The 15th International IEEE Conference on Intelligent Transportation Systems

ITSC2012

September 16~19, 2012, Anchorage, Alaska, USA

The Wild Frontier in Intelligent Transportation

Program Book

IEEE

ITSS
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Welcome Message from the General Chair

Jeffrey Miller

I would like to welcome everyone to Anchorage, Alaska and the 15th IEEE Intelligent Transportation Systems Conference – The Wild Frontier in Intelligent Transportation! Over the past few years, this conference has been held in a lot of great places around the world – Toronto, Seattle, Beijing, St. Louis, Madeira, Washington DC. All of those conferences had a great turn out of attendees, a tremendous technical program, and social events that displayed the unique culture of the city. The organizing committee of ITSC 2012 has tried to build on the success of the previous years and continue to raise the bar for future ITSCs. I hope the organizers in The Hague, Qingdao, and Las Palmas take good notes during this conference.

I really was quite fortunate in the organizing committee I had for this conference. Wei-Bin Zhang and Yinhai Wang have put together a tremendous technical program with high quality papers and plenary sessions that span North America, Europe, and Asia, as well as academia, industry, and government. Javier Sanchez Medina was by far the best registration chair I could have hoped for, and he also picked up the web site, all the social networking, and many other tasks that did not fall on any specific person. Jim Krogmeier kept us all in line with the finances, and Brendan Morris has some great student activities planned. Heng Wei was responsible for the program, and as you all can see, the program turned out great. Zhiheng Li put together all of the workshops that we have prior to the start of the conference, and our publicity co-chairs, Urbano Nunes, Fei-Yue Wang, and Matt Barth, helped get the word out to all of you about the conference deadlines.

In addition to having a very active committee, I want to acknowledge two members of the organizing committee in particular who put in more time and effort than any volunteer should. Wei-Bin Zhang spent countless hours on the technical program, from following up with reviewers and the technical program committee to organizing all of the accepted papers into the sessions. He worked to get all of the plenary speakers, and his dedication to this conference, as well as balancing his role as the Program Manager at PATH, was definitely required for it to be the success that it is. Javier Sanchez Medina was also instrumental in making sure that all of the intricate details of the conference were handled. Javier helped us through all of the complications that Papercept gave us in the paper upload and registration process. (NOTE: That last sentence is definitely an understatement.) He managed the web site and made updates nearly as fast as they were requested. I think he may be the only other person who tries to clear out his inbox on a daily basis as quickly as I do. I can’t tell you how many times we were responding to each other’s emails nearly in real-time. When you see Wei-Bin and Javier at the conference, please acknowledge their contributions to the conference with a sincere “thank you.”

The social activities we have planned for the conference include a lot of Alaskan culture. You will get exposed to native Alaskan dancers, the folksy flavor of Alaskan music, the animals that call the state home, and some of the best local cuisine you can find in the state. There should be ample time to catch up with old colleagues, network with new ones, see a small part of the largest state in the US, and enjoy the great culture that happens in the Last Frontier.
For anyone who is thinking about running a conference, I would highly recommend talking with any of the people on the ITSC 2012 organizing committee. They all would be invaluable resources for you. For anyone thinking about being a general chair, you should know that I have received over 4000 emails in the prior two years leading up to the conference. I think I needed to respond to at least 3000 of those.

Now that you are at the conference, if you have any questions, please ask one of the student volunteers or members of the organizing committee. I hope you are able to network with colleagues, learn about some new and different ideas, enjoy the great food and culture of Alaska, and see at least one moose before you leave!

Prof. Jeffrey Miller, Ph.D.
ITSC2012 General Chair
University of Alaska Anchorage
Anchorage, Alaska
USA
Welcome Message from the Program Chairs

Wei-Bin Zhang and Yinhai Wang

We are excited about the technical program for the 15th IEEE Intelligent Transportation Systems Conference (ITSC 2012). Highlighted by the conference theme, The Wild Frontier in Intelligent Transportation, ITSC 2012 covers a broad range of topics critical to ITS planning, technology development, implementation, research, education, and cost-to-benefit analysis. As will soon be witnessed, the technical program for ITSC 2012 is both intellectually stimulating and practically informative.

We are proud to announce that ITSC 2012 attracted 438 submissions from 44 countries or regions, making it a truly international conference. As in the previous years, the majority of papers came from the U.S. (102), followed by Mainland China (82), Germany (40), Japan (32), France (22), Taiwan (12), Canada (11), South Korea (11), United Kingdom (11), India (10), and the Netherlands (10). After a rigorous review process, a total of 318 papers were included in the final technical program for presentation and publication in the conference proceedings.

These papers address important research fields, including simulation and modeling (8.9%), driver assistance systems (6.4%), optimization and control (4.2%), data mining and analysis (4.0%), traffic control (3.9%), imaging and image analysis (3.9%), advanced vehicle safety systems (3.6%), etc. Seventy-two technical sessions, including sixty-seven regular sessions and five special sessions, have been scheduled for the paper authors to share their knowledge with conference participants. Such a rich technical program allows as many as eight parallel tracks for ITSC 2012 attendees to choose from during non-plenary session periods.

More excitingly, six internationally recognized experts from North America, Europe, and Asia have committed their in-depth presentations at three plenary sessions. They will offer their valuable findings, thoughts, and vision on important ITS issues, such as cutting edge research on connected vehicles and state of the art on high-speed rail system development.

Furthermore, four pre-conference workshops have been scheduled with top notch experts being the panelists to discuss key issues on pedestrian/bicycle data collection, probe data analysis, unmanned aerial vehicle applications, and transportation data management. We believe that these workshops will identify effective solutions and future work directions to these important problems.

Completion of such a rich conference program would not have been possible without strong voluntary help. During the preparation of ITSC 2012, we received strong support from ITS professionals around the world as evidenced by the high amount of paper submissions,
quality reviews, and session commitments. Particularly, we would like to express our deep gratitude to the 65 associate editors and 688 paper reviewers for their dedication and great efforts. Also, we are grateful to all authors, speakers, conference committee members, sponsors, and other conference participants for their hard work and great efforts that will lead ITSC 2012 to a great success!

ITSC has been an excellent platform for information exchange, experience sharing, and professional networking over the past fourteen years. We hope ITSC 2012 to be another wonderful and rewarding experience in your memory.

Wish you a very pleasant stay in Anchorage!

Mr. Wei-Bin Zhang
ITSC 2012 Program Co-Chair
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Hualiang Teng, University of Nevada, USA
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Guohui Zhang, University of New Mexico, USA
Liping Zhang, Google, USA
Sheng Zhang, Tsinghua University, China
Yu Zhang, University of South Florida, USA
Jianyang Zheng, Maryland Department of Transportation, USA
Kun Zhou, University of California at Berkeley, USA
Fenghua Zhu, Chinese Academy of Sciences, China
Introduction to Keynote Speakers

Dr. Joseph I. Peters

Director, Federal Highway Administration’s Office of Operations Research and Development

Keynote Speech: “Pioneering the Wild Frontier in Intelligent Transportation”

Over 50 years ago, the federal government pioneered the building of the interstate highway system in the US. Over 20 years ago, the federal government pioneered a new era defined by the “Intelligent Vehicle-Highway Systems Act of 1991.” Today, the federal challenge is to pioneer the transportation frontiers in telecommunications, big data, and automation in ways that will revolutionize the ways we live.

Dr. Joseph I. Peters, Director of the Federal Highway Administration’s Office of Operations Research and Development, will address the role that the federal government plays in creating R&D opportunities for electrical and electronics engineers who are pioneering the frontier in intelligent transportation. He will briefly highlight provisions of new legislation entitled, “Moving Ahead for Progress in the 21st Century Act,” especially as they apply to intelligent transportation research. He will describe activities and opportunities at the Turner-Fairbank Highway Research Center and its new Saxton Transportation Operations Laboratory, as well as ongoing efforts as part of US DOT’s connected vehicle research.

Dr. Joseph I. Peters directs a multi-disciplined staff in planning, conducting, and coordinating research, development, test, evaluation, and technology transfer initiatives aimed at improving traveler mobility on the Nation’s highways. Over the past five years, his office has accomplished pioneering research and development of cooperative adaptive cruise control systems showing significant throughput, fuel savings, and environmental benefits associated with reduction of stop and go traffic. His office is currently developing and testing communications technologies for broadcasting traffic signal phase and timing information to vehicles and pedestrians as well as cooperative vehicle-highway communications technologies for enabling eco drive applications at signalized intersections. With the new Saxton Transportation Operations Laboratory up and running, his office will be providing new opportunities for senior level and student fellowships on site at the lab.

Joe has over 40 years of R&D experience including positions with the US DOT’s Intelligent Transportation Systems Joint Program Office, a large government consulting company, US Air Force Systems Command, the US Army Research Institute for the Behavioral and Social Sciences, and, in the very beginning of his career, a research position at FHWA’s Fairbank Highway Research Station. Dr. Peters is a graduate of Loyola College in Baltimore, MD, where he majored in Biology. He received his M.A. in Human Factors Psychology and his Ph.D. in Applied-Experimental Psychology from The Catholic University of America. He is the recipient of the Secretary of Transportation’s Award for Meritorious Achievement and the FHWA Administrator’s Award for Superior Achievement.
Mr. John Horsley

Executive Director, American Association of State Highway and Transportation Officials (AASHTO)

Keynote Speech: “State of the ITS Industry”

Twenty years ago, transportation professionals recognized that technologies are essential for getting the most out of our existing infrastructure – leading to the establishment of Intelligent Transportation Systems (ITS) programs in the United States. Today, using advanced technologies to improve information for travelers, reduce congestion, and improve safety is a growing practice among state DOTs. States are increasingly using “smart technologies” to improve system performance, safety and reliability. Citizens have come to expect that transportation agencies will use new technologies to help them get where they want to go, when they want to get there.

John Horsley, the Executive Director of the American Association of State Highway and Transportation Officials (AASHTO), will discuss about some great examples of how states across the country are turning to high-tech solutions to solve their transportation challenges.

In 1999, John Horsley became Executive Director of AASHTO, which advocates policies and provides technology leadership on behalf of States to improve the Nation’s transportation system.

Previously, Horsley was nominated by the President and confirmed by the Senate as Associate Deputy Secretary of Transportation where he served from 1993 to 1999 as the Department’s advocate for intermodal policies, quality of life initiatives and as liaison to State and Local Governments, US Congress, and transportation constituencies.

A native of the Northwest, Horsley was elected to five terms as County Commissioner in Kitsap County, a community just west of Seattle. He is a graduate of Harvard, an Army veteran, a former Peace Corps volunteer and Congressional aide, and did graduate study at Georgetown University. He is Past President of the National Association of Counties, and was founding Chairman of the Rebuild America Coalition.

He and his wife Deanna have been married for 36 years and have two children: Adam and Jennifer.
Dr. Christoph Stiller

President of the IEEE Intelligent Transportation Systems Society (2012-2013)

Keynote Speech: “Towards Swarms of Self-Driving Automobiles”

This presentation focuses on key technologies for automobiles that perceive their environment and based on this knowledge automatically navigate through everyday traffic in an autonomous and cooperative manner. Methods for 3D machine perception based on lidar, radar, and video sensors are outlined. The possible contribution of prior knowledge from digital maps is elaborated. Beyond classical metrology the recognition and basic understanding of situations must be accomplished for automated decision-making and trajectory planning. When multiple self-driving automobiles are present they are able to communicate their plans and mutually negotiate their trajectories. Inspired by biological swarms it is shown that a coordinated and homogenized traffic flow can be achieved through cooperative yet distributed planning. Results from autonomous vehicles are shown in real world urban and platooning scenarios including AnnieWAY the recent winner of the Grand Cooperative Driving Challenge.

Christoph Stiller studied Electrical Engineering in Aachen, Germany and Trondheim, Norway, and received the Diploma degree and the Dr.-Ing. degree (Ph.D.) from Aachen University of Technology in 1988 and 1994, respectively. He worked with INRS-Telecommunications in Montreal, Canada for a post-doctoral year as Member of the Scientific Staff in 1994/1995.

In 1995 he joined the Corporate Research and Advanced Development of Robert Bosch GmbH, Germany.

In 2001 he became chaired professor and director of the Institute for Measurement and Control Systems at Karlsruhe Institute of Technology, Germany.

