiple acoustic sensors and the lidar sensor respectively. In a second step we will present a method which extends the given approach in order to identify and to localize cars with a certain sound signature, e.g., emergency vehicles. We will give experimental results for real traffic scenarios.

10:50 Tetsuya Kaneko, Ichiro Kageyama, Yukio Kuriyagawa and Tetsunori Haraguchi
Micro-Scale Traffic Simulator for Analyzing Mutual Interference between Personal Mobility Vehicles and Traffic Flow
SPEAKER: Tadjine Hadj Hamma
ABSTRACT. The personal mobility vehicle (PMV) described in this paper has typical biomimetic characteristics, which incline the vehicle body inside a curve. Since the behavior of this vehicle is similar to that of a two-wheeled vehicle, it is necessary to examine the PMV and the potential for interference with other vehicles in the midst of ordinary road traffic. Therefore, we simulated vehicle dynamics (including a driver model and a road-transportation system) and then analyzed the results, to guarantee the PMV's compatibility with micro-scale traffic flow.

11:15 Adrian Sonka, Louisa Liesner, Torben Pawelek, Florian Krauns, Roman Henze and Ferit Küçükay
Environment Perception and Event Detection for Object Prediction in Traffic
SPEAKER: Adrian Sonka
ABSTRACT. Information about the vehicle environment becomes increasingly important as the development of automated driving functions progresses. This paper not only addresses a perception of the current environment, but also an estimation of possible future states. A multi-purpose method for measuring objects, lane markings and road boundaries using a reference sensor system that includes laserscanners is presented. The focus lies on recording a comprehensive environment description that is needed for the examination of vehicle interaction. The results are utilized in the corresponding tool chain for postprocessing, event detection and analysis for object prediction applications. In a final step, different possible applications are introduced.
**12:40 Jens Schmuederich, Sven Rebhan, Thomas Weisswange, Marcus Kleinehagenbrock, Robert Kastner, Morimichi Nishigaki, Shunsuke Kusuhara, Hiroyuki Kamiya, Naoki Mori and Shinnsuke Ishida**

A novel approach to driver behavior prediction using scene context and physical evidence for intelligent Adaptive Cruise Control (i-ACC)

**SPEAKER:** Jens Schmuederich

**ABSTRACT.** Conventional driver assistance systems suffer from relatively late reaction timing. Adaptive Cruise Control (ACC) systems, for example, react to vehicles cutting-in from neighboring lanes once these vehicles are at least partly driving on the host vehicle's lane. The improvement by state of the art prediction approaches is limited, because the reliable approaches base on features, which are characteristic for the phenomenological effect of a behavior change. That means they are capable of predicting a behavior once it started. The Honda i-ACC overcomes the above mentioned limitation of delayed reaction by using a novel approach of behavior prediction. This approach combines two prediction methods: A context based prediction (CBP) and a physical prediction (PP). The CBP evaluates the situational context of a predicted vehicle and does not use any phenomenological feature. It is thus capable of long-term prediction. In contrast, the PP evaluates phenomenological features by accumulating the predicted vehicle's history of recent positions and comparing them to a set of trajectories, which allows for an accurate short-term prediction. In an evaluation on 15000km of driving in Europe we will show that the new prediction approach achieves both, reliable and long-term prediction.

**13:05 Julian Eggert, Stefan Klingelschmitt and Florian Damerow**

**The Foresighted Driver: Future ADAS Based on Generalized Predictive Risk Estimation**

**SPEAKER:**

**ABSTRACT.** Separately developed functionality as well as increasing situation complexity poses problems for building, testing, and validating future ADAS. These will have to deal with situations in which several current ADAS domains interplay. We argue that a generalized estimation of the future ADAS function benefit is required for efficient testing and evaluations, and propose a quantification based on an estimation of the predicted risk. We show that such an approach can be applied to several different types of risks and to such diverse scenarios as longitudinal driving, intersection crossing and lane changes with several traffic participants. Resulting trajectories exhibit a proactive, “foresighted” driver behavior which smoothly avoids potential future risks.

**13:30 Yoshitaka Marumo, Takashi Nakano, Yohei Michitsuji and Hiroyuki Kobayashi**

**Driver's Judgment Assistance System at Signalized Intersection by Indicating GO/NOGO Indices**

**SPEAKER:** Yoshitaka Marumo

**ABSTRACT.** This study examines the driver assistance system which informs the passage possibility at a signalized intersection ahead. The assistance system indicates the distance which the vehicle can forward by maintaining the present velocity until turning to the red signal using the signal information. If the indicated distance is shorter than the distance to the intersection from the vehicle, the system also indicates a stopping distance by assuming the ordinary deceleration. The driving simulator experiments are conducted to evaluate the proposed assistance system. The assistance system encourages the earlier deceleration before the amber signal and prevents the emergency braking behavior or the risky passage through the intersection.

**13:55 Derong Yang, Xiaoli Xie, Fredrik Bruzelius, Bruno Augusto, Bengt Jacobson and Mats Jonasson**

**Evaluation of Post Impact Control Function with Steering and Braking Superposition in High-fidelity Driving Simulator**

**SPEAKER:**

**ABSTRACT.** This paper evaluates the effectiveness of an active chassis control function after an initial light impact. The experiment was designed in a high-fidelity driving simulator with motion platform that is adapted to mimic a real-world crash. The post-impact control function here superimposes individual-wheel brake and steering wheel torque in order to minimize the vehicle maximum lateral deviation from its original traveling lane. It is found out that drivers with the function intervention has smaller lateral deviation after the disturbance from an initial impact, and thus less risk of leaving the road which may cause a secondary impact. The driver reaction with and without the function is also found to be different in terms of both braking the steering behaviours.

**14:20 Nils Lube and Maminirina Ranovona**

**Simulation of lane departure accidents in Germany**

**SPEAKER:** Maminirina Ranovona

**ABSTRACT.** The aim of this paper was to extend an existing simulation environment for lane departure accidents in the USA and Japan to be applicable for Germany. The German situation was described primarily using the German in-depth accident Study (GIDAS) as input to the simulation. Simulation output was validated against accident data. Two changes to the simulation environment were proposed: First, use of weighted empirical cumulative
distributions for input variables, and second, use of weighted logistic regression for injury risk curves. Further methodological consideration, should be given to inclusion of non-injury cases, object grouping and treatment of uncertainty.

**12:40-14:45 Session 4B: Automated driving - driver behaviour**

**CHAIRS:** Svenja Scherer and Jonas Sjöberg  
**LOCATION:** ScaniaSalen

**12:40**  
*Marie-Pierre Pacaux-Lemoine, Philippe Simon and Jean-Christophe Popieul*  
**Human-Machine Cooperation principles to support driving automation systems design**  
**SPEAKER:** Car manufacturers and automotive suppliers design more and more Advanced Driving Assistance Systems (ADAS) that are quickly installed into cars. Nevertheless, such ADAS address different types of driving activities and driver’s behaviors; they might concern longitudinal and lateral controls, lane changes, navigation, and try to take into account driver state and behavior. But what about the complementarity of such different ADAS if they are all together implemented in one car? And what about their interactions with the driver? Interactions have to be defined according to the levels of automation selected by the car manufacturer. In the French national project CoCoVeA (French acronym for Cooperation between Driver and Automated Vehicle), three levels of automation have been studied involving several existing ADAS. And this paper proposes a methodological approach to identify competences and capacities of driver and ADAS in the case of many driving situations in order to check complementarity, function allocation, authority management, as well as cooperative aspects in order to assess reliability of such a Human-machine system and the acceptance and even the attractiveness of highly automated vehicle.

**13:05**  
*Patrick Roßner, Svenja Scherer, Katharina Simon, Martin Jentsch and Angelika C. Bullinger*  
**Join the joyride before it’s too late! Effects of autonomous driving on perceived driving enjoyment**  
**SPEAKER:** Svenja Scherer  
**ABSTRACT:** Autonomous driving vehicles will become a key element of mobility in the near future. Although it opens up new opportunities for the individual and increases traffic safety, there is a highly controversial debate about how much this new way of driving is accepted by the driver. In this article, relevant factors and expectations for autonomous driving are investigated. The basic theories on determinants for driving enjoyment will be opposed to different levels of automation for vehicles to predict their possible effect on driving enjoyment. An insight will be given into content analysis and online survey. Results indicate that attitudes towards autonomous driving can vary between situations. Especially situations with a high dynamic aspect such as driving a curved road are rejected, while over 90% of the participants were able to name at least one situation where they could imagine to be driven with an autonomous vehicle. This paper contains a detailed presentation of the results and is completed with the discussion of possible impacts of autonomous driving on the driver, on society, and its potential implication for the automotive industry.

**13:30**  
*Molin Sundbom and Jonas Sjöberg*  
**A study of appropriate model complexity for estimation of car-following behavior**  
**SPEAKER:**  
**ABSTRACT:** This paper investigates model complexity, or equivalently, necessary model structure, for describing car-following behavior. The recently suggested PrARX modeling framework is systematically investigated and compared with simpler model structures containing less tuning parameters to see to what extent complex models can be motivated. The results indicate that for long prediction horizons there is no gain having a complex model structure. However, one-step ahead prediction of complex models can be useful for classification of whether the driver should be braking or not.

**13:55**  
*Raisa Pokom, Christine Chauvin and Serge Debernard*  
**Augmented Reality Interface Design for Autonomous Driving**  
**SPEAKER:**  
**ABSTRACT:** The submitted abstract presents our methodology for designing interface for autonomous driving. The methodology is based on a cognitive approach, the Cognitive Analysis, which permits to extract Augmented Reality information that will convey driver's attention to particular points of interest in the environment. It will be evaluated on lane changes and handover scenarios.

**14:20**  
*Yoshimi Furukawa, Kazuaki Takeya, Daisaku Senoo, Hiroshi Hasegawa and Toshio Ito*  
**Development of Motor-and-bicycle Anti Roll-down System**  
**SPEAKER:** Daisaku Senoo  
**ABSTRACT:** Motorcycle and bicycle Anti-Roll-down System, that controls vehicle roll angle by gyro moment created by the directional changes of flywheel axis, is proposed. Control system is designed by referring the vehicle motion model and effects of gyroscopic torque on vehicle motion. The effects of the proposed system is evaluated and validated by theoretical analysis and vehicle motion simulation.
12:40 Mostafa Anwar Taie  
**New Trends in Automotive Software Design for the Challenges of Active Safety and Autonomous vehicles**  
SPEAKER: Mostafa Anwar Taie  
ABSTRACT. The automotive mobility innovative systems like: Advanced Driver Assistance Systems (ADAS), Active Safety Systems, Autonomous Driving and even Connected Vehicles are continuously being developed for more convenient driving and for achieving higher safety standards. Therefore, software and hardware designs have to handle the increasing challenges and complexities introduced by those systems. Interactive distributed automotive real time systems are typically used to implement such complex systems, which have many real-time constraints distributed in several Electronic Control Units (ECUs) and communication bus(es). This requires form OEMs to specify accurate software integration performance requirements for different suppliers, which is very tough task and contains many integration challenges. This talk will discuss the new trends in the embedded systems software design to over come the challenges introduced by active safety and autonomous driving systems. The state of the art industrial solutions in software real-time architectural design will be discussed like ATESSST2 project and Timm-2-use project. Moreover, the AUTOSAR timing extension standard (used to describe timing specifications, real-time constraints and probabilistic timing properties for events and event chains) will be explored as a good practice to provide clear timing requirements for each ECU. It also provides sufficient timing information for real time measurements and for efficient validation of the system real time requirements. A practical example of BMW tools (Artime, T1 and Artip), as mentioned in BMW’s publications, for AUTOSAR timing extension will be shown. Moreover, some other advanced real-time architectural design methods shall be discussed like: modeling the timing requirements and real-time constraints, modeling the real-time architectural design (operating systems tasks and interrupts), simulating the real-time architectural design, optimizing & refining the real-time architectural design, verifying the timing requirements and time triggered based real-time Architecture. Recent approaches predict the tasks and ISRs execution times used in the real-time architectural designs at early phases of the development. One of the approaches uses machine learning algorithms and provides good estimates of the tasks’ execution times and the overall CPU loads. Afterwards, the complete real-time architectural design simulation and verification is used to be able to refine and optimize the design. Moreover, eVlaue, European project for evaluation of active safety systems, will be explained with its performance testing process and the impact on software design. Active safety and self-driving systems are increasing the usage of sensors fusion (e.g. fusion between laser scanners, radars, cameras, and ultrasonic sensors) and the usage of high speed buses (e.g. Ethernet, MOST) to exchange data between sensors and their control units. Therefore, combination of some embedded hardware systems are needed (e.g. multi-core, FPGA, DSP processors, High speed automotive buses, etc.). This talk will explain the impact of using those complex hardware systems on software design taking Audi zFAS computer, shown in CES 2014 in Las Vegas, as an industrial solution example.