Dr. Stiller serves as President of the IEEE Intelligent Transportation Systems Society (2012-2013), Associate Editor for the IEEE Transactions on Intelligent Transportation Systems (2004-ongoing), IEEE Transactions on Image Processing (1999-2003) and for the IEEE Intelligent Transportation Systems Magazine (2012-ongoing). He has served as Editor-in-Chief of the IEEE Intelligent Transportation Systems Magazine (2009-2011). He has been program chair of the IEEE Intelligent Vehicles Symposium 2004 in Italy and General Chair of the IEEE Intelligent Vehicles Symposium 2011 in Germany. His autonomous driving team AnnieWAY has been finalist in the Darpa Urban Challenge 2007 and winner of the Grand Cooperative Driving Challenge in 2011.
According to the standardization of Chinese Train Control System (CTCS), there are the two train operation control systems for high speed railways in China: CTCS2 and CTCS3. The two systems are widely applied in high speed railways in China to ensure the safety and efficiency of operation for high speed trains. This presentation will provide an overview of the train operation control systems for high speed railways in China. The discussions will also be about the operation principle of CTCS2 and CTCS3 and the challenges train operation control systems face, as well as further developments of the two systems for high speed railway networks in China.

Professor Bin Ning was a Vice President of Beijing Jiaotong University (BJTU) since December 1997 and the Executive Vice President of BJTU since 2004, and he was appointed President of Beijing Jiaotong University in 2008. Professor Bin Ning received his Bachelor, Master and Ph.D. degrees of Engineering from Beijing Jiaotong University. He is a fellow of the Association of International Railway Signaling Engineers (IRSE), a member of IEEE, a fellow of the Institute of Engineering and Technology (IET), and a fellow of the China Railway Society. He also serves as the Deputy Director of the China Traffic System Engineering Society and the Deputy Director of the Beijing Railway Society.
Dr. Makoto Itami

Professor of Tokyo University of Science, Japan


Recently, ITS systems are widely being developed and deployed in order to realize a safe and comfortable traffic environment. In ITS, wireless communication technology is one of the most important technologies. Dr. Makoto Itami will discuss about the development and deployment of ITS wireless communication systems in Japan such as VICS (Vehicular Information and Communication Service), ETC (Electronic Toll Collection) and ITS spot based on DSRC. In addition, the Japanese standard for inter-vehicle communication using the UHF band and its use in safety applications are also introduced.

Dr. Makoto Itami received his B.E., M.E. and D.E. degrees in Electrical Engineering from the University of Tokyo in 1984, 1986 and 1989, respectively. He then joined Department of Applied Electronics, Tokyo University of Science. He has been engaged in researches in digital communication systems, especially OFDM, UWB, spectrum spread communication and ITS communication. Between 2002 and 2003, he was a visiting research fellow of King’s College, London. He is currently a professor of Tokyo University of Science. He is a member of IEEE, IEICE and ITE.
Mr. Ocie Adams

Project Manager for Statewide Maintenance and Operations
Intelligent Transportation Systems for the Alaska DOT and Public Facilities

Keynote Speech: “Smart Maintenance and Operations Vehicles”

The Alaska Department of Transportation and Public Facilities partnered with the University of Minnesota to deploy the Smart Maintenance and Operations Vehicles in 2005 in Thompson Pass, Alaska. Thompson Pass receives an average annual snow fall of around 250 inches and winds in excess of 122 MPH. The port of Valdez is a primary shipping and resupply line for Eastern Alaska and the termination point of the Alaska Oil Pipeline. Closure of the Richardson Highway can result in emergency services and commercial operators not being able to deliver critical medical services, fuel, groceries, and pipeline maintenance supplies to the Richardson and Alaskan Highways.

With frequent zero visibility conditions in Thompson Pass the department needed a system that could assist the operators with snow removal and ice control duties. The University of Minnesota offered the best solution to our question. How do we give our operators tools that will help them stay on the road when the visibility would otherwise curtail snow and ice control operations? The University of Minnesota’s solution was technology similar to that used in a fighter aircraft. Attend the Smart M&O Vehicles presentation to hear the solution.

Mr. Ocie Adams serves within the Commissioner’s Office as the Project Manager for Statewide Maintenance and Operations Intelligent Transportation Systems for the Alaska Department of Transportation and Public Facilities. In this capacity, Ocie oversees the safe and efficient maintenance and operation through the use of technology of over 5600 miles of state owned roadways, 253 rural airports, 845 bridges and 720 State owned and/or managed buildings. His deployment of communications technology ensures that the department can do business even from the remotest parts of Alaska. Ocie is also responsible for managing the Airport Improvement Plan for the Surface Preservation Maintenance, the Obstruction Removal and the Airport Equipment Purchase programs. He has 11 years with the department. Ocie started his career working in Operations and Maintenance serving in the United States Air Force for 25 years as: Operator, Operator Mechanic, Air Traffic Controller, Combat Control Superintendent (Air Force Special Operations), Operations Superintendent, and retired from the Air Force as the Maintenance & Operations Superintendent 11th Air Force.

Ocie states that he absolutely loves living and working in Alaska with the unique challenges it poses. He said after being in the Air Force and traveling around the world several time, he finds the rest of the world a disappointment when compared to Alaska.
About ITSS

The IEEE Intelligent Transportation Systems Society (ITSS) advances the theoretical, experimental, and operational aspects of Electrical Engineering and Information Technologies as applied to ITS. The Society is interested in theoretical, experimental, and operational aspects of electrical and electronics engineering and information technologies as applied to ITS, defined as those systems utilizing synergistic technologies and systems engineering concepts to develop and improve transportation systems of all kinds.

The ITS Society has three different publications that are distributed quarterly. The Transactions on Intelligent Transportation Systems has repeatedly had the highest impact factor of all ITS and transportation-related journals. The Intelligent Transportation Systems Magazine appeals to a wider audience and publishes papers and articles that relate to all areas of ITS. The papers published in the Magazine undergo the same review process as that of the Transactions and have a similar acceptance rate. The Intelligent Transportation Systems Newsletter provides a large number of readers with information about the ITS Society, abstracts from the next issue of the Transactions, and other items that are of interest to a reader-base that does not solely consist of ITS Society members.

The ITS Society is overseen by the Board of Governors. This consists of 15 individuals elected by the members of the Society, and 10 individuals elected by the Board (known as the Executive Committee). The Board of Governors meets three times annually, typically through a teleconference in spring and in-person meetings in conjunction with the Intelligent Vehicles Symposium and the Intelligent Transportation Systems Conference. The Executive Committee meets one additional time in winter. If you are interested in becoming a BOG member, please speak with any of the current BOG members to find out more.
General Information about ITSC 2012

The 15th IEEE Intelligent Transportation Systems Conference (ITSC2012) is held September 16-19, 2012 in Anchorage, Alaska. The ITSC2012 theme is The Wild Frontier in Intelligent Transportation. The conference brings together researchers, engineers, practitioners, managers, and policy makers from academia, industry, and government to share and discuss the latest in Intelligent Transportation Systems (ITS) research and development (R&D) results and implementation strategies. It will include dedicated sessions, workshops, and forums at which researchers, practitioners, government experts, and decision makers will share the latest research, success stories, and implementation needs of ITS.

Venue: Hilton Anchorage

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The Hilton Anchorage is conveniently located in downtown Anchorage. Taxis are available to transport people from the Anchorage International Airport to the Hilton Anchorage. The ride should take approximately 10 minutes and cost around $20. Cars can be rented, though the Hilton does charge for valet parking. Street parking is permissible, though check posted signs as most of the streets in downtown Anchorage are metered.

Registration for the conference will be on the second floor of the Hilton, starting on Sunday at noon. Registration will continue through Wednesday afternoon, opening one hour before the first session and closing 30 minutes after the last session.

The plenary sessions and the lunches will occur in the Alaska/Aleutian ballrooms on the second floor of the Hilton. All of the sessions of the conference will be either on the first floor (Lupine, Fireweed), second floor (Dillingham, Katmai, King Salmon, Iliamna, Denali), or the 15th floor (Chart). The reception on Sunday evening will occur in the Top of the World restaurant on the 15th floor, and the banquet on Tuesday evening will be in both the Top of the World restaurant and the Chart room on the 15th floor.

Please make sure to wear your badge for all conference events, including the reception and the banquet. Tickets for beverages included in your bag should be brought to the designated event as well.
Any questions or concerns should be brought to the attention of the registration desk. The volunteers at the registration desk will be able to direct you to the appropriate person to handle the question if they are not able to.

Sightseeing Information

For those of you who have time to see a different part of the state other than the inside of the Hilton, here are a few recommendations.

- No visit to Alaska would be complete without seeing the largest peak in North America – Denali, also known as Mount McKinley, stands 20,320 feet high (6193.5 meters). Although the Denali National Park is about a three hour drive from Anchorage, seeing the beautiful, pristine forests and mountains along the way makes it perfect for wildlife viewing as well. Transportation can be provided by renting a car, riding a bus, or taking the Alaska railroad. If you are going by car or bus, make sure to note Sarah Palin's city of Wasilla on the way.

- Driving south from Anchorage will put you on the scenic Seward Highway along the Cook Inlet. Watch for beluga whales in the inlet to the west and dall sheep on the cliffs to the east.

- Continuing south about 90 minutes from Anchorage can take you through the longest tunnel in North America (2.5 miles or 4.0 kilometers) to the small city of Whittier. Taking a glacier cruise out of Whittier will show you more glaciers than you have probably seen in your entire life – some companies advertise showing you at least 26!

- Even though you should always be on the lookout for moose, bears, and bald eagles while in Alaska, there are only two places where viewing them can be guaranteed. The Alaska Zoo is in Anchorage and features many cold-weather animals, not just from Alaska. This is the only place you can see a polar bear in Anchorage, though my favorite animal is the musk ox. The Alaska Wildlife Conservation Center is a rehabilitation center for Alaskan animals about an hour south of Anchorage. You can see the Alaskan animals in enclosures that closely resemble their natural surroundings, and the center features many of Alaska’s wildlife.

- I know that many of you have heard about the great fishing we have in Alaska. Since we are a little late in the season, I would suggest getting in touch with some fishing charters to see if they are still operating. Some charters run out of Seward (about two hours south of Anchorage) and Whittier (about 90 minutes south of Anchorage).

- If you want to stay a little closer in Anchorage and still see nature, the coastal trail, which is just a few minute walk from the Hilton, will provide you with amazing views of Cook Inlet, which is part of the Pacific Ocean.

- The Anchorage Museum, many wonderful dining options, tourist stores, fur shops, and many other attractions can be found by walking a few blocks in any direction from the Hilton. If you are interested in seeing the local nightlife in Alaska, I would recommend F Street Bar or Darwin’s Theory, both within walking (or stumbling) distance of the Hilton.