13:05 Ichiro Kageyama and Yukiyo Kuriyagawa  
**On Construction of Driver Model for Analysing Driver Characteristics**  
SPEAKER:  
ABSTRACT. This paper deals with a fundamental study to analyze driver characteristics using driver model. At the first stage of this research, we consider a possibility for identification of driver control manner by using a preview driver model. Influence of each term for preview in the model has been considered by using experimental data, and the order of the model has been decided. And it is shown that the model above can describe an ordinary control action of a driver. From these results, it is shown that the driver model constructed in this research is effective for driver’s various analyses.

13:30 Andréa Palmberg, Jakob Imberg, Selpi Selpi and Robert Thomson  
**The effect of curve geometry on driver behaviour in curves by using naturalistic driving data**  
SPEAKER: Selpi  
ABSTRACT. Traffic accidents are commonly found on horizontal curves. It is therefore important to study how the curve geometry affects the driver behaviour. This paper focuses on analysis of speed and maximal lateral acceleration in seven curves on two-lane rural highways in Sweden. The curve geometry factors studied are radii, presence and length of spiral transitions, tangent lengths and radius of previous curve. Of the studied factors, radii and spiral transitions were found to influence the driver behaviour most. Both larger radii and longer spiral transitions result in higher speeds in curves, and speed variations within curves seemed to be independent on choice of speed entering the curve.
13:55 Toru Kumagai
What Determines Where Drivers Press the Gas Pedal When Crossing an Unsignalized Intersection?
SPEAKER: Toru Kumagai
ABSTRACT. We investigated factors determining the start position, defined as the point where a driver presses the gas pedal immediately prior to entering an intersection. Start positions are highly important for safety, because they mark the point where drivers complete their safety confirmation and begin accelerating to enter an intersection. Drivers’ intersection crossing behavior, without right-of-way, was recorded at six unsignalized intersections in a residential area of Tsukuba, Japan. A total of 8 subjects drove the vehicle, at each intersection, 36 times. We analysed only the first three and last three trials because our previous study showed that start positions changed over repeated trials. We used linear regression analysis to identify significant explanatory variables. For the last three trials, own-road width (p < 0.01), crossroad sidewalk width (p < 0.01), and driver properties such as the start position alteration pattern (p < 0.01) were significant. The adjusted R-squared was 0.60, and the root mean square error was 0.80. The distance from the nearest edge of the crossroad to the start position typically increased when the crossroad sidewalk width and/or own-road width were broad, and was roughly equal to or less than the crossroad sidewalk width. For the first three trials, however, only own-road width (p < 0.01) was significant, and crossroad sidewalk width and the start position alteration pattern were not significant. The R-squared was 0.48, and the root mean square error was 1.29. These results suggest that subjects did not grasp the dimensions of the intersections sufficiently, in approaching the crossing, to drive as effectively as they otherwise would. Through repeated trials, they learned these dimensions, and drove more effectively as a result. This suggests that drivers should be better informed of intersection dimensions, for improved safety. The statistical significance of the start position alteration pattern indicated that individual drivers tended to maintain their characteristic driving behavior when crossing the intersections, which clearly demonstrated the importance of driver behavior properties as explanatory variables. It seems important, then, to consider this pronounced tendency when seeking to provide suitable assistance to individual drivers, with the aim of improving driver safety.

14:20 Le Anh Son, Hirofumi Aoki, Tatsuya Suzuki and Hiroto Hamada
Parameters Optimization Using Genetic Algorithm Technique for Vestibulo-ocular Reflex model
SPEAKER: Le Anh Son
ABSTRACT. The Vestibulo-ocular reflex (VOR) model proposed by Merfeld and Zupan (2002) has been used in a wide number of medical applications as well as the driver behavior model. This model is one of the reflex eye movements. It can deal with the interaction between the otolith and the semicircular canal with four parameters to compensate for the individual difference of the VOR characteristics and two parameters to compensate for that of the eye muscle characteristics. In order to increase the reliability, exact ability of this model, by using genetic algorithm (GA) the parameters were identified base on the result of experiment and simulation. We conducted 12 experiments with the motion capture and the eye movement equipment. The new parameters identified by the new GA technique improved simulation results compares with Merfeld parameters and the previous GA method by applying the generating near optimal initial population and changing fitness function. The range of each parameter on VOR model was identified with main purpose to choose the best parameters for each model application. We developed a Matlab toolbox for identifying parameter base on Matlab Graphical User Interfaces.

14:45-15:10 Coffee & Green Tea Break

15:10-16:55 Session 5A: Driver analysis
CHAIR: Chiyomi Miyajima
LOCATION: Palmstedtsalen

15:10 Marcus Mai, Thomas Tüschen and Günther Prokop
A physiological based Driver Model for longitudinal Vehicle Guidance and its Challenges in Validation
SPEAKER: Marcus Mai
ABSTRACT. In this paper, a numerical driver behaviour model is presented in terms of how drivers possibly regulate their deceleration in braking tasks. It is based on David N. Lee’s t-theory, which describes how drivers can perceive values of relative motion like time to collision or headway. This physiological model provides more universal application possibilities than purely empirical models, but its validation within critical traffic situations constitutes great issues. Therefore, a highly dynamic driving simulator providing all the requirements needed is currently under development at the Dresden University of Technology.

15:35 Ekim Yurtsever, Chiyomi Miyajima, Selpi Selpi and Kazuya Takeda
Driving Signature Extraction
SPEAKER: Ekim Yurtsever
ABSTRACT. This study proposes a method to extract the unique driving signatures of individual drivers. We assume that each driver has a unique driving signature that can be represented in a k dimensional principal driving
component (PDC) space. We propose a method to extract this signature from sensor data. Furthermore, we suggest that drivers with similar driving signatures can be categorized into driving style classes such as aggressive or careful driving. In our experiments, 122 different drivers have driven the same path on Nagoya city express highway with the same instrumented car. GPS, speed, acceleration, steering wheel position and pedal operations have been recorded. Clustering methods have been used to identify driving signatures.

16:00 Henrik Eriksson, Josef Nilsson, Jan Jacobson, Peter Janevick and Håkan Andersson
AstaZero – an Open Facility for Active Safety Research
SPEAKER: Henrik Eriksson
ABSTRACT. The AstaZero proving ground for testing of vehicle active safety systems was inaugurated in August 2014. Since then, several research projects have already been active on the proving ground. This paper will introduce the test track, give examples of such research activities, and show the benefits of an open facility for active safety research.

16:25 Daniel Wanner, Lars Drugge, Johannes Edrén and Annika Stensson Trigell
Modelling and experimental evaluation of driver behaviour during single wheel hub motor failures
SPEAKER:
ABSTRACT. A failure-sensitive driver model has been developed in the research study presented in this paper. The model is based on measurements of human responses to different failure conditions influencing the vehicle directional stability in a moving-base driving simulator. The measurements were made in a previous experimental study where test subjects were exposed to three sudden failure conditions that required adequate corrective measures to maintain the vehicle control and regain the planned trajectory. A common driver model and a failure-sensitive driver model have been compared, and results for the latter agree well with the measured data. The proposed failure-sensitive driver model is capable of maintaining the vehicle control and regaining the planned trajectory similar to the way in which humans achieved this during a wheel hub motor failure in one of the rear wheels.

15:10-16:55 Session 5B: Driver analysis and support systems
CHAIR: Jonas Fredriksson
LOCATION: ScaniaSalen

15:10 Shohei Kitazawa and Tetsuya Kaneko
Study on Difference of the Traveling Trajectory with Change in Vehicle Response Characteristics in the Lane Change Situation
SPEAKER: Shohei Kitazawa
ABSTRACT. We believe that a driver’s operation and vehicle’s motion characteristics during a lane change differ by driver. This study examined a driver’s acceptance and operation in relation to a change in the vehicle’s response using a four-wheel steering vehicle. We changed the frequency response characteristics of the yaw rate for the steering wheel operation by changing the control parameters of the four-wheel steering system. In addition, we conducted some experiments using this experimental vehicle. The results show that the vehicle response that was acceptable to the driver was characterized, and the behavior of drivers in relation to the vehicle response was determined.

15:35 Satoru Takenaka, Sayaka Nogami, Yukiko Kuriyagawa, Hiroki Seto, Haruhiko Nakatsui and Yosuke Tate
Driving support systems to encourage safe driving in complex situations: ways to provide information to the driver in a less distracting manner
SPEAKER:
ABSTRACT. The premise of driving support systems is to reduce a driver’s load and traffic accidents as a whole. However, we feared that such systems can degenerate a driver’s ability by causing an overreliance on driving assistance systems consciously and/or unconsciously. Therefore, we produced a pre-reminder system that reduces encounters with accident factors by helping the driver turn their attention back to safe driving methods. We installed the system in a driving simulator and conducted an experiment to assess the system. As a result, the pre-reminder system did work as intended, and the driver’s behaviour was focused more on the road, lessening overreliance on road safety systems.

16:00 Kei Sato, Hiroshi Mouri and Masao Nagai
Analysis of Drivers’ Behavior at Non-signalized Intersection Without Right-of-Way Using a Developed Simulation Program
SPEAKER: Kei Sato
ABSTRACT. In Japan, many head-on collisions occur on subsidiary roads at non signalized intersections and elderly drivers tend to cause this type of accidents. Therefore, to clarify the principal accident causation of head-on collisions is strongly required in our country which is an aging society. In the current study a simulation program was established based on the experimental data and the driving behavior of expert drivers and elderly drivers were compared with focusing on the collisions with crossing bicycles, drivers’ confirming safety behavior and their foot positions.
16:25 Kazuto Yokoyama, Yukiyasu Akemi, Toshihide Satake, Ryotaro Suzuki and Michitoshi Azuma

Automatic Parking System for Electrified Vehicles Using Sonar Sensors

ABSTRACT. Mitsubishi Electric has been developing an automatic parking system. The main part in the system is provisionally named e-Park controller. It executes PSM (parking slot measurement) using our sonar sensors to find a parking slot available. Simultaneously, the controller estimates states of the vehicle and calculates an optimal path to the parking slot. After the path planning, reference signals for our electric power steering and driving motor control systems are generated to track the path automatically. The parking can be executed externally using our device for the keyless entry system. For safety, the parking system also has an emergency braking function based on the sonar sensors and operation of the driver. This paper mainly focuses on the design of the path planning algorithm and the vehicle speed controller. The automatic parking system is verified in experiments.

15:10-16:55 Session SC: Risk assessment

CHAIRS: Tsukasa Shimizu and Takahiro Wada
LOCATION: Runan

15:10 Yuichi Saito, Makoto Itoh and Toshiyuki Inagaki

Detection of Drowsy Driving via a Dual Control Theoretic Driver Assistance

ABSTRACT. Driver drowsiness is one of major causes of fatal traffic accidents. We proposed a driver assistance system with a dual control theoretic scheme, which tries to perform safety control of a vehicle as well as identification of a driver’s state (e.g., low arousal, degradation of mental and physical states) simultaneously. The dual control theoretic driver assistance works in a situation-adaptive manner, and it takes into account sleepy driver characteristics and circumstantial contexts. This paper gives an analysis of driver behavior when the driver assistance is active, and discusses the type of assist that is effective for prevention of sleep-related vehicle accidents.

15:35 Kyuwon Kim, Beomjune Kim, Kyongsu Yi, Kyoungjun Lee, Hyojjin Chong and Bongchul Ko

Integrated Risk Assessment based Robust Vehicle Motion Control for Application to Automated Vehicles

ABSTRACT. This paper describes an approach to vehicle motion control algorithm for application of an automated vehicle. A full recognition of environment is achieved by data fusion and data interpretation based on the dynamic measurements from the environmental sensors such as radar and vision. The recognition of environment is transformed into an artificial risk potential representation, which is collision probability. In order to guarantee lateral stability in the high speed maneuver, constraints of the vehicle motion based on vehicle dynamics have been considered. Probabilistic predictions of surrounding vehicles are included into the risk potential function for represent the predicted collision risk based on the estimated motion of the subject vehicle and the surrounding vehicles. The potential field interpretation has been proposed to represent the risk potential to the surrounding vehicles based on the predicted motion of the vehicles. The proposed motion control algorithm has been investigated via closed-loop simulation.

16:00 Donghoon Shin, Beomjune Kim and Kyongsu Yi

Probabilistic Threat Assessment of Vehicle States Using Wireless Communications for Application to Integrated Risk Management System

ABSTRACT. This paper presents a probabilistic threat assessment of vehicle states using wireless communications for application to integrated risk management system. Since one of the main concerns in risk assessment is an assessment of collision risk, it is necessary to estimate the probability of collision occurrence of the ego vehicle which expresses driver sensitivity. Recent developments in vehicle onboard computers and wireless communications devices, also known as dedicated short-range communication (DSRC) devices allow the exchange of information between vehicles (V2V communications). The prediction performance of the proposed method, which integrates V2V communications to conventional advanced driver assistance systems (ADAS), has been investigated via simulations using the commercial vehicle software Carsim and Matlab/Simulink. It is shown the threat assessment performance for the given driving situations can be significantly enhanced by the proposed algorithm. This leads to improvement of conventional driver assistance functions of ADASs.

16:25 John Sullivan, Rini Sherony and Shan Bao

The influence of roadway features on observed lane departure warning response in a simulator

ABSTRACT. A simulator study was conducted to characterize driver steering responses to lane departure warnings. Drivers were asked to perform a distracting secondary task while their vehicles were occasionally pushed to the side of the roadway to encourage lane departures. Three lane departure warning treatments were investigated: no warning, an auditory warning, and a tactile warning using steering wheel vibration. Overall drivers’ corrective steering responses suggested that both the presence of a lane departure warning and characteristics of the roadway environment influenced the magnitude of the steering corrections observed.
Program with abstracts: Thursday, September 10, 2015

08:30-09:15 Session 6: Keynote 2: Highly automated driving: Whom can you trust?
  Dipl.-Ing. Benedikt Schonlau, Head of Department Active Safety & Lighting Functions, IAV GmbH, Germany

CHAIR: Pongsathorn Raksincharoensak
LOCATION: Runan

Who should be allowed to update maps? Can you trust the map authors? What has to be done to trust algorithms? What about data age? How is trust diminishing with growing data age? And what level of trust is really needed for highly automated driving? This keynote illustrates the problem of trust for highly automated driving and discusses high level strategies for getting trust into automated vehicles.

ABSTRACT. Intelligent Transport Systems (ITS) are currently being developed in a lot of different industry sectors. The biggest challenge is to make those systems safe and reliable. Main focus of ITS in automotive industry is Highly Automated Driving (HAD). Highly Automated Driving is in an advanced development state and will get into production status in a few years. This new technology is required to be safe and reliable by design, not by bad experience and enhancements. In complex ITS, where system boundaries are not limited to single products from one OEM, safety and reliability is a question of trust. Can we trust those vehicles with variable HAD system boundaries, that they do not endanger participants and their surrounding field? From a technical point of view, a trust chain of all required technologies is essential. But which technology is trustful enough? Could it be surrounding field sensing (camera, laser or radar), global dynamic maps, local dynamic maps, GNSS, V2X, sensor data fusion or driving algorithms?

09:15-09:40 Coffee & Green Tea Break

09:40-11:45 Session 7A: Detection, sensing and localization
  CHAIRS: Tokihiko Akita and Johan Degerman
  LOCATION: Palmstedtsalen

09:40 Maryam Foroughi, Uri Iurgel, Alexander Ioffe and Wolfgang Doerr
  Free Space Grid for Automotive Radar Sensors

  SPEAKER:

  ABSTRACT. A new method for generating a separate two-dimensional free space grid map for ADAS based on data from radar sensors is presented in this paper. We introduce a free space model based on an inverse sensor model to compute the Gaussian-based free space probability for each cell of the free space grid map. A Bayesian approach is used for free space probability estimation independently from the occupancy probability, which enables increased amount of information for environment description. For this purpose, two free space grid maps are generated: The instantaneous free space map is generated in each measuring cycle and the accumulated free space map is generated once and updated in each measuring cycle. We describe how the free space grid maps are generated and updated by new observations. In contrast to other approaches, the detection accuracy is taken into account in the free space model. Finally we present the experimental results obtained from real world environments.

10:05 Johan Degerman, Klas Alenljung and Yoshihiro Abe
  Simultaneous localization and mapping (SLAM) for automotive using forward looking radar

  SPEAKER:

  ABSTRACT. Localization is the process of nding ones relation to the surrounding stationary objects, and mapping is the process of determining the relation between the stationary objects. Mapping requires a sensing technique, and in addition to that a known (or estimated) location. If we neglect the possibility of external support such as GPS or street maps and instead consider localization using ranging sensors, we are facing two strongly interconnected problems that needs to be solved simultaneously. We have investigated the possibility to perform SLAM (simultaneous localization and mapping) in automotive using a forward-looking radar, primarily designed for ACC (adaptive cruise control) and PCS (pre-crash safety). Our positioning is not only relying on the inertial measurements speed and yaw-rate from the vehicle, but also incorporates radar measurements and performs extended Kalman filter SLAM (EKF-SLAM). Using collected data from a single forward-looking radar, we have shown that it is possible to enhance the positioning performance without support from GPS. The heading of the vehicle was drifting as yaw-rate error accumulated, but when adding EKF-SLAM we mitigated this problem. However, this system was very sensitive to parameter settings, as well as radar misalignment, and needs a thorough on-line calibration. Robustness can be achieved by increasing the field of view or having side-looking radars.
10:30 Makoto Itoh, Ryo Ishikowa and Toshiyuki Inagaki

Evaluating Body Movements of a Drowsy Driver with Pressure Distribution Sensors

SPEAKER: ABSTRACT. The purpose of this research is to develop a method to detect driver drowsiness with pressure distribution sensors on the driver seat. Use of such sensors has an advantage that the measurement can be done in a non-intrusive manner, and that sensing data can always be obtained while driving. We conducted an experiment with a fixed-base driving simulator. The results suggested that driver body movement increases when driver drowsiness begins to increase.

10:55 Megumi Suzuki, Kenichi Miyazaki, Takao Iwaki, Keisuke Shibuya, Junichi Fujita and Akihito Sawa

The Development of High Sensitivity Uncooled Infrared Night Vision Sensors for driving assistance use

SPEAKER: ABSTRACT. Uncooled sensors for use in night vision are a promising technology for use in active driver-assistance systems (ADAS) in combination with active-type sensors. However, the sensitivity of conventional uncooled sensors is low because attempts to achieve high sensitivity with conventional sensors are hampered by their high resistivity, which increases thermal noise. To overcome this problem, we have developed new uncooled sensors that have a low resistivity and high sensitivity. This was achieved by improving the crystal quality of the detector materials. Consequently, the sensitivity of the developed sensors was about five times higher than that of conventional low-resistivity sensors. This result could expand the range of use of such sensors and might improve object-recognition accuracy in forward-facing ADAS.

11:20 Keisuke Kazama, Kei Sato, Yasuhito Akagi, Pongsathorn Raksincharoensa and Hiroshi Mouri

Localization Method Based on Road Boundary Detection

SPEAKER: ABSTRACT. We tried to develop the new localization method by simple 2D-plane map without deterioration of estimation accuracy. The boundary line has a lot of features e.g. changes of height, color and brightness, but they are sensitive for noises. From the robustness point of view, it is difficult to match the road boundary line with the boundary line on 2D map. The localization method using 3D point cloud matching or texture matching are so accurate, but these have disadvantage in adaptation to the change of environment. So, we decide to make the classifier to classify as road area or the other area, and propose the new localization method that has advantage in robustness by matching the identified shape of road area with the shape of the road on 2D plane map. First, we calculate the HOG features from the range data acquired by 3D LiDAR. Then, we make the road plane classifier applying SVM.

09:40-11:45 Session 7B: Safety on crossing (invited session)

Organizer: Cristina Olaverri Monreal, Austrian Institute of Technology, Enrique Cabello, Rey Juan Carlos University

CHAIR: Cristina Olaverri
LOCATION: Scania salen

09:40 René Schönrock, Franziska Wolf, Jan Krause and Tim Ruß

Smart Traffic Cone - Dynamic detection and localization of traffic disruptions

SPEAKER: ABSTRACT. Suddenly occurring disruptions on the road and especially at intersections – such as accidents, disabilities by vehicles and objects – may cause significant adverse effects on the traffic flow and in turn lead themselves to potentially dangerous situations. By using its integrated GNSS receiver and its mobile communication device the smart traffic cone provides timely and spatially accurate information about local disruptions in the road environment. It is a tool for police, rescue, recovery and service staff for detecting hazard areas that could not be detected so far.

10:05 Enrique Cabello

Lessons learnt in non-supervised record of real crossings

SPEAKER: Enrique Cabello

ABSTRACT. This paper presents an artificial vision based video-sensor designed to detect pedestrian-vehicle conflicts at crossing points. This video sensor detects moving objects by isolating them from the background. Then the speed and trajectories are estimated using a Kalman filter. Potential conflicts are then predicted. This system has been tested at two real crossing points at the city of Salamanca (Spain).