Although this just touches the surface of all Alaska has to offer, I hope this gives you some ideas for planning your time in Alaska away from the conference. Please do not hesitate to ask any of the local students or committee members. Any of us would love to tell you about all of the great activities Alaska has to offer.
Useful Sightseeing Web Links

- http://www.travelalaska.com/
- http://www.whygoalaska.com/
Conference Program At A Glance

15th International IEEE Conference on Intelligent Transportation Systems
September 16-19, 2012, Anchorage, Alaska, USA

ITSC 2012 Technical Program for Sunday September 16, 2012

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<td>13:00-15:00 SA2 King Salmon</td>
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<td>Workshop 1: Emerging Technologies for Pedestrian/Bicycle Detection</td>
<td>Workshop 2: Probe Data Analysis, Challenges, &amp; Opportunities</td>
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## ITSC 2012 Technical Program for Monday September 17, 2012

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</table>
| 08:00-10:30 MP1L  
Aleutian/Alaska  
Plenary Session on Monday |

| 11:00-12:30 MA1  
Chart  
Automated Vehicle Operation 1 |
| 11:00-12:30 MA2  
Denali  
Communication Technologies and Protocols 1 |
| 11:00-12:30 MA3  
Dillingham  
Pedestrian and Vehicle Detection |
| 11:00-12:30 MA4  
Fireweed  
Lidar, Vision and Radar Sensing |
| 11:00-12:30 MA5  
Iliamna  
Calibration, Validation and Sensitivity Analysis of Traffic Simulation Models |
| 11:00-12:30 MA6  
Katmai  
Congestion Pricing and Demand Management |
| 11:00-12:30 MA7  
King Salmon  
Incident Detection |
| 11:00-12:30 MA8  
Lupine  
Eco Driving and Energy Efficient Intelligent Infrastructure 1 |

| 14:00-15:30 MB1  
Chart  
Automated Vehicle Operation 2 |
| 14:00-15:30 MB2  
Denali  
Communication Technologies and Protocols 2 |
| 14:00-15:30 MB3  
Dillingham  
Lane Detection and Lane Keeping |
| 14:00-15:30 MB4  
Fireweed  
Vision Sensing and Image Processing -1 |
| 14:00-15:30 MB5  
Iliamna  
Agent-Based Methods for Modeling and Analysis |
| 14:00-15:30 MB6  
Katmai  
Traveler Information |
| 14:00-15:30 MB7  
King Salmon  
Traffic Management and Control 1 |
| 14:00-15:30 MB8  
Lupine  
Eco Driving and Energy Efficient Intelligent Infrastructure 2 |

| 16:00-17:30 MC1  
Chart  
Advanced Vehicle Active Safety Systems |
| 16:00-17:30 MC2  
Denali  
Communication Technologies and Protocols 3 |
| 16:00-17:30 MC3  
Dillingham  
Vehicle Detection and Classification |
| 16:00-17:30 MC4  
Fireweed  
Vision Sensing and Image Processing 2 |
| 16:00-17:30 MC5  
Iliamna  
Simulation and Modeling 2 |
| 16:00-17:30 MC6  
Katmai  
Travel Time Estimation and Prediction |
| 16:00-17:30 MC7  
King Salmon  
Traffic Management and Control 2 |
| 16:00-17:30 MC8  
Lupine  
Eco-Driving and Energy Efficient Intelligent Infrastructure 3 |
# ITSC 2012 Technical Program for Tuesday September 18, 2012

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<td>Plenary Session on Tuesday A</td>
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<td>Driver Behavior and Safety System</td>
<td>Denali</td>
<td>Communication Technologies and Protocols 4</td>
<td>Detection of Driving Environment 1</td>
<td>Vision Sensing and Image Processing 3</td>
<td>Simulation and Modeling 4</td>
<td>Route Planning and Guidance</td>
<td>Parallel Transportation Management Systems</td>
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<td>Chart</td>
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<tr>
<td>Driver Assistance Systems - Speed Control</td>
<td>Denali</td>
<td>Advanced Technologies and Innovative Concepts for Promoting Traffic Safety and Mobility</td>
<td>Intersection Detection and Safety</td>
<td>Simulation and Modeling 5</td>
<td>Emergency and Freight Operation</td>
<td>Emergency Operation and Management</td>
<td>Parking Technologies</td>
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ITSC 2012 Technical Program for Wednesday September 19, 2012

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<tr>
<td>09:00-10:30 WA1 Chart Driver Assist Systems - Traffic Signal/Sign Recognition</td>
<td>09:00-10:30 WA2 Denali Advanced Vehicle Technologies 1</td>
<td>09:00-10:30 WA3 Dillingham Vehicle Localization and Autonomous Navigation 1</td>
<td>09:00-10:30 WA4 Fireweed ITS Implementations 2</td>
<td>09:00-10:30 WA5 Iliamna Simulation and Modeling 1</td>
<td>09:00-10:30 WA6 Katmai Intelligent Solutions for Air Transportation and Air Space – (ISATAS)</td>
<td>09:00-10:30 WA7 King Salmon Weather Response Systems</td>
<td>09:00-10:30 WA8 Lupine Traffic Data Fusion</td>
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<tr>
<td>11:00-12:30 WB1 Chart Driver Assistance Systems 1</td>
<td>11:00-12:30 WB2 Denali Driver Assistance Systems 2</td>
<td>11:00-12:30 WB3 Dillingham Vehicle Localization and Autonomous Navigation 2</td>
<td>11:00-12:30 WB4 Fireweed ITS Implementations 1</td>
<td>11:00-12:30 WB5 Iliamna Simulation and Modeling 3</td>
<td>11:00-12:30 WB6 Katmai Travel Time Estimation and Its Applications</td>
<td>11:00-12:30 WB7 King Salmon Traffic Flow Management</td>
<td>11:00-12:30 WB8 Lupine Analysis Using Probe Vehicle Data</td>
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<tr>
<td>14:00-15:30 WC1 Chart Driver Assistance Systems - Lateral Control</td>
<td>14:00-15:30 WC2 Denali Advanced Vehicle Technologies 2</td>
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<td>14:00-15:30 WC4 Fireweed Human Factors Studies</td>
<td>14:00-15:30 WC5 Iliamna Simulation and Modeling 7</td>
<td>14:00-15:30 WC6 Katmai Advanced Public Transportation Systems</td>
<td>14:00-15:30 WC7 King Salmon Experimental Investigations</td>
<td>14:00-15:30 WC8 Lupine Network Level Traffic Analysis</td>
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Conference Floor Plan (Function Space Layouts)

WEST TOWER
Detailed Technical Program

Technical Program for Sunday September 16, 2012

Workshop 1: Emerging Technologies for Pedestrian/Bicycle Detection

Sunday, September 16th, 1:00 PM – 3:00 PM
SA1 Invited Session
Dillingham

Workshop Description

Sustainable transportation is a concept that is quickly gaining momentum. Walking and biking are becoming much more popular, and the demand for larger networks of pedestrian and bike trails is increasing quickly. This requires good quality pedestrian and bicycle data for both planning and facility operations purposes. Present pedestrian and bicycle data collection approaches are largely limited to surveys, which are either administered on location or via a broad distribution and manual counts, which involve field data collection by personnel and automatic spot counts. Existing algorithms for automatic spot counts are not satisfactory. New methods and technologies are desired to reduce the cost and improve the accuracy for pedestrian and bicycle data collection. This workshop brings top experts in the pedestrian and bicycle data collection field to share their knowledge and vision on the following issues:

1. Needs for Pedestrian and Bicycle Detection;
2. Existing Technologies and Challenges;
3. Emerging Technologies that Can Be Applied in the Future; and
4. Future Directions and Resources

Panelists

- Al Fletcher, Field Operations Engineer / Safety / Team Leader, FHWA’s Division Office in Alaska
- Jean-Francois Rheault, Director, Eco-Counter
- Edgar Seemann, Professor, Darmstadt University of Technology
- Luis F. Miranda-Moreno, Assistant Professor, McGill University
- Yinhai Wang, Professor, University of Washington [Panel Chair]

Workshop 2: Probe Data Analysis, Challenges, & Opportunities

Sunday, September 16th, 1:00 PM – 3:00 PM
SA2 Invited Session
King Salmon

Workshop Description

The wide availability of probe-based data either from crowd-sourced apps, passenger vehicles, freight and other means is opening doors for many new applications, performance monitoring capabilities, and operational enhancements. However, probe data presents unique challenges with respect to collection, interpolation, aggregation, sheer data quantity, data quality, and a lack of volume measurements--just to name a few. This workshop will explore ways in
which researchers in both the public and private sector are working with probe data to address these issues. Attendees will also see demonstrations of several cutting edge probe data applications that are being developed for safety, operations, and performance measurement. Following brief presentations and demonstrations, workshop attendees will be engaged in a moderated discussion relating to various probe-data issues and processing methodologies.

Panelists

- **Alexandre Bayen**, UC Berkeley: Mobile Millennium. GPS enabled smartphones for integrated corridor management.
- **Walter Fehr**, RITA: The Federal perspective on massive probe data challenges with examples from a 1-year Safety Pilot Model Deployment of over 3,000 vehicles.
- **Michael L. Pack**, University of Maryland CATT Laboratory: Rapid, Multi-state Bottleneck Prioritization & Corridor Analysis using Probe Data. [Panel Chair]
- **Ted Trapanier**, INRIX: Multistate next-Gen passenger probe data safety sensor analysis.
- **Stan Young**, Traffax: Bluetooth probe data analysis and potential.

**Workshop 3: Transportation Applications of Unmanned Aerial Vehicles**

Sunday, September 16th, 3:30 PM – 5:30 PM  
**SB1 Invited Session**  
Dillingham

Workshop Description

Unmanned aerial vehicle (UAV) technologies are getting into the stage for commercial applications. Off the shelf UAV products became smaller and less expensive. Combining surveillance video technologies with UAV may enable data collection in areas where the geographic locations of potential transportation-related problems are only crudely known or in areas where conventional data collection technologies based on point detections cannot gather the data needed for important transportation studies. This workshop brings together top experts who conducted pilot studies on UAV applications in transportation to share their knowledge and vision on the following issues:

1. Existing UAV Technologies Suitable for Transportation Applications;
2. Success Stories and Lessons Learned;
3. Potential Benefits of Data Collectable from UAV-based Systems; and
4. Future Directions and Resources.

Panelists

- **Qingzhou Mao**, Associate Director, State Key Laboratory of Information Engineering in Surveying, Mapping, and Remote Sensing, Wuhan University
- **Zhong-Ren Peng**, Professor, University of Florida
- **Martin Ruhé**, Dipl.-Ing., Transportation Studies, German Aerospace Center
- **Zuo Zhang**, Associate Dean, School of Information Science and Technology, Tsinghua University [Panel Chair]
Workshop Description

In recent years, traffic detectors have been intensively deployed in major highway systems across the country. These sensors generate tremendous traffic data that are extremely valuable for traffic management, forecast, and control. How to manage the data efficiently and produce the most useful information out of them have been crucial challenges faced by traffic professionals. This need is particularly highlighted by the recent “big data” initiatives. Considering that many different kinds of transportation data management systems have been developed, this workshop brings together top experts with such experience to share their knowledge and vision on the following issues:

1. Needs and Challenges for Transportation Data Management and Sharing
2. Existing Platforms and Their Pros and Cons
3. Emerging Technologies that Can Be Applied in the Future
4. Future Directions and Resources

Panelists

- **Jonathan Corey**, STAR Lab Manager, University of Washington
- **Zhaocheng He**, Associate Professor, ITS Laboratory, Sun Yat-Sen University
- **Michael Pack**, Director, CATT Laboratory, University of Maryland
- **Yi Zhang**, Professor, Tsinghua University [Panel Chair]
### Technical Program for Monday September 17, 2012

#### MP1L

**Plenary Session on Monday** (Plenary Session)

**08:00-09:30**  
**MP1L.1**  
*Pioneering the Wild Frontier in Intelligent Transportation*.  
Peters, Joseph  
USDOT/Federal Highway Administration

**09:30-10:30**  
**MP1L.2**  
*State of the ITS Industry*.  
Horsley, John  
American Association of State Highway & Transportation Officials

#### MA1

**Automated Vehicle Operation 1** (Regular Session)

**11:00-11:18**  
**MA1.1**  
Solyom, Stefan  
Volvo Car Corp.  
Coelingh, Erik  
Volvo Car Corp.

**11:18-11:36**  
**MA1.2**  
*Temporal Analysis of the Gate Concept As Enabler for Highly Automated Driving Based on the Conduct-By-Wire Approach*, pp. 7-12.  
Geyer, Sebastian  
Tech. Univ. Darmstadt  
Karg, Melanie  
Tech. Univ. Darmstadt  
Hakuli, Stephan  
IPG Automotive GmbH  
Winner, Hermann  
Tech. Univ. Darmstadt  
Franz, Benjamin  
Tech. Univ. Darmstadt  
Kauer, Michaela  
Tech. Univ. Darmstadt

**11:36-11:54**  
**MA1.3**  
He, Wen  
Tsinghua Univ.  
Guisheng, Chen  
Chinese Inst. of Electronic System Engineering  
Shuming, Tang  
Chinese Acad. of Sciences  
Deyi, Li  
Chinese Inst. of Electronic System Engineering  
Mu, Guo  
Tsinghua Univ.  
Tianlei, Zhang  
Tsinghua Univ.  
Peng, Jia  
Military Transportation Inst.  
Feng, Jin  
Xian Communication Inst.

**11:54-12:12**  
**MA1.4**  
Sezer, Volkan  
Istanbul Tech. Univ.  
Ercan, Ziya  
Istanbul Tech. Univ.  
Heceoglu, Hasan  
Istanbul Tech. Univ.  
Gokasan, Metin  
Istanbul Tech. Univ. Electrical & Electronics Engineeringi  
Bogosyan, Setar  
Istanbul Tech. Univ.