10:30 Tim Ruß, Sebastian Naumann and Juri Sidorenko

Avoiding Collisions between Pedestrians/Cyclists and Vehicles at Signal Controlled Intersections using V2X

SPEAKER: ABSTRACT. Especially at intersections, pedestrians and cyclists are endangered by crossing vehicles. Modern sensor and radio communication technologies offer the possibility to detect dangerous situations and to prevent accidents. In the joint research project UR:BAN, the following is being researched and implemented prototypically: At intersections, so called vulnerable road users are being detected by radar, as well as their mobile devices, like smartphones. After the upcoming introduction of the new communication technology V2X, vehicles can distribute
information gathered by their internal sensors. All these data sources serve a so called cyclist and pedestrian protection system. It calculates trajectories and predicts possible collisions. V2X and mobile devices with Wi-Fi or a return channel to warn all road users in time and in an appropriate way.

10:55 Stephanie Schwarz, David Sellitsch, Manfred Tscheleigi and Cristina Olaverri Monreal

Safety in Pedestrian Navigation: Road Crossing Habits and Route Quality Needs
SPEAKER: Cristina Olaverri Monreal

ABSTRACT. Still most commercial navigation tools used by pedestrians fail to encompass a comprehensive organization and prioritization of safety-related route qualities and accordant information in the user interface. To support pedestrian route choices to minimize potential dangers, we study in this paper user requirements for an enhanced pedestrian navigation system that considers safety related route quality parameters. Besides effectiveness, related factors of distance and time, safety was highly prioritized to become an explicit requirement for the conceptual design. The acquired data from an online survey provides the basis for pedestrian's classifications and requirements regarding user friendly interfaces for mobile routing and navigation that enhance road safety.

11:20 Sebastian Naumann, Olaf Czogalla and Felix Kühner

A Safety Index for Road Crossing
SPEAKER: Olaf Czogalla

ABSTRACT. Normally, pedestrians do not walk on streets but on sidewalks. Thereby, crossing the road is often necessary. Particularly in peripheral areas, dedicated crosswalks are rare and pedestrians are forced to cross roads apart from them. In order to integrate road crossing into a routing and navigation system for pedestrians a decision of where to cross the road is needed. In order to express how safe it is to cross the road at a certain location we suggest an index. Among others, the value of the index depends on various criteria as the roads' geometries, the traffic volume and the speed of the vehicles. In order to safely cross a road, a free gap with a certain length between two consecutive vehicles on a lane is required. The calculation of the index is mainly based on the probability of the availability of such a gap. All criteria are directly extracted from OpenStreetMap or derived from them.

09:40-11:45 Session 7C: Automated driving, motivations and challenges (invited session)
Organizer: Ferit Küçükyay and Roman Henze, TU Braunschweig

This session ends with a roundtable discussion giving room for reflections and comments.

CHAIR: Roman Henze
LOCATION: Runan

09:40 Hideo Inoue

ADAS with Driving Intelligence for Future Innovation
SPEAKER: Hideo Inoue

ABSTRACT. Japan is facing up to the challenges of a rapidly aging society. In addition to measures to help vitalize this situation, the automotive sector is also working to resolve issues such as congestion and traffic accidents. With this background, My talk introduces two collaborative projects about intelligent vehicle research and development in Japan. The first project aims to develop an intelligent driving system to achieve a safe and secure traffic society for elderly drivers. The main purpose of this project is to realize an intelligent driving system incorporating an experienced driver model to help recover the deterioration in the recognition, decision-making, and operation capabilities of elderly drivers, and to achieve a significant improvement in road safety. The second is the Smart Traffic Flow Control Project. This project focuses on the fact that an advanced driver assistance system (ADAS) with driving intelligence has the potential not only to enhance safe and secure driving but also to reduce congestion. This paper uses these topics to describe perspectives about intelligent vehicle technologies.

10:05 Pongsathorn Raksinchaoensak

Potential-Field Based Motion Planning and Control Algorithm for Autonomous Driving Intelligence System
SPEAKER: Pongsathorn Raksinchaoensak

ABSTRACT. Predicting future risk during driving in urban road is one of key solutions to enhance safety performance of vehicles. This study proposes a motion planning and control system based on collision risk potential prediction characteristics of experienced drivers. By optimizing the potential field function in the framework of optimal control theory, the desired yaw rate and the desired longitudinal deceleration are theoretically calculated. The validity of the proposed motion planning and control system is verified by comparing the simulation results with the actual driving data by experienced drivers. The safety performance of the intelligent driving system to avoid potential collisions is shown in pedestrian crossing scenario.

10:30 Bernd Hartmann

Road Condition Estimation - the next step towards Vision Zero on its way to Automated Driving
SPEAKER: Bernd Hartmann

ABSTRACT. Industry Talk - not conference paper – invited
10:55  Tadjine Hadj Hamma, David Seidel, Schonlau Benedikt, Grimm Stephan and Pflug Robert
Safe Driving Generation 1 – Cooperative Safety Functions
SPEAKER:
ABSTRACT. In automobile industry the ongoing development of vehicle functions plays an important role for safety and comfort. The enlargement of the driver’s environment perception is an enormous potential because additional information provide the opportunity of developing novel functions. In this context the Car2Car Communication Consortium launched the standardization for V2X-communication. A transceiver (CCU) offers a WLAN-based exchange of information between road users (Vehicle-to-Vehicle) or road user and infrastructure (Vehicle-to-Infrastructure). The CCU could be seen as a further sensor like radar and camera, which for example is able to receive information about the position of other road users and / or the signal phase of the relevant traffic light (TL). It is possible to design cooperative functions, which can process more than one sensor within a sensor data fusion. These functions can be subdivided into the scopes comfort and safety. For example a vehicle controls the own velocity by using an actuator due to a V2X-message sent by the relevant TL. As a result the vehicle is able to brake automatically in front of the TL and run-up automatically if the red signal phase is over. For a proper behavior of the comfort function, the detection of amongst other roads user and lanes (vehicle’s environment) is necessary. This can be done via radar and / or camera. To ensure the safety of these kind of comfort functions, an implementation of a monitoring is necessary (“Safety Layer”). This scope has safety functions like the Automatic Emergency Brake (AEB), which can be triggered by receiving V2X-messages. Target of this paper is the discussion of a V2X-based Emergency Brake as a part of the functional Safety Layer.

11:20  Gunnar Tornmalm and Tony Sandberg
Scania Autonomous Transport Solutions
SPEAKER:
ABSTRACT. ADAS in HCV. Scania Heavy-DAS Project (1st autonomous Truck). Automated Mining. Active Brake Systems.

11:45-13:00 Lunch Break

13:00-14:40 Session 8A: Estimation techniques for active and passive safety
CHAIR: John Hansen
LOCATION: Palmstedtsalen
13:00  Yang Zheng and John Hansen
MobileUTDrive: An Android Portable Device Platform for In-vehicle Driving Data Collection and Display
SPEAKER:
ABSTRACT. Smart portable device used in car provides a cost effective approach to obtain driving dynamic signals and location information by utilizing its inertial sensors. MobileUTDrive is an Android App that we developed for in-vehicle data collection. This paper first describes motivation of using portable device for driving record, and then discuss the system design in hardware and software aspects. Finally, and details of software implementation is presented.

13:25  Hisashi Imanaga and Shigeru Kashima
Estimation methods of Number of Accident Considering quality of active and passive safety performance
SPEAKER:
ABSTRACT. This study proposes a model to estimate the number of accidents using two parameters. One parameter expresses quality of active safety, and the other one expresses quality of passive safety. This model uses data on accident occurrence from 1999 to 2009. The estimated parameters indicate that during this period the quality of active safety did not increase, whereas the quality of passive safety did increase.

13:50  Shohei Ueda and Takahiro Wada
Modeling Driver’s Skill of Merging Operation toward Its Assistance System
SPEAKER: Shohei Ueda
ABSTRACT. Merging into the traffic flow on an expressway is a challenging driving task. We aim to develop a driver assistance system for such a demanding driving task. Our previous study revealed that a driver’s decision making of the merging space in the oncoming traffic skill can be inferred by the driver’s behaviors after the driver was able to see the environment of the main lane. In addition, the study suggested that the merging behaviors were different among drivers and it seemed to depend on driver’s skill. Thus, the present paper proposed a method to characterize driver’s skill in merging operation based on the driver model and driver’s active longitudinal control toward a driver assistance system for merging.

14:15  Hirofumi Yotsutsuji, Takahide Matsumoto, Keiichiro Yonemura and Hideyuki Kita
An Experimental Study on the Effect of Sequential Transverse and Lateral Markings on Perceived Speed in Curved Road
SPEAKER: Hirofumi Yotsutsuji
ABSTRACT. For the purpose of enhancing road markings to prevent speeding on curved road, we focused on the vehicle speed inducement effect of sequence patterns of sequential transverse and lateral markings on a straight section of roadway leading into a transition section of the curved road. We tested the effectiveness of several sequence patterns through a driving simulation experiment with a driving simulator (DS) and a driver perception experiment with recorded moving pictures (MPS). The sequence patterns were characterized by patterns of progressively and concurrently reduced spacing of transverse lines on the lane surface and lateral poles on both the shoulder edge and the median strip. While estimating trends in spot speed that was perceived by a driver (test subject) who went into the curve entrance under the influence of sequence patterns, we examined a discrepancy between the perceived speed transition and the vehicle speed transition, by using hidden Markov model (HMM) on the estimation. We prepared four types of the sequence patterns including the types which had greater decrease rates of the intervals of spacing in the beginning, middle, and end sections than in the remaining sections among all the sections consisting of the pattern. The experimental results concluded that the sequence pattern type which had greater decrease rates in the end section than in remaining sections might be encouraged to be laid on the curved road, in terms of a safe vehicle speed inducement effect.

13:00-14:40 Session 8B: Automated driving - vehicle platoons

CHAIR: Yoshitaka Marumo
LOCATION: Scania Salen

13:00 Dongwook Kim, Taeryoung Chung and Kyongsu Yi
Lane-level Localization using Around View Monitoring Camera for Automated Urban Driving
SPEAKER: Dongwook Kim
ABSTRACT: This paper describes a method of lane-level localization for automated driving using around view monitoring (AVM) camera. Today’s on-board sensors such as radar or camera do not reach a satisfying level of development from the point of view of robustness and availability. Thus, map data is often used as an additional data input to support these systems. A digital map is used as a powerful additional sensor. So we propose a lane map-based localization using an AVM camera. The maps are created beforehand using an AVM camera and RTK GPS. A pose estimation of vehicle was derived from a low-cost GPS and an iterative closest point (ICP) match of real-time sensor data to lane map. And the estimated pose was used as an observation inside a Kalman filter framework. The performance of the proposed localization algorithm is verified via vehicle tests in ITS proving ground. It has been shown through vehicle tests that good localization performance can be obtained. The proposed algorithm will be useful in the implementation of automated driving.

13:25 Jeffrey Too Chuan Tan and Yoshihiro Suda
Automatic Vehicle Following of Personal Mobility Vehicles for Autonomous Platooning
SPEAKER: Jeffrey Too Chuan Tan
ABSTRACT. The motivation of this work is to enhance personal mobility vehicles (PMV) with autonomous vehicle technologies, such as autonomous vehicle platooning to realize new potentials and possibilities for future urban transportation system. This paper reports our development on the automatic vehicle following system building for autonomous platooning of PMV. We have developed a 3D sensing system for both object (front vehicle) detection and longitudinal distance sensing. We have conducted straight and curved paths vehicle following experiments using the automatic vehicle following system fine-tune the control parameters. We have furthered our investigation to evaluate the performance of the developed system in autonomous platooning of two automatic following PMVs with a leading human-driven PMV. The experimental results have proven the effectiveness of the developed vehicle following system to achieve autonomous platooning of PMV.

13:50 Alon Tuchner and Jack Haddad
Vehicle Platoon Formation Using Interpolating Control with Integral Action
SPEAKER: Alon Tuchner
ABSTRACT. In this paper, a control design approach known as interpolating control is used for cooperative vehicle longitudinal control in order to form vehicle platoons. The objective is to regulate the vehicles’ speeds and the spacings between the vehicles, from their initial conditions into a shared consensus. A discrete state space formulation is used to model the system, in which constraints are enforced. The interpolating control approach is implemented and compared with other methods such as MPC. The paper presents an implementation of the interpolating controller that includes integral action, for the purpose of improving the steady state performance in the presence of a disturbance. We show that this controller can indeed eliminate the steady state error, defined as the output of the system, if the disturbance is a bounded step function and the initial conditions are feasible.

14:15 Takuma Ito, Masahiro Mio, Kyochi Tohriyama and Minoru Kamata
Novel map platform based on primitive elements of traffic environments for automated driving technologies
SPEAKER: Takuma Ito
ABSTRACT. To realize driver assistance systems based on automated driving technologies, intelligent vehicles need to recognize surrounding driving environments. On this point, sensing technologies with high-cost sensors have
several problems for future popularization. Therefore, this research aimed at developing automated driving technologies with lean sensors via the enhancement of existing ADAS Horizon.

13:00-14:40 Session 8C: Autonomous driving and crash analysis

CHAIR: Balazs Kulcsar
LOCATION: Runan

13:00 Sehyun Tak and Hwasoo Yeo
The Study on the Risk Proactive Cooperative Cruise Control System with Different Market Penetration Rate Scenarios
SPEAKER:
ABSTRACT. Based on an analysis of collision risk propagation, a vehicle Traffic Predictive Cruise Control (TPCC) system, responding to the change of downstream traffic situation, is proposed in this study to improve traffic operation, safety, and fuel efficiency of vehicle. The proposed TPCC system consists of four parts: (1) Collision risk calculator of a subject vehicle, which represent the state of the subject vehicle. (2) Vehicle Control algorithm only based on the collision risk of the subject vehicle, (3) Cooperative measure for representing downstream traffic state, which is based on the results of an analysis of collision risk propagation, (4) TPCC algorithm, which controls the vehicle by using both collision risk of the subject vehicle and cooperative measure. By using both collision risk of subject vehicle and cooperative measure, which represent the integrated collision risk of leader vehicles, TPCC is designed to proactively determine actuation of vehicle by adjusting parameters of vehicle control algorithm before high collision risk arisen from leader vehicles reaches to the subject vehicle. A simulation using the real vehicle trajectories from the NGSIM data validates the performance of TPCC algorithm with various market penetration rates. It is found that the proposed TPCC system can contribute to CO2 emission reduction, traffic flow stability, and safety improvement. Such results are due to the effects of suppression of the high collision risk generated from downstream traffic and removal of unnecessary fluctuation of speed.

On the Potential of Accelerating an Electrified Lead Vehicle to Mitigate Rear-End Collisions
SPEAKER:
ABSTRACT. This paper analyzes the potential safety benefit from autonomous acceleration of an electrified lead vehicle to mitigate or prevent being struck from behind. Safety benefit was estimated based on the expected reduction in relative velocity at impact in combination with injury risk curves. Potential issues and safety concerns with the operation and implementation of such a system in the real world are discussed from an engineering and human factors stand point. In particular, the effect of the pre-collision acceleration in reducing whiplash injury risk due to change in head posture and reduction of crash severity is also discussed. In general, this study found that autonomously accelerating an electrified lead vehicle can mitigate and prevent rear-end collisions and significantly increase the safety benefits from existing systems such as autonomous emergency braking.

13:50 Shigeyoshi Tsutsumi, Kei Sato and Masao Nagai
Analysis of Vehicle Accident Involving Bicycle at Non-signalized Intersection by Near-Crash Incident Database
SPEAKER:
ABSTRACT. This paper describes the factor of crossing collision involving bicycle at non-signalized intersection by analyzing near-crash incident. In recent years, the traffic accident shows gradual decreasing in the number of fatalities, whereas slowly decreasing the total number of accidents and injuries in Japan. In order to decrease the total number of accident, it is necessary to investigate the factors of accident. So the feature of crossing collision involving bicycle at non-signalized intersection was analyzed by traffic accident data and near-crash incident database collected with the drive recorders.

14:15 Kristofer Kusano, Rong Chen and Hampton Gabler
Effect of Driving Context on Time to Collision at Brake Application during Car Following
SPEAKER:
ABSTRACT. Collision Warning (FCW) systems that have customizable warning delivery settings may improve driver acceptance, thus increasing the benefits of such systems. In order to design FCW warning thresholds that match a driver’s expectations, system designers need to characterize when the brakes are normally applied. However, a driver’s normal braking behavior may vary with the driving context, e.g., traffic congestion or daylight conditions. This study examined over 2.6 million brake applications from the 100-Car naturalistic driving study to determine the effect of driver demographics (age group and gender) and driving context (day of week, time of day, travel speed, and traffic congestion) on brake application time. The results showed that both demographics and driving context were statistically significant indicators of the time to collision (TTC) that drivers applied the brakes during car following.
15:20 Marc Bechler, Amira Horozovic and Robert Kastner
Evaluation of Car-2-X Scenarios for Automated Driving

SPEAKER:

ABSTRACT. Car-to-X technology enables vehicles to directly exchange information with other vehicles or with roadside infrastructure components using standardized communication and message protocols. So far, several cooperative Car-to-X use cases were defined to improve road safety and traffic efficiency, which will be introduced in different stages. In this paper, we will evaluate these use cases of the early deployment phase – such as electronic emergency brake lights or green light speed optimal advisory – with respect to their suitability to automated driving. We will see that their current specification only have minor contributions for improving automated driving scenarios. However, we will also see that by improving this use cases we can have a significant impact on automated driving technology. Moreover, our evaluation shows that Car-to-X is an essential base technology for cooperative automated driving scenarios.

15:45 Takuma Ito, Tatsuya Shino and Minoru Kamata
Improvement of Elderly Drivers’ Acceptability for Proactive Collision Avoidance Using Passive Information Sharing

SPEAKER: Takuma Ito

ABSTRACT. In this research, we focus on improving acceptability of proactive collision avoidance systems to elderly drivers by using passive information sharing with drivers. In this paper, the information sharing mainly consists of visual contents. As a result of the evaluation experiment by a driving simulator to investigate the effectiveness of the information sharing, we confirmed that passive information sharing were able to improve the acceptability.

16:10 Raissa Pokam, Serge Debernard and Christine Chauvin
Towards autonomous driving: an Augmented Reality Interface Design for lane change

SPEAKER:

ABSTRACT. Autonomous vehicles allow the driver to be out of the loop of the driving task, under particular conditions. Interaction between the driver and the technical agent is crucial especially in autonomous mode and in handover processing. It is essential to identify the information requirements to meet the driver’s needs. Technology advancement has introduced Augmented Reality, which is said to enhance vision. In this paper, we explore the use case of lane change. By applying a cognitive method, we extract information related to lane change maneuver. We present what the Augmented Reality representation will potentially look like at the end of our study. Finally, future research avenues are outlined.

16:35 Georgios Chrysakis, Helen Monkhouse and Stratis Kanarachos
Vehicle Controllability Assessment Using Detailed Multibody Vehicle Simulations

SPEAKER:

ABSTRACT. ISO 26262, the functional safety standard for automotive electric and electronic (E/E) systems, requires a controllability assessment to be made as part of the hazard and risk classification process. As well as influencing the function’s Automotive Safety Integrity Level (ASIL), the verifiable controllability may also limit the functions intervention options and intensity during normal operation. For electric driven vehicles this limits their accident-avoidance/mitigation potential. For an in-wheel motor driven electric vehicle it is questioned whether the failure of a motor could lead to a risk. It is obvious that the result of the risk assessment depends on the operating scenarios chosen. As numerous factors define a driving situation, the possible detailing of these factors is unlimited. In a previous paper, we have presented the results of a study regarding the controllability of a vehicle driven by in-wheel motors using a simplified linear bicycle model. In this paper we extend the previous work by qualitatively and quantitatively identifying the hazards associated with in-wheel motors and by quantify the vehicle level effects that could be expected using validated detailed multibody vehicle models in both straight line and cornering events.
publication of the first iGLAD data (1,550 accidents) a study was done dealing with the creation of pre-crash simulations out of international accidents. For the first time the benefit of an ADAS can be evaluated prospectively in the wide variety of global traffic accident scenario. This paper provides an overview of the challenges that come with merging data from different investigation areas. The main focus will be on the methodology to derive PCM from this international d a-tabase. This also includes the definition of minimum requirements to enable the simulation of the vehicle behavior in the pre-crash phase. Furthermore, methods were developed how to deal with unknown data with regard to the different data quality and quantity. Finally the paper shows the unique possibility to analyze active safety systems from a global point of view by implementing and assessing an exemplary ADAS for different global traffic accident scenarios.

With the work done within the study, especially with the definition of minimum requirements and the developed methods, it is possible to create pre-crash simulations not only for upcoming iGLAD releases but also for other international accident databases.

15:45 Shuguang Li, Toshiyuki Sugimachi, Kimihiko Nakano, Yoshihiko Tabuchi, Yoshihiro Suda, Kouji Yamamoto, Hideki Takahashi, Yoshitomo Orino, Noriyuki Oka, Kayoko Yoshino and Toshinori Kato

**Driving operations and parietal lobe activity correlate with driving skill during curve driving**

**SPEAKER:**

**ABSTRACT.** Elucidation of the relationship between brain activity and driver behavior may assist in the development of new driver models for next-generation driving-assistant systems that adapt to drivers’ individual characteristics. However, multiple regions of the brain are involved in driving, so it is first necessary to investigate the role of each region. In this paper, we examined the relationship between driving skill and parietal lobe activity. We performed experiments using a driving simulator featuring a curved course modeled on a real test course. When drivers steered around the curve, data on their driving operations and the state of their vehicle were recorded, and their cortical activity was measured using functional near-infrared spectroscopy. Subsequently, jerk, which is the derivative of acceleration with respect to time, was utilized to divide drivers into the high-skilled and low-skilled groups. We found that high-skilled drivers operated the accelerator pedal and steering wheel smoothly while steering into the curve. Simultaneously, the parietal lobe was more active in the high-skilled group than in the low-skilled group at the entrance to the curve. The parietal lobe is known to integrate sensory information from various modalities. Therefore, our findings suggest that the integration of sensory information strongly influences driving skill.

16:10 Daniel Lechner, Claire Naude, Thierry Serre, Maxime Dubois-Lounis, Michèle Guilbot, Jean-Yves Fournier and Vincent Ledoux

**Characterization of Driving Dynamics on road incidents collected by EDR**

**SPEAKER:** Claire Naude

**ABSTRACT.** French government decided to support the SVRAI project (Saving Lives through Road Incident Analysis Feedback) to answer the question "Can incident data analysis help to avoid accidents?" Thus a 12 months data collection involving 50 public vehicles, fitted with a dedicated EDR named EMMA, was carried out. This paper focuses on results concerning vehicle dynamics: 339 incidents were collected, among which 70% concern the lateral direction, with 70 % in right hand turns vs 30 % in left ones. Based on additional data synthesizing complete travels, 3D representations of dynamic parameters are also shown interesting to characterize driver performance.