#### MA2

**Communication Technologies and Protocols 1** (Regular Session)

**11:00-11:18**  
**MA2.1**  
Naranjo, Jose  
Univ. Pol. de Madrid  
Talavera, Edgar  
Univ. Pol. de Madrid  
Anaya, Jose Javier  
Univ. Pol. de Madrid  
Jiménez, Felipe  
Univ. Pol. de Madrid  
Zato, José Gabriel  
Univ. Pol. de Madrid  
Gomez, Nuria  
Univ. Pol. de Madrid

**11:18-11:36**  
**MA2.2**  
*Performance Evaluation of V2I-Based Channel Aware Floating Car Data Transmission Via LTE*, pp. 31-36.  
Ide, Christoph  
TU Dortmund Univ.  
Dusza, Bjorn  
TU Dortmund Univ.  
Wietfeld, Christian  
TU Dortmund Univ.

**11:36-11:54**  
**MA2.3**  
Vijitkunsawat, Wuttichai  
Rajamangala Univ. of Tech. Krunghthep  
Anunvrapong, Pramote  
Rajamangala Univ. of Tech. Krunghthep

**11:54-12:12**  
**MA2.4**  
Perronnet, Florent  
Univ. de Tech. de Belfort-Montbéliard (UTBM)  
Abbas-Turki, Abdeljalil  
Univ. de Tech. de Belfort Montbéliard  
Buisson, Jocelyn  
Voxelia  
El Moudni, Abdeliah  
Univ. of Tech. of Belfort-Montbéliard (UTB)  
Zéo, Renan  
Voxelia  
Ahmane, Mourad  
Univ. of Tech. of Belfort-Montbéliard (UTBM)

#### MA3

**Pedestrian and Vehicle Detection** (Regular Session)

**11:00-11:18**  
**MA3.1**  
Liu, Yan  
Peking Univ.  
Lu, Xiaqing  
Peking Univ.  
Xu, Jianbo  
Peking Univ. Founder Group Co.LTD  
Qin, Yeyang  
Peking Univ.  
Tang, Zhi  
Peking Univ.

**11:18-11:36**  
**MA3.2**  
*Positioning of Road Users by RSSI with Road Surface Reflection Model*, pp. 54-60.  

### MA3.3

**Monocular Target Detection on Transport Infrastructures with Dynamic and Variable Environments**, pp. 61-66.

- Alvarez Pardo, Sergio
- Fernandez Llorca, David
- Sotelo, Miguel A.
- Garcia Lorente, Alejandro

11:36-11:54

### MA3.4

**Urban Road User Classification Framework Using Local Feature Descriptors and HMM**, pp. 67-72.

- Takahashi, The Univ. of Tokyo
- Toshimitsu
- Kim, HyungKwan
- Kamijo, Shunsuke

12:12-12:30

### MA3.5

**Two-Stage Part-Based Pedestrian Detection**, pp. 73-77.

- Megelmose, Andreas Aalborg Univ.
- Priolletti, Antonio Univ. of Parma
- Trivedi, Mohan M. Univ. of California at San Diego
- Brogni, Alberto Univ. of Parma
- Moeslund, Thomas B. Aalborg Univ.

11:54-12:12

### MA4

**Lidar, Vision and Radar Sensing** (Regular Session)

#### MA4.1

**Sensor System Blockage Detection for Night Time Headlight Control Based on Camera and Radar Sensor Information**, pp. 78-83.

- Gavriilidis, Alexandros Univ. of Wuppertal
- Mueller, Dennis Delphi Electronics & Safety
- Müller-Schneiders, Stefan Delphi Deutschland GmbH
- Kummert, Anton Univ. of Wuppertal
- Velten, Jörg Univ. of Wuppertal

11:00-11:18

#### MA4.2

**A Cost-Effective Radar System for Automotive Powertrain Control Applications**, pp. 84-89.

- Beg, Chris Univ. of Waterloo
- Vajedi, Mahyar Univ. of Waterloo
- Nezhad-Ahmedi, Mohammad-Reza Univ. of Waterloo
- L. Azad, Nasser Univ. of Waterloo
- Safavi-Naeini, Safieeddin Univ. of Waterloo

11:18-11:36

#### MA4.3


- Nishigaki, Morimichi Honda R&D Europe
- Rebhan, Sven Honda Res. Inst. Europe

11:36-11:54

### MA4.4

**Einecke, Nils Honda Res. Inst. Europe GmbH**

11:54-12:12

### MA5

**Calibration, Validation and Sensitivity Analysis of Traffic Simulation Models** (Special Session)

- Organizer: Antoniou, National Tech. Univ. of Athens
- Organizer: Punzo, Vincenzo European Commission Joint Res. Centre
- Organizer: Brackstone, Mark IOMI Consulting

11:00-11:18

#### MA5.1

**Parallel Public Transport System and Its Application in the Evacuation of Large-Scale Activities (I)**, pp. 102-107.

- Zhu, Fenghua Inst. of Automation, Chinese Acad. of sciences
- Chen, Songhang Chinese Acad. of Sciences
- Lv, Yisheng Chinese Acad. of Sciences
- Ye, Peijun Chinese Acad. of Sciences

11:18-11:36

#### MA5.2


- Montanino, Marcella Univ. of Naples Federico II
- Ciufla, Biagio Joint Res. Centre - European Commission
- Punzo, Vincenzo European Commission Joint Res. Centre

11:36-11:54

#### MA5.3

**Efficient Real Time OD Matrix Estimation Based on Principal Component Analysis (I)**, pp. 115-121.

- Djukić, Tamara Delft Univ. of Tech.
- Flötteröd, Gunnar KTH Royal Inst. of Tech.
- van Lint, Hans Delft Univ. of Tech.
- Hoogendoorn, Serge Delft Univ. of Tech.

11:54-12:12

#### MA5.4


- Korcek, Pavol Brno Univ. of Tech.
- Sekanina, Lukas Brno Univ. of Tech. - Faculty of InformationTechnology
- Fucik, Otto Brno Univ. of Tech. - Faculty of InformationTechnology

12:12-12:30

#### MA5.5

**Effectiveness of Speed Measures to Improve Roundabout Capacity “Case Study”**, pp. 130-133.

- Abaza, Osama Univ. of Alaska Anchorage
**MA6**

**Congestion Pricing and Demand Management (Regular Session)**

11:00-11:18 MA6.1


- Kaparias, Ioannis, City Univ. London
- Bell, Michael Geoffrey, Imperial Coll. London
- Harrison,

11:18-11:36 MA6.2

*Empirical Evaluation of a Dynamic and Distributed Taxi-Sharing System*, pp. 140-146.

- d'Orey, Pedro M., Univ. of Porto, Inst. de Telecomunicações
- Fernandes, Ricardo, Inst. de Telecomunicações
- Ferreira, Michel, Inst. de Telecomunicações

11:36-11:54 MA6.3


- Bui, Kim, Massachusetts Inst. of Tech.
- Huynh, Vu, Massachusetts Inst. of Tech.
- Frazzoli, Emilio, Massachusetts Inst. of Tech.

11:54-12:12 MA6.4

*Assessing Economic Impacts of Implementing a Vehicle of Miles Traveled Fee in Nevada*, pp. 155-159.

- Paz, Alexander, Univ. of Nevada, Las Vegas
- Nordland, Andrew, Univ. of Nevada, Las Vegas
- Khan, Alauddin, Nevada Department of Transportation

12:12-12:30 MA6.5


- Hoh, Baik, Nokia Res. Center
- Yan, Tingxin, Univ. of Massachusetts, Amherst
- Deepak, Ganesan, Univ. of Massachusetts, Amherst
- Ken, Tracton, Nokia Res. Center
- Toch, Iwuchukwu, Nokia Res. Center
- Juong-Sik, Lee, Nokia Res. Center

**MA7**

**Incident Detection (Regular Session)**

11:00-11:18 MA7.1

*Prediction of Freeway Traffic Incident Delay Based on Simulation*, pp. 167-171.

- Zhang, Hongbin, Southeast Univ.
- Ni, Fujian, Southeast Univ.
- Yang, Shunxin, Southeast Univ.

11:18-11:36 MA7.2

*An Unsupervised Feature Learning Approach to Improve Automatic Incident Detection*, pp. 172-177.

- Ren, Jimmy SJ., City Univ. of Hong Kong
- Wang, Wei, City Univ. of Hong Kong
- Wang, Jiawei, USTC-CityU Joint Advanced Res.

11:36-11:54 MA7.3


- Dadic, Ivan, Faculty of Traffic and Transportation Sciences
- Damir, Skaro, AK Siget
- Vidovic, Kresimir, Faculty of Traffic and Transportation Sciences
- Ševrović, Marko, Faculty of Transport and Traffic Sciences
- Sostaric, Marko, Faculty of Traffic and Transportation Sciences
- Jeremic, Dragana, Faculty of Tech. Sciences

11:54-12:12 MA7.4


- Hirirotappa, Kittipong, NECTEC
- Thajchhayapong, NECTEC
- Suttipong, NECTEC
- Likitkhajorn, Chakrit, NECTEC
- Poolsawat, Anurak, NECTEC

**MA8**

**Eco Driving and Energy Efficient Intelligent Infrastructure (Regular Session)**

11:00-11:18 MA8.1


- Xia, Haitao, Univ. of California-Riverside
- Boriboonsomsin, Kanok, Univ. of California-Riverside
- Schweizer, Friedrich, BMW Tech. Office Mountain View
- Winckler, Andreas, BMW Tech. Office Mountain View
- Zhou, Kun, Univ. of California-Berkeley
- Zhang, Wei-Bin, Univ. of California-Berkeley
- Barth, Matthew, Univ. of California-Riverside

11:18-11:36 MA8.2


- Malikopoulos, Andreas, Oak Ridge National Lab.
- Aguilar, Juan, Oak Ridge National Lab.

11:36-11:54 MA8.3

*Enhanced Eco-Driving System Based on V2X Communication*, pp. 200-205.

- Chen, Yuxiao, Tsinghua Univ.
- Zhang, Dezhao, Tsinghua Univ.
- Li, Keqiang, Tsinghua Univ.

11:54-12:12 MA8.4

*A RFID Based E-STOP Sign and Its Impacts to Vehicle Emissions*, pp. 206-211.

- Qiao, Fengxiang, Texas Southern Univ.
- Wang, Jinghui, Texas Southern Univ.
**Automated Vehicle Operation 2 (Regular Session)**

### 14:00-14:18


- Tourani, Siddharth
- Mukhija, Piyosh
- Krishna, K Madhava


- Wang, Shuijing
- Heinrich, Steffen
- Wang, Miao
- Rojas, Raúl

### 14:18-14:36


- Nguyen, Duong-Van
- Kuhnt, Lars
- Schlemper, Jens
- Thamke, Stefan
- Kuhnt, Klaus-Dieter

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- Maurer, Markus

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- Ogata, Satoshi
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- Urquía, Gorka
- Perallos, Asier
- Carballo, Roberto

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- Ogata, Satoshi
- Sakakibara, Sho
- Ohno, Kohei
- Itami, Makoto


- Enriquez, Dj
- Bautista, Alexander
- Field, Paloma
- Kim, Sun-il
- Jenson, Sean
- Ali, Muhammad
- Miller, Jeffrey

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- Zhang, Sumin
- Deng, Weiwen
- Wang, Ye
- Zhao, Qingsong


- Deusch, Hendrik
- Wiest, Juergen
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- Konrad, Marcus

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- Yao, Wentao
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centor, pp. 282-287.
Lee, Jin-Woo General Motors, Res. and Development
Litkouhi, Bakhtiar General Motor R&D Center

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Kühnl, Tobias Bielefeld Univ.
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Fritsch, Jannik Honda Res. Inst. Europe GmbH

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Lategahn, Henning Inst. of Measurement & Control

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Tomographical Scene Reconstruction in the Active Safety Car Project, pp. 307-312.
Velten, Joerg Univ. of Wuppertal
Schauland, Sam Riedel Communications
Gavrilidis, Alexandros Univ. of Wuppertal
Schwertfeger, Tim Univ. of Wuppertal
Boschen, Fritz Univ. of Wuppertal
Kummet, Anton Univ. of Wuppertal

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Mukherjee, Dibyendu Univ. of Windsor
Saha, Ashirbani Univ. of Windsor
Wu, Q. M. Jonathan Univ. of Windsor

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El-Tantawy, Samah Univ. of Toronto
Abdulhai, Baher Univ. of Toronto

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Li, Caixia the Univ. of New South Wales
Anavatti, Sreenatha Univ. of New South Wales

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A Model for Automatic Collection and Dynamic Transmission of Traffic Information Based on VANET, pp. 373-378.