16:35 Hironori Suzuki and Takaya Ishikura

**Green Phase Countdown Timer for Reducing Drivers’ Dilemma at Signalized Intersection**

**SPEAKER:** Hironori Suzuki

**ABSTRACT.** This paper developed a driving support system to reduce the driver’s dilemma at signalized intersection. When facing an amber signal phase, the drivers occasionally come across the dilemma whether they should stop or pass the intersection stop line. The proposed system provides the remaining green time (RGT) to the drivers in real-time to support the stop/pass decision making. Driving simulator experiment equipped with the RGT indication system showed that the proposed system significantly reduced the probability of facing the dilemma and encouraged the drivers to decelerate earlier and stop before entering the intersection. Also, logistic regression analysis (LRA) revealed that approaching speed of a vehicle is the most significant factor to affect the stop/pass decision before the amber onset whereas remaining distance and acceleration rate affect it much more after fallen into the amber phase.
control module (ACM) operation. In particular, delta-V (technically defined as the velocity vector difference before and after impact) data are very important in determining that a collision has occurred and evaluating accident severity. The aim of this study was to assess delta-V characteristics and to clarify the performance of event data recorders in ACM operation with focus on delta-V values recorded during collision with a tubular metal guardrail.

15:45 **Rong Chen, Kristofer D. Kusano and Hampton C. Gabler**

**Age and Gender Difference in Braking Behaviour from the 100-Car Naturalistic Driving Study: The Implication for Autonomous Braking System Design**

**SPEAKER:** Rong Chen

**ABSTRACT.** Autonomous braking systems have potential benefits in active safety systems and Advanced Driver Assistance Systems. Ideally, emerging driver assistance systems which can automate certain driving aspects would apply braking in a human-like fashion. A better understanding of driver braking behavior can assist active safety and driver assistance system designers to better tailor the vehicle braking pattern to the driver and driving context. The objective of this study was to determine the potential effect of driver age and gender on braking profile. The approach of this study was to extract braking patterns in normal driving from the 100-Car Naturalistic Driving Study. Braking events with a closing lead vehicle were identified and extracted from the database. For each braking event, maximum brake force and braking profile was calculated from the instrumented vehicles. The result of the study shows that driver age and gender, as well as vehicle speed at start of braking, all have a statistically significant effect on driver braking profile. The results of this study have substantial implications for improving future autonomous braking system design to better tailor the system activation time to individual driver according to age, gender, and vehicle speed.

16:10 **Irene Isaksson Hellman and Magdalena Lindman**

**Evaluation of Rear-End Collision Avoidance Technologies based on Real World Crash Data**

**SPEAKER:** Irene Isaksson Hellman

**ABSTRACT.** Over the last decade, collision avoidance technologies targeting rear-end collisions have been introduced by many vehicle manufacturers. However, evaluation of the real world performance of these systems are rare. The objective of this study was to evaluate the real world effectiveness of systems called Forward Collision Warning and Brake support combined with Adaptive Cruise Control (CWB+ACC). These systems were introduced as optional equipment in Volvo car models in 2006. The data analyzed comes from a detailed, representative dataset based on insurance claims. The rate of rear-end frontal collisions was compared for cars with and without CWB+ACC, controlling for different generations of CWB+ACC as well as presence of Low-speed Emergency Braking functionality. For cars with CWB+ACC, rear-end crashes with frontal impacts were reduced with 38%. Also, the data showed a clear progress in crash avoidance efficiency as a function of CWB+ACC development. For the third generation of CWB+ACC, the estimated collision avoidance effect was 45%. In future studies, the additional safety performance that collision avoidance technologies bring in the form of crash mitigation needs to be investigated.

16:35 **Esteban R. Gelso and Jonas Sjöberg**

**Towards a consistent threat assessment at traffic junctions using road information and naturalistic data: A test example**

**SPEAKER:**

**ABSTRACT.** This paper presents enhanced versions of two metrics: the Time-to-Brake (TTB) and the Brake-Treat-Number (BTN), which are used as measures to describe the degree of being critical of traffic situations. The main idea is to include road information as input to obtain a more advanced prediction of the leading vehicle. The results, illustrated by an example using real data, show a better assessment of the collision potential hazard and no false alarms.
### Program with abstracts: Friday, September 11, 2015

#### 08:30-09:15 Session 10: Keynote 3: Road traffic safety, automated cars and infrastructure – potentials and possibilities

**Prof. Anders Lie, Swedish Transport Administration, Sweden**

**CHAIR:** Anna Nilsson-Ehle  
**LOCATION:** Runan

An overview of the safety development of the modern road transport system is given. The focus is around Vision Zero. Anders Lie has been an active partner in the development of the Vision Zero. He has furthermore set-up in depth studies of all fatal crashes in Sweden starting from 1997.

**ABSTRACT.** Modern cars have safety and control potentials that allow an almost automated function. Automated cars is an element of the future road transport system. It is often claimed that this development is a key element for improved safety. In this presentation an overview of the safety development of the modern road transport system is given. The focus is around Vision Zero. Further it is discussed how infrastructure can be enhanced to support and get a larger efficiency and safety.

### 09:15-09:40 Coffee & Green Tea Break

### 09:40-11:20 Session 11A: Analysis and Modeling for Driver Performance I (invited session)

**Organizer:** Motoki Shino, The University of Tokyo

**CHAIR:** Motoki Shino  
**LOCATION:** Palmstedtsalen

#### 09:40 Ryo Iwaki, Kenji Sato, Takashi Wakasugi and Nobuyuki Uchida

**Analysis and Modeling of Driver behavior on Pedestrian Crossing Road Situation (1st report: Modeling of driver's response)**

**SPEAKER:**

**ABSTRACT.** This study analysed drivers’ avoidance actions towards pedestrians. Specifically, it studied these actions to construct models that would demonstrate drivers’ avoidance of pedestrians crossing a road. An experiment was conducted to gather data on drivers’ actions in response to pedestrians. Actual cars were used, and a pedestrian dummy appeared before them at various times (i.e., 2 seconds, 3.5 seconds and 5 seconds). The time of lifting one's foot off the gas pedal, the time of braking and the deceleration used to avoid colliding with pedestrians were individually examined using the acquired data. The three variables were analysed in relation to the time to collision with pedestrians. As a result, this study successfully produced models of a series of drivers’ actions in response to pedestrians appearing before them as well as of the time required to avoid a collision.

#### 10:05 Nobuyuki Uchida, Takashi Tagawa and Kenji Sato

**Development of instrumented vehicle with Augmented Reality (AR) for driver performance evaluation**

**SPEAKER:**

**ABSTRACT.** Observing drivers’ behaviours by reproducing traffic accidents and conflict situations is important for developing advanced driver assistant systems. For the purpose, an instrumented vehicle, named the JARI-ARV (Japan Automobile Research Institute - Augmented Reality Vehicle), was developed to reproduce realistic traffic accident and conflict scenarios without endangering the driver. In this study, we examined acceptability and controllability in following cases: a right turn and encounter with a pedestrian by comparing the JARI-ARV with a normal (unaltered) same model vehicle. Results of the experiment indicated that drivers tend to react to virtual traffic participants, in the same way as driving a normal vehicle. Applicability of the JARI-ARV for human factor research was confirmed.

#### 10:30 Motoki Shino, Yuta Shimazu, Takashi Tagawa and Minoru Kamata

**Pedestrian Collision Risk Indices Based on Driving Behavior During Right Turns at Intersections**

**SPEAKER:** Motoki Shino

**ABSTRACT.** According to traffic accident statistics, 4481 fatal traffic accidents were reported in Japan in 2011—an extremely large number. Of these accidents, half occurred at intersections, and 40% of those were person-to-vehicle accidents, which typically result in high death rates. The causes of these accidents were judgment error, operation error, and particularly oversight, i.e., the driver not recognizing a pedestrian within a sufficient stopping distance. In this paper, pedestrian collision risk indices are proposed for use in identifying driving behavior that leads to collisions with pedestrians during right turns at intersections. These indices are based on the formulation of a strategy for passing through an intersection. The validity of the index was assessed using the Japan Automobile Research Institute’s Augmented Reality Vehicle (JARI-ARV).
09:40‐11:20 Session 11B: Safety and driver assistant systems

CHAIRS: Tania Dukic Willstrand and Hironori Suzuki
LOCATION: Scaniasalen

09:40 Takashi Nakano, Yoshitaka Morumo and Hironori Suzuki
Driver Assistance System by Indicating Predicted Driving Evaluation Index at Rear-End of Preceding Vehicle
SPEAKER: Takashi Nakano
ABSTRACT. This study examines the driver assistance system to predict driving behavior considering information on the pre-preceding vehicle. The system indicates the predicted driving evaluation index at the rear-end of the preceding vehicle to avoid the driver’s distraction. Driving simulator experiments are carried out with several participants who are instructed to follow a preceding and a visible pre-preceding vehicles with and without the driving assistance system. The participants with the assistance system could reduce the relative speed with the pre-preceding vehicle and acceleration of the following vehicle. These effects make it possible to suppress the variation of the collision risk to the preceding vehicle and to reduce fuel consumption of the following vehicle. In addition, the proposed assistance system shortened the drivers’ reactions to the emergency deceleration of the preceding vehicle in comparison with the conventional assistance system, which is indicated at the onboard monitor in the following vehicle.

10:05(7,11),(992,993)
Görekem Büyükyıldız, Olivier Pion, Roman Henze and Ferit Küçükay
Driver models based on lateral dynamics for adaptation of assistance systems
SPEAKER: Görekem Büyükyıldız
ABSTRACT. The continuous demand to increase the road safety induces that the driver in the vehicle development and research being taken increasingly in the focus. An important focus of research is to determine the driver’s ability to respond to situations appropriately and thus to drive the vehicle safely in traffic. At the Institute of Automotive Engineering (IAE) of the Technical University of Braunschweig, a driver model has been developed, which makes it possible to identify the specific driver characteristic in the form of an individual “fingerprint”. By means of the knowledge of the “fingerprint” conclusions can be drawn on: the driving style, the driver’s age/ driver control behaviour and the driver performance. Within the context of this paper, the relevant quantities are derived by means of a driver model that serves the adaptation of driver assistance systems. Furthermore, the existing correlations between the driver’s performance and the driver control behaviour will be analysed as part of the driver’s fingerprint. For this purpose, relevant vehicle and track camera signals are extracted from the CAN bus and used for the driver modelling. For this purpose, relevant vehicle and track camera signals are extracted from the CAN bus and used for the driver modelling. Genetic algorithm is used for the identification and optimization of the so-called “timeshifted driver model” control parameters. The brief presentation of a methodology used for calculating the individual driver condition parameter sets in real time on the test vehicle constitutes the conclusion of this article.

10:30 Raphael Pfeffer, Tobias Leichsenring and Sebastian Schwab
Vehicle-in-the-Loop as a Method to Tangibly Experience Active Safety Systems at an Early Stage
SPEAKER: Raphael Pfeffer
ABSTRACT. Vehicle-in-the-Loop (VIL) is a method designed to consistently experience advanced driver assistance (ADAS) functions across all stages of the development process in the real-world vehicle. Consequently, VIL provides a useful complement to the development of ADAS along the V-Model. The possibility to have a real-world test vehicle autonomously driven by a driver model increases the highly desirable reproducibility in test driving. In addition, thanks to VIL, entire test catalogs (e.g. Euro NCAP tests) can be run in automated mode on a test track. Furthermore, VIL is a safe and resource-saving method for trials with test subjects. In contrast to using a driving simulator, the test subjects experience real-world vehicle dynamics in the vehicle itself. The utilization of Augmented Reality technologies complements the VIL tests in off-site terrain by virtual objects. This enables manufacturers and system suppliers to comprehensively investigate customer acceptance of new functions and to reduce the risk of developments heading in the wrong direction.