Zhang, Qi Univ. of Science & Tech. Beijing
Zhao, JianHao Univ. of Science & Tech. Beijing

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Hrazdira, Adam Brno Univ. of Tech.
Cela, Arben ESIEE Paris
Hamouche, Redha ESIEE Paris
Reama, Abdellatif ESIEE Paris
Rezende, Bernardo Univ. Federal de Minas Gerais
Niculescu, Silviu- Lab. de Signaux et Systemes (L2S, Iulian UMR CNRS 8506)
Villedieu, Christophe AKKA Tech.

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Comparison of VSP Profiles for Three Types of Intersection Control and Implications for Emissions, pp. 415-420.

Hallmark, Shauna Iowa State Univ. USA
Mudgal, Abhisek Iowa State Univ.

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Umedu, Takaaki Osaka Univ.
Togashi, Yuji OsakaUniversity
Higashino, Teruo Osaka Univ.

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Gu, Qing Beijing Jiaotong Univ.
Cao, Fang state key Lab. of rail traffic control and safety,Beijing
Tang, Tao Beijing Jiaotong Univ.

15:12-15:30 MB8.5

An Analysis on Excursion Characteristics of Electric Assist Bicycles by Travel Behavioral Comparison Based on Trajectory Data, pp. 433-437.

Inagaki, Tomoyuki Seikei Univ.
Mimura, Yasuhiro Toyota Transportation Res. Inst.
Ando, Ryosuke TTRI (Toyota Transportation Res. Inst.)

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1. **MC1.1**
   - **Title:** Semantic-Based Road Environment Recognition in Mixed Traffic for Intelligent Vehicles and Advanced Driver Assistance Systems (I), pp. 444-450.
   - **Authors:**
     - Guo, Chunzhao, Toyota Central R&D Lab. Inc.
     - Mita, Seiichi, Toyota Tech. Inst.

2. **MC1.2**
   - **Title:** By-Standing Relay Vehicles, pp. 479-484.
   - **Authors:**
     - Dhakal, Sagar, Res. In Motion
     - Jia, Yupeng, Univ. of Rochester
     - Nguyen, Nam, Res. In Motion

### Session MC2

1. **MC2.1**
   - **Title:** Simulation Modeling of Visible Light Communication Channel for Automotive Applications, pp. 463-468.
   - **Authors:**
     - Lee, SeokJu, Yeungnam Univ.
     - Kwon, Jae Kyun, Yeungnam Univ.
     - Jung, Sung-Yoon, Yeungnam Univ.
     - Kwon, Young-Hoon, LED-IT Fusion Tech. Res. Center

2. **MC2.2**
   - **Title:** Radar Simulation in SiVIC Platform for Transportation Issues Antenna and Propagation Channel Modelling, pp. 469-474.
   - **Authors:**
     - Pechberti, Steve, IFSTTAR
     - Gruyer, Dominique, IFSTTAR
     - Vigneron, Vincent, Univ. d’Evry - Informatique, Biologie Intégrative etSystème

### Session MC3

1. **MC3.1**
   - **Title:** Tire Classification from Still Images and Video, pp. 485-490.
   - **Authors:**
     - Bulan, Orhan, Xerox Corp.
     - Bemal, Edgar, Xerox Corp.
     - Loce, Robert, Xerox Corp.
     - Wu, Wencheng, Xerox Corp.

2. **MC3.2**
   - **Title:** Application of Random Forest Algorithm to Classify Vehicles Detected by a Multiple Inductive Loop System, pp. 491-495.
   - **Authors:**
     - Shajahan, Sheik, Indian Inst. of Tech. Madras
     - Mohammed Ali, Indian Inst. of Tech. Madras
     - Joshi, Niranjan, Indian Inst. of Tech. Madras
     - George, Boby, Indian Inst. of Tech. Madras
     - Vanajakshi, Lelitha, Indian Inst. of Tech. Madras

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1. **MC4.1**
   - **Title:** A Smart Vision Systems for Advanced LGV Navigation and Obstacle Detection, pp. 508-513. Attachment
   - **Authors:**
     - Bertozzi, Massimo, Univ. of Parma - Italy
     - Bombini, Luca, Univ. of Parma - Italy
     - Broggi, Alberto, Univ. of Parma - Italy
     - Coati, Alessandro, Univ. of Parma - VisLab - The Artificial Vision andIntelligent

2. **MC4.2**
   - **Title:** Robust Free Space Detection in Occupancy Grid Maps by Methods of Image Analysis and Dynamic B-Spline Contour Tracking, pp. 514-521.
   - **Authors:**
     - Schreier, Matthias, TU Darmstadt
     - Willert, Volker, TU Darmstadt

Lefaudeux, Benjamin INRIA
Nashashibi, Fawzi INRIA

16:54-17:12 MC4.4
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Sterlin, Susanne Robert Bosch GmbH
Dietmayer, Klaus Univ. of Ulm

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Xie, Kunqing Peking Univ.
Song, Guojie PKU

Liu, Ruqi Peking Univ.
Xing, Xingxing Peking Univ.
Song, Guojie Peking Univ.
Xie, Kunqing Peking Univ.
Zhang, Ping Peking Univ.

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Zhang, Yi Tsinghua Univ.
Hu, Jianming Tsinghua Univ.
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Pei, Xin Tsinghua Univ.

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Jaworski, Pawel MIRA Ltd
Edwards, Tim MIRA Ltd
Burnham, Keith Coventry Univ.
Haas, Olivier Coventry Univ.

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An Extended Cell Transmission Model Based on Digraph for Urban Traffic Road Network, pp. 558-563.
Han, Xingguang Beijing Univ. of Tech.
Chen, Yangzhou Beijing Univ. of Tech.
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MC6 Travel Time Estimation and Prediction (Regular Session)
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Ernst, Joseph M. Oak Ridge National Lab.
Krogmeier, James V. Purdue Univ.
Bullock, Darcy Purdue Univ.

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Experienced Travel Time Prediction for Freeway Systems, pp. 570-575.
Yildirimoglu, Mehmet Ec. Pol. Federale de Lausanne
Geroliminis, Nikolaos Ec. Pol. Federale de Lausanne

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Chen, Hao Virginia Tech.
Rakha, Hesham A. Virginia Tech.

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Short-Term Travel Time Estimation and Prediction for Long Freeway Corridor Using NN and Regression, pp. 582-587.
Wang, J.Y. National Chiao Tung Univ.
Wong, K.I. National Chiao Tung Univ.
Chen, Y.Y. National Chiao Tung Univ.

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Uthaicharoenpong, Tawit Nanyang Tech. Univ.
Wang, Yu NANYANG Tech. Univ.
Frazzoli, Emilio Massachusetts Inst. of Tech.
Wang, Danwei Nanyang Tech. Univ.

16:18-16:36 MC7.2
Medina, Juan C Univ. of Illinois at Urbana-Champaign
Benekohal, Rahim F. Univ. of Illinois Urbana-Champaign

16:36-16:54 MC7.3
Miller, Jeffrey Univ. of Alaska Anchorage
Donat, Wolfram Univ. of Alaska Anchorage
Harris, John Univ. of Alaska Anchorage

16:54-17:12 MC7.4
Adaptive Control of Hyperbolic PDE System with Uncertain Parameters, pp. 608-612.
Wadoo, Sabiha New York Inst. of Tech.
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TTS Wireless Communication Systems in Japan*. Itami, Makoto Tokyo Univ. of Science

TPL2

09:00-09:45

Smart Maintenance and Operations Vehicles*. Adams, Ocie Alaska DOT

Towards Swarms of Self-Driving Automobiles*. Stiller, Christoph Karlsruhe Inst. of Tech.

TA1

11:00-11:18


Measuring Driver Awareness Based on Correlation between Gaze Behavior and Risks of Surrounding Vehicles, pp. 644-647. Mori, Masataka Nagoya Univ.

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<td>Qiao, Yijun, The Univ. of Texas at Austin Qiao, Fengxiang, Texas Southern Univ.</td>
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<td>Shen, Truman, Takata Holdings Inc.</td>
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<td>12:12-12:30</td>
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<td>Automated Transportation Transfer Detection Using GPS Enabled Smartphones</td>
<td>Stenneth, Leon, Univ. of Illinois Chicago; Thompson, Kenville, The Graduate Center CUNY; Stone, Waldin, The Graduate Center CUNY; Alowibdi, Jalal, Univ. of Illinois Chicago</td>
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<td>Xu, Yanyan, Shanghai Jiao Tong Univ.; Kong, Qing-Jie, Shanghai Jiao Tong Univ.; Liu, Yuncai, Shanghai Jiao Tong Univ.</td>
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<td>Zhou, Zhao, Shanghai Jiao Tong Univ.; Lin, Shu, Shanghai Jiao Tong Univ.; Xi, Yugeng, Shanghai Jiao Tong Univ.</td>
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<td>Edwards, Derek, Georgia Inst. of Tech.; Elangovan, Arun Kumar, RideCell, LLC; Watkins, Kari E., Georgia Inst. of Tech.</td>
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Deng, Weiwen Jilin Univ.
Zhao, Qingrong General Motors Company
Sun, Hao Jilin Univ.

Optical Flow Based Head Movement and Gesture Analysis in Automotive Environment, pp. 882-887.
Martin, Sujitha Univ. of California at San Diego
Tran, Cuong Univ. of California at San Diego
Tawari, Ashish Univ. of California at San Diego
Kwan, Jade Univ. of California at San Diego
Trivedi, Mohan M. Univ. of California at San Diego

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Platho, Matthias Univ. of Ilmenau
Eggert, Julian Honda Res. Inst. Europe GmbH

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Quintero M., Christian G. Univ. del Norte
Onate Lopez, Jose Universitat Politècnica de Catalunya
Cuervo Pinilla, Andres C. Univ. del Norte

Marinescu, Dan Trinity Coll. Dublin
Curn, Jan Trinity Coll. Dublin
Bouroche, Melanie Trinity Coll. Dublin
Cahill, Vinny Trinity Coll. Dublin

Inter-Vehicle Sensor Fusion for Accurate Vehicle Localization Supported by V2V and V2I Communications, pp. 907-914. Attachment
Conde Bento, Luis Manuel Inst. de Sistemas e Robotica
Nunes, Urbano Inst. de Sistemas e Robotica
Parafita, Ricardo Jorge Inst. de Sistemas e Robotica
Pedrosa, - Univ. de Coimbra

Hynicea, Ondrej Brno Univ. of Tech.
Honzik, Petr Brno Univ. of Tech.
Kucera, Pavel Brno Univ. of Tech.
Pavlata, Karel Brno Univ. of Tech.

Lu, Henghui Tsinghua Univ.
Zhang, Sheng Tsinghua Univ.
Lin, Xiaokang Tsinghua Univ.

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Mathibela, Bonolo Univ. of Oxford
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Posner, Ingmar Oxford Univ.
Newman, Paul Univ. of Oxford

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Revillard, Marc IFSTTAR
Gruyer, Dominique IFSTTAR
Pollard, Evangeline Inria-Rocquencourt

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Knoop, Victor L. Delft Univ. of Tech.
Buist, Peter J. Delft Univ. of Tech.
Tiberius, Christiaan C.J.M. Delft Univ. of Tech.
vAn Arem, Bart Delft Univ. of Tech.

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Zheng, Yuan Inst. of Automation, Chinese Acad. of Sciences
Peng, Silong Inst. of Automation, Chinese Acad. of Sciences

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Chen, Zezhi Kingston Univ.
Ellis, Tim Kingston Univ.
Velastin, Sergio A Kingston Univ.