10:55 Tania Dukic Willstrand, Thierry Bellet, Thomas Broberg, Christina Stave, Jean-Christophe Paris, Björn Peters and Claude Marin-Lamallet
What ADAS are the most promising for our future older drivers? Evidences reported from France and Sweden
SPEAKER:
ABSTRACT. Focus groups were conducted in both France and Sweden as part of the SAFEMOVE project. The aim of the study was to identify and assess difficulties experienced by older drivers (+70) due to age-related declines in sensory, physical and cognitive abilities and potential consequences in terms of both traffic safety and mobility. Furthermore, the aim was to identify Advanced Driving Assistance Systems (ADAS) liable to improve safe mobility for the target group and to compare the situation between France and Sweden. Three main topics investigated were trip planning and navigation task, speed control and regulation, and intersection crossing (more particularly when turning on the left). For each one, data collected focused on both older drivers’ experienced difficulties and their interests or expectations towards driver support like ADAS. There was in general a positive attitude to driver support systems but participants were also concerned about costs. Furthermore, several differences between French and Swedish older drivers were found.
09:40 Human-Machine Shared Driving Characteristics of Autonomous Driving Intelligence System in Collision Avoidance Manoeuvre

ABSTRACT. This paper investigates the effectiveness of shared driving characteristics in collision avoidance maneuver when the human and the autonomous driving system act in parallel. In the development of driver-in-the-loop ADAS, it is important to study how the autonomous steering assistance function should be designed in order to obtain good driver acceptance when both human and the system act in parallel as a shared control task. From the viewpoint of man-machine system, it is essential to investigate the shared control law for enhancing the collision avoidance performance while minimizing the conflict between the control action of the driver and the system. This paper employs the steer-by-wire system in the experiment as it can control the vehicle dynamics and steering reaction torque characteristics independently. The driving simulator experiment is conducted and the effect of the steering assistance system is discussed.

10:05 A Lane-Change Gap Acceptance Scenario Developed for Heavy Vehicle Active Safety Assessment: A Driving Simulator Study

ABSTRACT. The aims of this study were to develop a lane-change scenario for driving simulators in order to analyse the characteristics of lane-change manoeuvres performed with heavy vehicles. The scenario was set up based on information from lane-change accidents and on-road lane-change observations. The gap acceptance scenario consisted of two consecutive lane changes and the intention was to study truck drivers’ accepted gap between two vehicles in the adjacent right lane, at the initiation of each lane change. An experiment was conducted with 18 truck drivers in a full-motion driving simulator with implemented high fidelity models of an 80tonnes and 32m long vehicle combination and a 40tonnes and 22m tractor semi-trailer. The results showed no statistically significant difference in the accepted gaps to the lead and lag vehicles in the target lane. For both heavy vehicles, the overall average lead gap and lag gap was estimated to 0.85s and 0.83s respectively, at the average velocity of 17.3m/s. The difference in lane-change duration for the two vehicles was statistically significant and estimated to an average of 8.7s for the tractor semi-trailer, and 10.5s for the A-double. The conclusion from the present study is that the drivers performed the lane changes equally well with the tractor semi-trailer and the long vehicle combination. There were no major differences between the manoeuvres other than the duration times, which can be justified by the difference in vehicle length. Future studies are able to use this scenario as a non-critical reference to more critical events in the development and assessment of active safety functionality and automated driving systems.

10:30 Evaluation of a Run-off-Road Scenario for Driving Simulators used for the Assessment of Automatic Steering-Wheel Interventions

ABSTRACT. The setup of a run-off-road scenario was based on the current knowledge about critical run-off-road situations and accidents. The scenario was initiated by a visual secondary task. During the task, an added clockwise yaw deviation, intended to create the run-off-road scenario, was presented visually but not by the vehicle dynamics or the lateral acceleration of the simulator’s motion system. Results from two experiments show that the drivers frequently neutralised the yaw deviation because of their lack of full attention to the secondary task, the occasionally rough yaw deviation, or a combination of both. Because of the frequently neutralised yaw deviations, the number of steering-wheel interventions from an implemented system, intended to steer back into the lane in run-off-road situations, became limited in number. The system generated in total 14 steering-wheel interventions, ranging from torque levels of 0.3 to 3.7Nm. During ten of the interventions, the driver counteracted the torque with one hand. Nevertheless, the drivers that had experienced the interventions would like to have a system that could steer back to the lane when approaching the road edge, and accept that it takes control of the steering wheel. Further research on shared steering control is required so that driver responses to interventions does not neutralise the intended safety benefit of the system.

10:55 Effect of Automatic Lane Changing on Driver's Behaviour Decision Process

ABSTRACT. This paper analyses the driver’s behavioural change about which the usage of automated driving system brings, focusing on the behaviours at changing lanes. Especially the relation between drivers’ sensitivity to risk factors in surrounding environment and their gaze behaviour were analysed. We assumed, in this research, an
automated driving of level 2 in the definition provided by NHTSA. At this level of automation, the drivers are required to monitor the driving situation and, when necessary, interrupt the system’s automatic control and thereby recover the safety of the driving. We have conducted a simulation experiment with fifteen drivers, and compared their behaviours in two conditions; the conventional manual driving and the driving where automated driving system automatically changes lanes. By analysing collectively the risk factors at changing lanes, shift of each driver’s sensitivity to risk at changing lanes were estimated. The experimental data shows the correlation between risk sensitivity and gaze behaviour.

11:20-12:40 Lunch Break

12:40-14:45 Session 12A: Analysis and Modeling for Driver Performance II (invited session)
Organizer: Motoki Shino, The University of Tokyo

CHAIR: Nobuyuki Uchida
LOCATION: Palmstedtsalen

12:40 Kenji Sato, Ryo Iwaki, Takashi Wakasugi and Nobuyuki Uchida
Analysis and modeling of driver behavior on pedestrian crossing situation (2nd report: Analysis of a crossing diagonally situation using JARI-ARV)

SPEAKER:
ABSTRACT. Pedestrian-crossing-related accidents were 26.0% of all fatal accidents that occurred in Japan in 2012. To prevent pedestrian-versus-vehicle accidents, several driver-support systems (alarms and automatic brakes) have recently been commercialized. For verification of the validity of these driver support systems, it is important to understand driver behavior regarding pedestrian crossing. In this study, we examined driving performance for situations where pedestrians suddenly crossed the road to construct a driving behavior model. Experiments were implemented using an instrumented vehicle, JARI-ARV, which was able to reproduce critical situations where pedestrians suddenly crossed the road in front of the instrumented vehicle using augmented reality technologies (computer graphics). Several walking patterns including diagonal crossing of the road were set up as experiment conditions. Consequently, a collision avoidance behavior model for a particular complex crossing pattern was determined.

13:05 Vachirawat Lertsilpachalearn, Yasuhiro Akagi and Pongsathorn Raksincharoensak
Motion Planning Method for Overtaking Bicycles in Urban Driving Scenario Based on Potential Field Framework

SPEAKER:
ABSTRACT. Autonomous driving in urban environment is more complicated due to the unpredictable movements of obstacles such as pedestrians and bicycles. This paper focuses on a motion planning of a vehicle for overtaking bicycles in a straight road. The motion of the vehicle is determined based on an artificial potential field model considering the relative velocity of the vehicle to a bicycle. By applying the potential field model of a static obstacle, our method simulates the relative motion of the vehicle to the bicycle regarding it as a static obstacle. Finally, the vehicle motion is compared with the actual driving data of expert drivers to verify the effectiveness of the proposed method.

13:30 Takayuki Kondoh, Shane McLaughlin, Tomohiro Yamamura, Nobuyuki Kuge, Miguel Perez and Takashi Sunda
Detailed Investigation of Real-time Steering Entropy Sensitivity in Calling Events

SPEAKER:
ABSTRACT. On-board driver state monitoring is considered one of technologies that could reduce traffic accidents caused by human errors, particularly in cases of higher workload due to driver distraction. An approach to assessing driver workload using a real-time steering entropy (RSE) method has been proposed by the authors. RSE quantifies the nature of a driver’s corrective steering with an index of relative entropy (RHp) from information theory. The higher the driver workload, the higher the RHp. In this paper, the RSE method was applied to naturalistic driving database gathered from 18 drivers in the United States under joint research between Virginia Tech Transportation Institute (VTII) and Nissan Motor. RHp was calculated in off line simulation, and cases where the driver’s state indicated higher RHp were reviewed in through using video. The result indicates that the RSE method detected over 80% of the cases within 300 sec from when the handheld call started. There may also be differences in the onset of RHp behavior between calls initiated by the driver (outgoing) and incoming calls.

13:55 Tsukasa Shimizu, Masayuki Okuwa and Pongsathorn Raksincharoensak
Analysis of Driver Behavior for Joint Human-Machine Systems Design of Intelligent Driving System

SPEAKER:
ABSTRACT. An intelligent driving system that combines the AEB function and the preventive driving assistance system (PDAS) that assists a driver to drive like an experienced driver can improve traffic safety in hazardous situations. We aim to develop PDAS in the shared control approach. This study analyzed driver behaviors in the passing-a-car scenario as an example of a potentially hazardous situation to assess the interaction between the driver and PDAS. Using driving data collected from 29 participants in a controlled test course environment, drivers
were categorized into four driver groups based on their safety margins in the passing-a-car scenario. Then the driver behaviors were compared among driver groups. Some drivers belonging to unsafe driver groups passed the parked car with insufficiently reduced speed for their lateral gap. Examining their pedal operations, we found two patterns of unsafe pedal operations resulting in the insufficient speed reduction: delayed pedal-off and no pedal-off. For these unsafe pedal operations, we proposed a speed reduction support strategy.

14:20 John M. Scanlon, Kristofer D. Kusano and Hampton C. Gabler
The Influence of Roadway Characteristics on Potential Safety Benefits of Lane Departure Warning and Prevention Systems in the U.S. Vehicle Fleet
SPEAKER: ABSTRACT. Nearly one-third of all fatal crashes in the U.S. are a result of road departures. Lane departure warning (LDW) and lane departure prevention (LDP) have the potential to mitigate crashes and seriously injured drivers that result from road departures. However, the effectiveness of these systems are dependent on roadway characteristics, such as shoulder width and the presence of lane markings. In the U.S., road shoulders are often narrow, and lane markings are frequently not present. The objective of this study was to determine the limiting influence of shoulder width and lane markings on the effectiveness of LDW and LDP. Real-world road departure crashes were simulated without LDW/LDP, with LDW, and with LDP. These crashes were then simulated again on roads with improved infrastructure, i.e. with lane markings and a 3.6 m shoulder width. LDW and LDP were estimated to prevent 53% and 68% of crashes, respectively, when the shoulder width was at least 3.6 m. In contrast, when no shoulder was present (29% of departure crashes), LDW was found to have no effectiveness and LDP was estimated to prevent only 1% of crashes. When the crashes were simulated again with roadway infrastructure modifications, the number of crashes that could be prevented with LDW/LDP were found to double. The results of this paper highlight the importance of roadway characteristics on potential safety benefits of LDW and LDP, and should inform policy on roadway design.