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Raghavan, Ayaj Palo Alto Res. Center Inc. (PARC, A Xerox Company)
Price, Robert Palo Alto Res. Center Inc. (PARC, A Xerox Company)

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Tayyab
Dauwels, Justin Nanyang Tech. Univ.
Goh, Chong Yang Nanyang Tech. Univ.
Oran, Ali SMART
Fathi Loshani, Esmail Nanyang Tech. Univ.
Xu, Muye Nanyang Tech. Univ.
Menoth, Dhanya Nanyang Tech. Univ.
Mitrovic, Nikola Nanyang Tech. Univ.
Jaillet, Patrick MIT

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Leone, Marco Univ. of Salerno
Saggese, Alessia Univ. of Salerno
Vento, Mario Univ. of Salerno
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Gomaa, Walid Egypt-Japan Univ. of Science and Tech. (E-JUST)
El-Shishiny, Hisham IBM Center for Advanced Studies in Cairo

Graser, Anita Austrian Inst. of Tech.
Ponweiser, Wolfgang Austrian Inst. of Tech.
Dragaschin, Melitta Austrian Inst. of Tech.
Brändle, Norbert Austrian Inst. of Tech.
Widhalm, Peter Austrian Inst. of Tech.

Aslam, Javed Northeastern Univ.
Lim, Sejoon MIT
Rus, Daniela MIT

A Predictive Model for the Passenger Demand on a Taxi Network, pp. 1014-1019.
Moreira-Matias, Luis LIAAD - INESC TEC
Gama, João Faculdade de Ec. Univ. do Porto
Ferreira, Michel Inst. de Telecomunicações
Damas, Luis Geolink

Exploring the Relationship between Mobile Phone Call Intensity and Taxi Volume in Urban Area, pp. 1020-1025.
Veloso, Marco Univ. of Coimbra
Phithaktitnukoon, Culture Lab. School of Computing Science, Newcastle University
Santi Bento, Carlos Univ. of Coimbra

Framework of Experienced Route Planning Based on Taxis’ GPS Data, pp. 1026-1031.
Zhuang, Lijian Res. Center of ITS, Sun Yat-sen Univ.
Gong, Junfeng Res. Center of ITS, Sun Yat-sen Univ.
He, Zhaocheng Res. Center of ITS, Sun Yat-sen Univ.
Xu, Feifei Res. Center of ITS, Sun Yat-sen Univ.

Comparison of Two Dynamic Lane Separation Controllers, pp. 1032-1037.
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Hegyi, Andreas Delft Univ. of Tech.
Hoogendoorn, Serge Delft Univ. of Tech.
vankooten, Jaap Arane

Using a Centralized Controller to Optimize the Traffic of Intelligent Vehicles in a Single Lane Highway Provided with a Suicide Lane, pp. 1049-1054.
Reghelin, Ricardo Univ. Tecnológica Federal do Paraná
Arruda, Lúcia Valéria Univ. Tecnológica Federal do Paraná

Khayyer, Pardis The Ohio State Univ.
Wollaeger, James The Ohio State Univ.
Onori, Simona The Ohio State Univ.
Marano, Vincenzo The Ohio State Univ.
Ozguner, Umit The Ohio State Univ.
Rizzoni, Giorgio The Ohio State Univ.

Research on Shift Schedule of Hybrid Bus Based on Dynamic Programming Algorithm, pp. 1067-1071.
Yu, Hui-long Beijing Institute of Tech.
Xi, Junqiang Beijing Institute of Tech.
Chen, Yongdan Beijing Institute of Tech.
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Hill, Graeme NEWCASTLE Univ.
Blythe, Phil NEWCASTLE Univ.

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Adam, Christian Chemnitz Univ. of Tech.
Waniellik, Gerd Chemnitz Univ. of Tech.

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Speeding Prediction with a Mathematical Model and Its Validation, pp. 1085-1090.

Zhao, Guozhen Inst. of Psychology, Chinese Acad. of Sciences
Wu, Changxu Inst. of Psychology, Chinese Acad. of Sciences

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A Context Aware Intelligent Speed Adaptation System: A Field Operational Test, pp. 1091-1096.

Hoogendoorn, Raymond Delft Univ. of Tech.
Breukink, Johan Delft Univ. of Tech.
avan Arem, Bart Delft Univ. of Tech.

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Game Theory Algorithm for Intersection-Based Cooperative Adaptive Cruise Control (CACC) Systems, pp. 1097-1102.

Zohdy, Ismail Virginia Tech.
Rakha, Hesham A. Virginia Tech.

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Chien, Stanley Indiana Univ. Univ. Indianapolis
Li, Lingxi Indiana Univ. Univ. Indianapolis
Chen, Yaobin Purdue School of Engineering and Tech. IUPUI

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Intersection Management for Autonomous Vehicles Using lcacc, pp. 1109-1114.

Zohdy, Ismail Virginia Tech.
Kamalanathsharma, Raj Virginia Tech. Transportation Inst.
Rakha, Hesham A. Virginia Tech.

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Hallmark, Shauna Iowa State Univ. USA
Hawkins, Neal Iowa State Univ.

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Saiprasert, Chalermpol National Electronics and Computer Tech. Center
Pattara-atikom, Wasan National Electronics and Computer Tech. Center

16:36-16:54 TC2.3

GIS-Based Road Safety Evaluation Model for Cyclist in Campus of Higher Education Mega Center, pp. 1127-1131.

Hu, Jihua Sun Yat-sen Univ.
Zhong, Guangpeng Sun Yat-sen Univ.
Cheng, Zhifeng Sun Yat-sen Univ.
Wang, Dalei Beijing Jiaotong Univ.

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Investigating Pedal Errors and Multi-Modal Effects: Driving Testbed Development and Experimental Analysis, pp. 1137-
1142.

Tran, Cuong Univ. of California, San Diego
Doshi, Anup Univ. of California, San Diego
Trivedi, Mohan M. Univ. of California at San Diego

TC3

Advanced Technologies and Innovative Concepts for Promoting Traffic Safety and Mobility (Special Session)

Organizer: Wei, Heng Univ. of Cincinnati
Organizer: Li, Zhixia Univ. of Wisconsin-Madison

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Li, Zhixia Univ. of Wisconsin-Madison
Yang, Qingyan Iters Inc.
Wei, Heng Univ. of Cincinnati

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Przybyla, Jay Univ. of Utah
Taylor, Jeff Univ. of Utah
Jupe, Jason Armstrong Forensic Engineers
Zhou, Xuesong Univ. of Utah

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Du, Lizhen  
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Reuter, Stephan  
Meissner, Daniel  
Dietmayer, Klaus  

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Goldhammer, Michael  
Strigel, Elias  
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Brunsmann, Ulrich  
Doll, Konrad  
Dietmayer, Klaus  

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Zhu, Guanwen  
Mao, Qingzhou  
Chen, Long  
Li, Ming  
Li, Qingquan  

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Thielen, Daniel  
Lorenz, Tobias  
Hannibal, Marco  
Küster, Frank  
Plätter, Jens  

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Niikias, Vasileios  
Vlahogianni, Elieni  
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Nikias, Vasileios  
Vlahogianni, Elieni  
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Sundberg, Marcus  
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Sinn, Mathieu  
Yoon, Ji Won  
Calabrese, Francesco  

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Katma  

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Katma  

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Come, Etienne
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Do, Quoc Huy
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Chakraborty, Samarjit
Zelek, John
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Srinivasa, Ramakrishna
Agnihotri, Samar
Zhou, Kai
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Varadarajan, Karthik
ACIN, TU Vienna
Vincze, Markus
ACIN, TU Vienna
Liu, Fuqiang
Tongji Univ.

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Old Dominion Univ.

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Hirosaki Univ.
Onoguchi, Kazunori
Hirosaki Univ.

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Gaviria, Carlos
Univ. of Cauca

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Yin, Derek
Univ. of Alberta
Qiu, Tony
Univ. of Alberta

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Univ. of Nevada, Las Vegas
Khaddar, Romesh
Univ. of Nevada, Las Vegas
Kachroo, Pushkin
Univ. of Nevada, Las Vegas
Paz, Alexander
Univ. of Nevada, Las Vegas
Shilayan, Neveen
Univ. of Nevada, Las Vegas

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LIACC, Univ. of Porto
Rocha, Ana Paula
Faculty of Engineering of Porto (Portugal)
Oliveira, Eugénio
Faculty of Engineering, Univ. of Porto

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Wang, Feng
The Univ. of Mississippi
Wang, Dan
The Hong Kong Pol. Univ.
Gong, Zhenghu
National Univ. of Defense Tech.
Liu, Jiangchuan
Simon Fraser Univ.

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Annoni Jr., Ronald
Inst. Tecnologico de Aeronautica
Forster, Carlos H. Q.
Inst. Tecnologico de Aeronautica

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Huang, Shimeng
Univ. of Pittsburgh
Feron, Eric
Georgia Inst. of Tech.
Mao, Zhi-Hong
Univ. of Pittsburgh

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Univ. of Alaska Anchorage
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Univ. of Alaska Anchorage

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Chung Hua Univ.
Hu, Ta-Yin
National Cheng Kung Univ.

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Univ. of Idaho
Serageldin, Ahmed
Univ. of Idaho
Abdel-Rahim, Ahmed
Univ. of Idaho
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Imperial Coll. London
Univ. di Roma Tre.

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Farokhi Sadabadi, Kaveh
Haghani, Ali
Univ. of Maryland
Univ. of Maryland

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Nunes, Urbano
Pedrosa, Ricardo Jorge
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Inst. de Sistemas e Robotica
Inst. de Sistemas e Robotica -

Baek, Seunghwan
Son, Minhyuk
Boo, Kwangsuk
Kim, Heungsob
Song, Jeonghoon
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TNO Automotive Korea
Inje Univ.
Inje Univ.
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Hang Zhou Urban Infrastructure Construction and Development Cent

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Reuter, Stephan
Konrad, Marcus
Munz, Michael
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Univ. of Ulm
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Chalmers Univ. of Tech.

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Intelligent Systems Centre,
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Veelaert, Peter  Ghent Univ. - Univ. Coll. Ghent
Philips, Wilfried  Ghent Univ. - IBBT

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Yamada, Harutoshi  Center for Spatial Information Science, Univ. of Tokyo
Imai, Ryuichi  National Inst. of Land and Infrastructure Management, MLIT
Usui, Tomotaka  Center for Spatial Information Science, Univ. of Tokyo
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Motani, Mehul  National Univ. of Singapore

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Abdulhai, Baher  Univ. of Toronto
Abdelgawad, Hossam  Univ. of Toronto

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Li, Shuangshuang  Inst. of Automation, Chinese Acad. of Sciences
Shen, Zhen  Inst. of Automation, Chinese Acad. of Sciences
Zhu, Fenghua  Inst. of Automation, Chinese Acad. of Sciences
Xiong, Gang  Inst. of Automation, Chinese Acad. of Sciences

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Shibata, Tomohiro  Nara Inst. of Science and Tech.

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Vo, Quoc Bao  Swinburne Univ. of Tech.
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Linköping Univ.
Gundlegård, David
Linköping Univ.
Rydergren, Claes
Linköping Univ.

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Okuda, Hiroyuki
Koutsopoulos, Haris N.
Nagoya Univ.
Nagoya Univ.
Nagoya Univ.

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Gao, Yiqi  
Hedrick, J. Karl  
Borrelli, Francesco  
Univ. of California, Berkeley  
Volo Cars  
Univ. of California, Berkeley  
Univ. of California, Berkeley  
Univ. of California, Berkeley  

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Gabler, Hampton Clay  
Virginia Tech.  
Virginia Tech.  

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Wan, Nianfeng  
Mita, Seiichi  
Yang, Ming  
Toyota Tech. Inst.  
Clemson Univ.  
Toyota Tech. Inst.  
Shanghai Jiao Tong Univ.  

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Chakraborty, Samarjit  
Zelek, John  
Clausi, David  
Univ. of Waterloo  
Tech. Univ. München  
Univ. of Waterloo, Systems Design Engineering, Canada  
Univ. of Waterloo, Systems Design Engineering, Canada  

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General Motors Company  
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General Motors Company  

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Ruhr-Universität Bochum  

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Yamada, Toshiro  
Harvard University  
Univ. of California at San Diego  

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Chuang, Li-An  
Chen, Yi-Hsiang  
Luo, Ming-Fang  
National Taiwan Univ.  
National Taiwan Univ.  
National Taiwan Univ.  
National Univ. of Kaohsiung  
National Taiwan Univ.  
National Taiwan Univ.  
Chung-Shan Inst. of Science and Tech.  