12:40-14:45 Session 12B: Safety system evaluation
CHAIR: Robert Thomson
LOCATION: Scaniasalen
12:40 Marvin Rabben, Dr.-Ing. Roman Henze and Prof. Dr.-Ing. Ferit Küçükyay
Dynamic Crash Target for the Assessment, Evaluation and Validation of ADAS and Safety Functions
SPEAKER: Marvin Rabben
ABSTRACT. The advancing integration of ADAS (Advanced Driver Assistance Systems) and the increasingly complex E/E architecture across all vehicle classes require a reliable and safe method for the assessment, evaluation and validation of said systems. At the Institute of Automotive Engineering (IAE), a test tool that functions as a full-size vehicle replacement has been developed allowing the full scope of tests to be performed while minimizing the risk to the test personal and vehicles involved. The test tool consists of three separate modules: a driving module, a soft crash target carrier and the soft crash target itself. The soft crash target carrier holding the soft crash target is connected to the driving module via detachable links. Considering a collision scenario as use case, the driving module separates from the soft crash target carrier just moments before a collision is imminent, performs evasive manoeuvres and thus leaves the possibly harmful collision area. The soft crash target is quickly exchanged according to the use case under consideration and is visible to common sensor technologies (radar, lidar, camera etc.). The developed test tool can furthermore be used for controllability studies according to ISO 26262 in cases where a second vehicle or collision partner is necessary.

13:05 Shin Tanaka
Simulation of reconstructing accidents for developing active safety system
SPEAKER: Shin Tanaka
ABSTRACT. This paper describes the development of a method to reconstruct accident scenarios by simulation as a means of helping to develop more effective active safety systems through quantitatively estimating the potential real-world accident reduction benefit of a system. This method enhances the validity of benefit estimation results by defining the road environment as well as the characteristics of the vehicle, system, and driver behavior based only on actual data. The validity of the method was also ensured by increasing the number of parameters considered and analyzing the dependency relationships between parameters, so that the simulation results reproduce the same characteristics as actual accident data. The robustness of this method was verified by inputting accident data from other regions around the world and confirming its ability to simulate accident scenarios in these regions. As a result, a method capable of simulating crossing pedestrian accidents, lane departure accidents, and rear-end accidents was developed using accident data from Japan, the U.S., and Europe. This method helps to identify the effectiveness of active safety systems in different accident scenarios and the type of support that is necessary to reduce accidents further. This information can then be fed back into active safety system development.
13:30 Hidehisa Yoshida and Hideya Yamaguchi

**Primitive Modelling of Driver’s Steering Torque using Front Field of View and Reaction Torque**

ABSTRACT. The cooperative driver steering assistance system takes various steering characteristics and improves driving performance with less disturbance. This research uses the driver’s steering torque for the driver model construction. The proposed basic driver model considers lateral deviation, as viewed from the front of the vehicle, for model input, and steering function for position changes in two models based on the lateral deviation and reaction torque. Driving simulator experiments are shown.

13:55 Toshihiro Hiraoka, Keita Nozaki, Shota Takada and Hiroshi Kawakami

**Safe Driving Evaluation System to Enhance Motivation for Safe Driving**

SPEAKER: Toshihiro Hiraoka

ABSTRACT. Systems to enhance a driver's motivation to drive safely are expected to be effective in reducing the number of traffic accidents. With the aim of encouraging drivers to drive in a pleasant and safe manner, the present study modifies the safe driving evaluation indices proposed in a previous study, and constructs a safe driving evaluation system based on game design methodologies and presents a novel design for guidelines governing a human-machine system. Driving simulator experiments were conducted to ascertain the effectiveness of the proposed system.

14:20 Jonathan Jonsson, Nils Lubbe, Johan Strandroth and Robert Thomson

**The Effect of Advanced Automatic Collision Notification (AACN) on Road Fatality Reduction in Sweden**

SPEAKER: Robert Thomson

ABSTRACT. This paper aims at estimating the effect of the Advanced Automatic Collision Notification (AACN) post-crash system on road fatality reduction in Sweden. The analysis was based on the Swedish Traffic Accident Data Acquisition (STRADA) database in combination with in-depth studies of fatal accidents. Logistic regression with backward selection was used to identify relevant variables and develop a statistical model. The variables ‘admission to trauma center’, ‘age’ and ‘injury severity’ were identified as significant and by applying the final model on fatalities in passenger cars the estimated fatality reduction due to AACN was calculated. AACN was estimated to potentially reduce road fatalities by 8.6% (95% CI = -0.3-16.4%).

12:40-14:45 Session 12C: Safe driving and simulators

CHAIRS: Jan Schröder and Birgitta Thorslund

LOCATION: Runan

12:40 Ahsan Ud-Din Qazi

**Extending Vehicle Linear Behaviour: A Retrospective Approach through Design and Simulation Strategies**

SPEAKER: Ahsan Ud-Din Qazi

ABSTRACT. Full Electric Vehicles (FEVs) with in-wheel motors offer more choices to dynamists and control engineers to fine tune the vehicle for better performance during steady state and transient manoeuvres. This paper investigates the design and simulation strategies to extend vehicle dynamics linear behaviour. A set of linear, non-linear and Multi-Body System (MBS) models are used to examine the lateral dynamics. A fully featured model of Subaru Impreza is constructed in MSC-Adams and various ISO standard test manoeuvres are performed and the response is validated against the test track data for Subaru Impreza. A torque biasing mechanism is implemented to extend the linear handling response of the vehicle and yaw rate gain associated with the vehicle architecture is improved.

13:05 Birgitta Thorslund and Jonas Jonsson

**Effects of hearing loss shown in both driving simulator and real traffic**

SPEAKER:

ABSTRACT. This paper describes two studies, one conducted in VTI driving simulator III and the other on roads in and around Linköping city center. In both studies two groups were included, one with age related hearing loss and one control group with normal hearing. The purpose was to examine differences between the groups in driving behavior, visual behavior and also to evaluate the effectiveness and acceptance of a tactile driver assistance system. The driving scenario in the simulator was a 35 km long rural road with a speed limit of 70 km/h. Twice per minute drivers were prompted by a vibration in the seat to perform a secondary task by first look at and then read back a complete sequence of four letters. On road, all participants undertook two drives of 14 km each while they performed two pre-programmed navigation tasks guiding them around two different routes. The same navigation system was used for both drives but during one drive the navigation system presented only the visual information and during the other drive there was an additional vibration in the seat to guide the driver in the right direction. Effects of Hearing Loss was seen on driving speed and on visual search behavior in both simulator and in real traffic. In the driving simulator, during secondary task and when passing a parked car, participants with HL drove 5-6 km/h slower. In real traffic, on road sections with a speed limit of 70 km/h, participants with HL drove 4 km/h slower. This more cautious driving behavior suggests that drivers with HL use compensatory strategies. The fact that corresponding results can be seen both in the simulator and on real road is interesting, on one hand for simulator validity in general but also for the opportunity to further study these issues in controlled simulator experiments.
13:30 Jan Schröder, Christian Berger and Thomas Herpel
A Methodology for Simulation and Validation of a Safety-Critical Electronic Control Unit for Integration Testing in Connected Hardware-in-the-Loop Environments

SPEAKER: Jonas Sjöberg

ABSTRACT. Model-based software using Matlab & Simulink is indispensable in the automotive sector. Hence, the approaches for requirements engineering, development, verification, and validation in this area are deeply studied. This study focuses on their specific application for simulation models of safety-critical software and hardware components in the domain. A methodology for the above-mentioned software development steps is proposed. Each step is explained and considerations regarding safety are outlined. The study concludes with showing the feasibility of combining stakeholder knowledge with current literature on model-based development.

13:55 Marcus Kleinehagenbrock, Morimichi Nishigaki, Robert Kastner, Jens Schmuedderich, Sven Rebhan, Thomas Weisswange, Hiroyuki Kamiya, Naoki Mori, Shunsuke Kusuhara and Shinnosuke Ishida

Introduction of Intelligent Adaptive Cruise Control (i-ACC) – a predictive safety system

SPEAKER: Robert Kastner

ABSTRACT. In 2015 Honda introduced their new intelligent Adaptive Cruise Control (i-ACC) to the market. It is the world’s first cut-in prediction system which can anticipate the behavior of other vehicles in a neighboring lane. More precisely, i-ACC can predict if a vehicle is about to change lane from a neighboring lane to the lane of the own vehicle. This way, i-ACC can react earlier than conventional ACC systems and, therefore, ensure increased safety and comfort. In stereotypical situations it can even react before the other vehicle starts moving to the own lane. This means that the system sometimes starts to decelerate before the driver even realizes that a cut-in will take place. Such situations were one reason to carry out a comprehensive subjective evaluation in order to verify the acceptance of i-ACC by test subject drivers. The results of this acceptance test are our focus point in this contribution. We will also compare these results to the outcome of an objective evaluation which was carried out before.

14:20 Beom Jun Kim, Dong Wook Kim, Jun Yung Lee, Kyu Won Kim, Young Seop Son and Kyong Su Yi

High-level Automated Driving on Complex Urban Roads with LiDAR, Vision, and GPS/map based Environment Representation

SPEAKER: Runan

ABSTRACT. This paper proposes a fully automated driving algorithm which is capable of automated driving on urban roads with guaranteed safety. The proposed algorithm consists of the following three steps: an environment representation, a motion planning, and a vehicle control. An environment representation system consists of three main modules: object classification, vehicle/non-vehicle tracking and map/lane based localization. A motion planning module derives an optimal trajectory as a function of time, from the environment representation results. A safety envelope definition module determines the complete driving corridor that leads to the destination while assigning all objects to either the left or right corridor bound. In the case of moving objects such as other traffic participants, their behaviors are anticipated in the near future. An optimal trajectory planner uses the safety envelop as a constraint and computes a trajectory that the vehicle stays in its bounds. The vehicle control module feeds back the pose estimate of the localization module to guide the vehicle along the planned trajectory. The effectiveness of the proposed automated driving algorithm is evaluated via vehicle tests. Test results show the robust performance on an inner-city street scenario.

14:45-15:10 Coffee & Green Tea Break

15:10-15:55 Session 13: Keynote 4: Drive Me – Self-driving cars for sustainable mobility
Dr. Erik Coelingh, Volvo Cars, Sweden

CHAIR: Jonas Sjöberg
LOCATION: Runan

To research the real life impact of self-driving vehicles Volvo will launch 100 self-driving cars in Gothenburg 2017. Erik Coelingh is Senior Technical Leader for Safety and Driver Support Technologies with the Volvo Car Corporation and Adjunct Professor at Chalmers University of Technology in Gothenburg, Sweden.

ABSTRACT. Self-driving cars have the potential to improve traffic safety and efficiency, but also provide drivers with the freedom to spend time in a different way. To research the real life impact of self-driving vehicles Volvo will launch 100 self-driving cars in Gothenburg 2017. Typical aspects that are addressed are societal and economical benefits, infrastructure requirements, legality and customer expectations. Furthermore, the technical challenge of highly-automated driving has to be solved, ensuring that the technology is sufficiently robust and safe such an ordinary customer can operate the vehicle. This presentation will give an update of the status and progress of the project.

15:55-16:20 Session 14: Prize and closing ceremony
CHAIR: Jonas Sjöberg
LOCATION: Runan
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