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Doll, Konrad  
Brunsmann, Ulrich  
Dietmayer, Klaus  
Univ. of Applied Sciences  
Univ. of Applied Sciences  
Friedrich-Alexander-Universität Erlangen-Nürnberg  
Univ. of Applied Sciences  
Univ. of Applied Sciences  
Univ. of Ulm  

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Lee, Yi-shu  
Chan, Yi-Ming  
Fu, Li-Chen  
Hsiao, Pei-Yung  
Chuang, Li-An  
Chen, Yi-Hsiang  
Luo, Ming-Fang  
National Taiwan Univ.  
National Taiwan Univ.  
National Taiwan Univ.  
National Univ. of Kaohsiung  
National Taiwan Univ.  
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Systemtechnikund Bildauswertung  

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Wu, Cheng-En  
Luo, Min-Fang  
National Taiwan Univ.  
National Taiwan Univ.  
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National Univ. of Kaohsiung  
National Kaohsiung First Univ. of Science and Tech.  
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Toyota Central R&D Lab. Inc.  
Toyota Central R&D Lab. Inc.  
Toyohashi Univ. of Tech.  

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Pedestrian Detection (Regular Session)  

Dillingham  

Tawari, Ashish  
Trivedi, Mohan M.  
Univ. of California at San Diego  
Univ. of California at San Diego  

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Băr, Tobias FZI Forschungszentrum Informatik
Reuter, Jan-Felix FZI Forschungszentrum Informatik
Zöllner, J. Marius FZI Forschungszentrum Informatik

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Bonnin, Sarah bielefeld Univ. Cor-Lab.
Kummert, Franz Bielefeld Univ.
Schmuedderich, Jens Honda Res. Inst. Europe GmbH

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Rossetti, Rosaldo Univ. do Porto - LIACC
Oliveri Monreal, Cristina Faculty of Mechanical Engineering, Tech.

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Bifulco, Gennaro Univ. of Naples Federico II
Nicola
Pariota, Luigi Univ. of Naples Federico II
Galante, Francesco Univ. of Naples Federico II
Fiorentino, Anita Fiat Group Automobile

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Wu, Jianping Tsinghua Univ.
McDonald, Mike Univ. of Southampton

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Samé, Allou Univ. Paris-Est, IFSTTAR/GRETTIA
Aknin, Patrice Univ. Paris-Est, IFSTTAR/GRETTIA

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Millonig, Alexandra Austrian Inst. of Tech.
Slezynski, Marek Austrian Inst. of Tech.
Ulm, Michael Austrian Inst. of Tech.

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Mohammed Ali Indian Inst. of Tech. Madras
George, Bobby Indian Inst. of Tech. Madras

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Srivasava, Biplov IBM Res.
Tamilselvam, Srikanth IBM Res.

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Lin, Chih-Che Information and Communications Research Lab., Industrial Technology
Chan, Ching-Yao ITS, Univ. of California at Berkeley

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Moutari, Salissou Queen's Univ. Belfast
Marshall, Adele H. Queen's Univ. Belfast
Moutari, Salissou Queen's Univ. Belfast

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Special Sessions

**Special Session MA5: Calibration, Validation and Sensitivity Analysis of Traffic Simulation Models**

11:00-12:30, Monday September 17, 2012, Iliamna

Special Session Organizers:
- **Constantinos Antoniou.** Assistant Professor, National Technical University of Athens, Greece
- **Vincenzo Punzo.** Senior Researcher at European Commission - Joint Research Centre, and Assistant Professor at University of Naples Federico II, Italy
- **Mark Brackstone.** Consultant, IOMI, Southampton, U.K.

Abstract:
Over the past few decades, a lot of research activity has been devoted on the development of traffic simulation models, which have, at the same time, seen extensive use in the commercial sector. These models are often complex systems of components with many diverse types of inputs and parameters. A few of these can be directly measured in the real world and fixed at certain values, while suitable probability density functions need to be estimated for all the others. Such estimation processes are essential to replicate measured conditions and account for the variability in the real world. While originally this involved primarily trial-and-error type approaches, during the last decade the process for the management of uncertainty in simulation models has been formalized. Tools and frameworks have been developed for systematic calibration and validation of models and sensitivity analysis is receiving increasing attention among researchers in the field as the main tool for providing the required feedback on the whole process and additional insight into the model properties and behaviors. Papers on all aspects of calibration, validation and sensitivity analysis of traffic simulation models are suitable for this session, including papers focused on:

1. Algorithms and methodological framework development;
2. Demand and supply calibration and validation;
3. Case studies and applications.

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</table>
Abstract:
Every year, there are a large number of injuries and fatalities caused by vehicle crashes. Vehicle active safety systems can sense and identify potential crash events and prevent or mitigate the collision either by warning the driver or by taking appropriate control actions such as autonomous braking. Recent advances in advanced vehicle active safety technology have greatly improved vehicle safety and significantly reduced vehicle crashes, thus saving many lives. The objective of this special session is to bring leading researchers from academia and industry together to exchange the latest research results in the field. This session will provide an interdisciplinary forum for researchers, developers, and practitioners to present state-of-the-art algorithms, techniques, and system designs in vehicle active safety and discuss the potential problems and solutions in real applications.

Speakers and Contributed Presentations:
Abstract:
Recently, ACP-based Parallel System Theory (PST), has been proposed as a new mechanism for conducting operations of complex systems, especially those involving complexity issues of both engineering and social dimensions, such as transportation systems. Basically, this theory consists of three steps: 1) modeling and representation using Artificial societies; 2) analysis and evaluation by Computational experiments; and 3) control and management through Parallel execution of real and artificial systems. In some complex urban traffic networks, PST has been successfully applied and validated in the real world. However, when applying PST to Intelligent Transportation Systems (ITS), the related ITS theory and technologies all face new challenges and need to be further investigated. This special session is proposed under the umbrella of the Artificial Transportation Systems & Simulation Technical Activities sub-committee of IEEE ITS Society, and aims to bring together researchers and practitioners to discuss issues, challenges and future directions of PST applied to Transportation Management Systems and share their R&D findings as well as their experiences in related areas.

Speakers and Contributed Presentations:

11:00-11:18 TA7.1
Quadtree-Based Domain Decomposition for Parallel Map-Matching on GPS Data (I), pp. 808-813.
Xia, Yingjie Hangzhou Normal Univ.
Liu, Yuncai Shanghai Jiao Tong Univ.
Ye, Zhoumin Hangzhou Inst. of Service Engineering, Hangzhou Normal Univ.
Abstract:
The importance of applying advanced communication, detection, and computational technologies to highway transportation systems has been arising in different areas of transportation society, especially for addressing various safety and congestion issues at arterial corridors and intersections. The continuously increasing traffic demand has revealed the inability of traditional traffic control systems to accommodate traffic in a safe and efficient manner. At the same time, numerous innovative concepts and unconventional solutions, which apply advanced technologies into traffic management and control, have emerged extensively. They are intended to promote both mobility and safety of exiting transportation systems, or explore long-term solutions that are potentially applied in future practice. The advanced technologies and innovative concepts include but are not limited to:
Machine-learning and other artificial intelligence techniques in traffic control and management
Advanced detection technologies and computational methods in intersection signal control
Autonomous vehicle management, including autonomous vehicle control strategies at intersections
ITS solutions in collision avoidance systems and incidence management systems
Computational methods and advanced technologies in speed enforcement, travel time prediction, intersection delay estimation, traffic state estimation, vehicle classification, and bottleneck traffic operations
GIS-T technologies in addressing traffic safety and real-time traffic management
Simulation techniques in promoting traffic safety

This special session is designated to invite relevant experts in traffic operations and management as well as highway safety to share their latest research and practical experiences in the aforementioned areas of interests. The objective of the special session is to provide a discussion forum focusing on the emerging advanced technologies and innovative concepts for promoting traffic safety and mobility.

Speakers and Contributed Presentations:

16:00-16:18 TC3.1

Li, Zhixia
Yang, Qingyan
Wei, Heng
Univ. of Wisconsin-Madison
Iteris, Inc.
Univ. of Cincinnati

16:18-16:36 TC3.2
Simplified, Data-Driven, Errorable Car-Following Model to Predict the Safety Effects of Distracted Driving (I), pp. 1149-1154.

Przybyla, Jay
Taylor, Jeff
Jupe, Jason
Zhou, Xuesong
Univ. of Utah
Univ. of Utah
Armstrong Forensic Engineers
Univ. of Utah

16:36-16:54 TC3.3
Parts-Based Object Recognition Seeded by Frequency-Tuned Saliency for Child Detection in Active Safety, pp. 1155-1160.

Cheng, Shinko
Molineros, Jose
Owechko, Yuri
Levi, Dan
Zhang, Wende
Hrl Lab. LLC
HRL Lab. LLC
HRL Lab. LLC
General Motors, Advanced Tech. Center, Israel
General Motors, Res. and Development

16:54-17:12 TC3.4
Level of Service for Parking Facilities (I), pp. 1161-1165.

He, Yulong
Sun, Xiaoduan
Du, Lizhen
Ruan, Jinmei
Das, Subasish
Beijing Univ. of Tech.
Univ. of Louisiana
Beijing Univ. of Tech.
Beijing Municipal Inst. of City Planning & Design
Univ. of Louisiana

17:12-17:30 TC3.5
Driving Motion Capture Based Driver Behavior Analysis (I), pp. 1166-1171.
Shi, Jianjun                    Beijing Univ. of Tech.
Wei, Heng                     Univ. of Cincinnati
Shi, Shengqing                Beijing Univ. of Tech.

Special Session WA6: Intelligent Solutions for Air Transportation and Air Space – (ISATAS)
09:00-10:30, Wednesday September 19, 2012, Katmai

Special Session Organizers:
Eugénio Oliveira: Full Professor at the University of Porto
Vladimir Gorodetsky: Professor of Computer Science, Chief Scientists of Intelligent, Systems Laboratory of the St. Petersburg Institute for Informatics and Automation of the Russian Academy of Science
Ana Paula Rocha: Auxiliar Professor at the Department of Computing Engineering, University of Porto
António Castro: Software Engineer at TAP Portugal, the Portuguese airline company

Abstract:
The aim of the ISATAS Special Session is to foster the discussion on issues concerning the development of Intelligent Solutions for real Air Transportation and Air Space problems, including Disruption Management, Airline Operations Control, Air Space Operations Control, Air Traffic Management and Control, Airport Logistics, Airspace Logistics, etc. By intelligent solutions we mean any that are the outcome of an intelligent system that is able to autonomously react and adapt to changes in the dynamic environment. This will be achieved through autonomic decision-making as well as by including features representing all the involved players’ problem-solving intelligent capabilities to reach their ultimate goals and intentions in the Air Transportation domain.

On the basis of theories and methodologies borrowed from a wide spectrum of disciplines, such as the Social Sciences, Distributed Computing, Artificial Intelligence and Multi-agent Systems, and many others, many important issues arise which challenge and motivate many researchers and practitioners from multidisciplinary fields, as well as different technical and scientific communities. We encourage and welcome contributions reporting on how the scientific community and practitioners are using intelligent techniques and methodologies to address real Air Transportation problems.

Speakers and Contributed Presentations:

<table>
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<tr>
<th>Time</th>
<th>Title</th>
<th>Authors/Institutions</th>
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<tbody>
<tr>
<td>09:00-09:18</td>
<td>Towards an Autonomous and Intelligent Airline Operations Control (I), pp. 1429-1434.</td>
<td>Castro, António J. M. LIACC, Univ. of Porto Rocha, Ana Paula Faculty of Engineering of Porto (Portugal) Oliveira, Eugénio Faculty of Engineering, Univ. of Porto</td>
</tr>
<tr>
<td>09:36-09:54</td>
<td>WA6.3</td>
<td></td>
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Annoni Jr., Ronald
Inst. Tecnologico de Aeronautica

Forster, Carlos H. Q.
Inst. Tecnologico de Aeronautica

09:54-10:12 WA6.4


Huang, Shimeng
Univ. of Pittsburgh

Feron, Eric
Georgia Inst. of Tech.

Mao, Zhi-Hong
Univ. of Pittsburgh
### Abstracts

#### Technical Program for Monday September 17, 2012

<table>
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<th>Time</th>
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<tr>
<td>08:00-09:30</td>
<td><strong>Pioneering the Wild Frontier in Intelligent Transportation</strong></td>
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<td>Peters, Joseph</td>
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<td>USDOT/Federal Highway Administration</td>
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<td>09:30-10:30</td>
<td><strong>State of the ITS Industry</strong></td>
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<td>Horsley, John</td>
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<td>American Association of State Highway &amp; Transportation Officials</td>
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<td>11:00-11:18</td>
<td><strong>Performance Limitations in Vehicle Platoon Control</strong>, pp. 1-6</td>
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<td>Solyom, Stefan</td>
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<td>Volvo Car Corp.</td>
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<td>Coelingh, Erik</td>
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<td>Volvo Car Corp.</td>
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Joe has over 40 years of R&D experience including positions with the US DOT's Intelligent Transportation Systems Joint Program Office, a large government consulting company, US Air Force Systems Command, the US Army Research Institute for the Behavioral and Social Sciences, and, in the very beginning of his career, a research position at FHWA's Fairbank Highway Research Station. Dr. Peters is a graduate of Loyola College in Baltimore, MD, where he majored in Biology. He received his M.A. in Human Factors Psychology and his Ph.D. in Applied-Experimental Psychology from The Catholic University of America. He is the recipient of the Secretary of Transportation's Award for Meritorious Achievement and the FHWA Administrator's Award for Superior Achievement.

Over 50 years ago, the federal government pioneered the building of the interstate highway system in the US. Over 20 years ago, the federal government pioneered a new era defined by the “Intelligent Vehicle-Highway Systems Act of 1991.” Today, the federal challenge is to pioneer the transportation frontiers in telecommunications, big data, and automation in ways that will revolutionize the ways we live.

Dr. Joseph I. Peters, Director of the Federal Highway Administration’s Office of Operations Research and Development, will address the role that the federal government plays in creating R&D opportunities for electrical and electronics engineers who are pioneering the frontier in intelligent transportation. He will briefly highlight provisions of new legislation entitled, “Moving Ahead for Progress in the 21st Century Act,” especially as they apply to intelligent transportation research. He will describe activities and opportunities at the Turner-Fairbank Highway Research Center and its new Saxton Transportation Operations Laboratory, as well as ongoing efforts as part of US DOT’s connected vehicle research.

Dr. Joseph I. Peters directs a multi-disciplined staff in planning, conducting, and coordinating research, development, test, evaluation, and technology transfer initiatives aimed at improving traveler mobility on the Nation's highways. Over the past five years, his office has accomplished pioneering research and development of cooperative adaptive cruise control systems showing significant throughput, fuel savings, and environmental benefits associated with reduction of stop and go traffic. His office is currently developing and testing communications technologies for broadcasting traffic signal phase and timing information to vehicles and pedestrians as well as cooperative vehicle-highway communications technologies for enabling eco drive applications at signalized intersections. With the new Saxton Transportation Operations Laboratory up and running, his office will be providing new opportunities for senior level and student fellowships on site at the lab.

John Horsley, the Executive Director of the American Association of State Highway and Transportation Officials (AASHTO), will discuss about some great examples of how states across the country are turning to high-tech solutions to solve their transportation challenges.

In 1999, John Horsley became Executive Director of ASHTO, which advocates policies and provides technology leadership on behalf of States to improve the Nation’s transportation system.

Previously, Horsley was nominated by the President and confirmed by the Senate as Associate Deputy Secretary of Transportation where he served from 1993 to 1999 as the Department’s advocate for intermodal policies, quality of life initiatives and as liaison to State and Local Governments, US Congress, and transportation constituencies.

A native of the Northwest, Horsley was elected to five terms as County Commissioner in Kitsap County, a community just west of Seattle. He is a graduate of Harvard, an Army veteran, a former Peace Corps volunteer and Congressional aide, and did graduate study at Georgetown University. He is Past President of the National Association of Counties, and was founding Chairman of the Rebuild America Coalition.

He and his wife Deanna have been married for 36 years and have two children: Adam and Jennifer.

One of the major benefits of driving vehicles in controlled, close formations such as platoons is that of reduced air drag. However, this will set hard performance requirements on the system actuators, sensors and controllers of each vehicle. This paper analyzes the effects of fundamental limitations on the longitudinal and lateral control performance of a platoon and the effects on following distance, perceived safety and fuel economy. The trade-off between minimizing fuel consumption and maintaining a safe following distance is

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**MA1 Automated Vehicle Operation 1 (Regular Session)**

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<td>11:00-11:18</td>
<td>MA1.1</td>
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analyzed and described. The analysis is based on fundamental properties of linear systems such as Bode's
phase area relation. Design guidelines are proposed and results from vehicle testing are presented.

11:18-11:36 MA1.2
Temporal Analysis of the Gate Concept As Enabler for Highly Automated Driving Based on the Conduct-By-Wire Approach, pp. 7-12

Geyer, Sebastian
Karg, Melanie
Hakuli, Stephan
Winner, Hermann
Franz, Benjamin
Kauer, Michaela
Tech. Univ. Darmstadt
Tech. Univ. Darmstadt
IPG Automotive GmbH
Tech. Univ. Darmstadt
Tech. Univ. Darmstadt
Tech. Univ. Darmstadt

Conduct-by-Wire (CbW) is an innovative vehicle guidance concept that shifts the vehicle control task from the stabilization level to the guidance level. Instead of continuous stabilization on a designated trajectory – using the conventional control elements for manual steering, braking and accelerating – a CbW vehicle is controlled by means of maneuver commands. One important element on the way to realizing CbW might be the gate concept that consists in a segmentation of the vehicle guidance task and the identification of decision points during the execution of a driver’s maneuver command. This article introduces an approach for the analysis of the time available for decision-making in systematically derived scenarios. For the first time, the results offer the basis for a suitability evaluation of the gate concept and thus a fundamental contribution to the technical feasibility assessment of CbW.

11:36-11:54 MA1.3
A Scaled-Down Traffic System Based on Autonomous Vehicles: A New Experimental System for ITS Research, pp. 13-18

He, Wen
Guisheng, Chen
Shuming, Tang
Deyi, Li
Mu, Guo
Tianlei, Zhang
Feng, Jia
Feng, Jin
Tsinghua Univ.
Chinese Inst. of Electronic System Engineering
Chinese Acad. of Sciences
Chinese Inst. of Electronic System Engineering
Tsinghua Univ.
Tsinghua Univ.
Military Transportation Inst.
Xi’an Communication Inst.

In this paper, we present our recent efforts on developing a physical environment for performing traffic experiments. The two main characteristics of this environment are: (1) the whole environment is scaled down from the real traffic, (2) the traffic behaviors are performed by numbers of miniature autonomous vehicles. Performing traffic experiments in an actual environment has long been a hard problem. Moreover, modeling traffic phenomena is also a tough task, due to the complexity of the natural traffic system. However, with the rapid development of autonomous vehicle technology, we have an opportunity to improve these problems from a new perspective. That is using autonomous vehicles to perform traffic experiments. But with the limitations in cost and land availability, directly using full size autonomous vehicles also seemed unrealistic. Thus, we built a 1/10 scaled-down traffic experimental system (SDTS) with more than 50 miniature autonomous vehicles. The environmental design, autonomous vehicles developing, agent modeling, traffic control, and real-time monitoring is considered systematically in system design. And this SDTS can be used as a repeatable, appraisable, and verifiable experimental platform for traffic researches, such as testing traffic solutions, verifying key technologies in intelligent vehicles, and performing experiments about ITS. By now, the SDTS has supported a series of workshops, exchange activities and competitions in China.

11:54-12:12 MA1.4
A New Fuzzy Speed Control Strategy Considering Lateral Vehicle Dynamics, pp. 19-24

Sezer, Volkan
Ercan, Ziya
Heceoglu, Hasan
Gokasan, Metin
Bogosyan, Seta
Istanbul Tech. Univ.
Istanbul Tech. Univ.
Istanbul Tech. Univ.
Istanbul Tech. Univ.
Istanbul Tech. Univ.

This paper introduces a new speed control strategy for autonomous/semi-autonomous navigation of ground vehicles. Different from the previous studies, steering angle is considered in addition to speed error and integral of the speed error. Because of the highly nonlinear nature of vehicle model, fuzzy logic strategy is used for controller design. Vehicle modeling equations and used parameters are also illustrated in the paper. Simulations are carried out to verify and demonstrate the effectiveness of the new method over the classical one which does not consider the steering angle. Both of these two methods have similar performances when steering angle is relatively low. However, in a more aggressive steering scenario, classical approach fails and vehicle loses its yaw stability while our method still continues to track the speed with a stable yaw dynamics.

11:00-11:18 MA2.1
Highway Test of V2V Mesh Communications Over WSN, pp. 25-30

Naranjo, Jose
Talavera, Edgar
Anaya, Jose Javier
Jiménez, Felipe
Zato, José Gabriel
Gomez, Nuria
Univ. Pol. de Madrid
Univ. Pol. de Madrid
Univ. Pol. de Madrid
Univ. Pol. de Madrid
Univ. Pol. de Madrid

Wireless vehicular communications are one of the most important technologies in the ITS field to improve the transport safety as well efficiency impact. Several standards definitions, hardware developments, research projects, use cases definitions and field operational tests are currently under deployment in order to accelerate the market availability of this technology. Nevertheless, though the possible applications of vehicular communications are defined, there is a lack of availability of completely functional communication technology to support these applications. In this paper we present the results of a V2V communications field operational test using Wireless Sensor Networks (WSN) as nodes of the VANET and three vehicles that circulate on public highways in free flow traffic situations. These results show that this communications technology is able to support continuous mesh data transmission with enough features of efficiency and reliability to be used as main data source in a
Vehicle flow statistics are utilized for performance evaluation. By using clustered frames containing different vehicles, the fault of channel measurement and ray tracing simulations are used. Applying channel-aware transmission, the Quality of Service (QoS) level of human communication can be obtained and simultaneously, the power consumption is significantly reduced. In addition, the fraction of active FCD devices on the highway can be increased.

Inter-vehicle communication is said to be part of the Next Generation Internet where vehicles can communicate to other vehicles or a base station in ad hoc manner to realize the Intelligent Transport System (ITS) which can increase road safety and provide traffic information etc. Several existing routing protocols are extensively studied for inter-vehicle communication. In this paper, we proposed the "Multi-Adaptive Routing Protocol" (MAR) which compared AODV and DSR protocols on the condition of with and without obstacle. The results show that MAR performs better than AODV and DSR protocols cause the throughput of MAR higher than AODV and DSR, but packet drop and packet collision are lower than ones.

This paper is a step towards a realization of a new way of controlling the ordinary traffic at urban intersections. The right of way is addressed to each vehicle individually, according to an optimized sequence. The paper aims to deepen the feasibility issue of a protocol dedicated to human drivers (ordinary vehicles). The proposed protocol is tested through a realistic intersection where vehicles are safely directed through the intersection. The implementation has raised some issues related to wireless communication and positioning systems. These issues are discussed and solutions are given for controlling particular intersections in urban area.
This paper describes a target detection system on transport infrastructures, based on monocular vision, for applications in the framework of Intelligent Transportation Systems (ITS). Using structured elements of the image, a vanishing point extraction is proposed to obtain an automatic calibration of the camera, without any prior knowledge. This calibration provides an approximate size of the searched targets (vehicles or pedestrians), improving the performance of the detection steps. After that, a background subtraction method, based on GMM and shadow detection algorithms, is used to segment the image. Next a feature extraction, optical flow analysis and clustering methods are used to track the objects. The algorithm is robust to camera jitter, illumination changes and shadows. Therefore it can work indoor and outdoor, in different conditions and scenarios, and independent of the position of the camera. In the paper, we present and discuss the results achieved up to date in real traffic conditions.

Takahashi, Toshimitsu The Univ. of Tokyo
Kim, HyungKwan The Univ. of Tokyo
Kamijo, Shunsuke The Univ. of Tokyo

Surveillance and safety systems for pedestrians and bicyclists are becoming much more important because there continue to be a large number of traffic accidents that involve vulnerable road users. In this paper, we propose an urban road user classification framework using local feature descriptors and hidden Markov models (HMM). Our framework achieved pedestrians, bicyclists, motorcyclist classification in high accuracy. The framework consists of two classification methods: pedestrian-bicyclist classification and bicyclist-motorcyclist classification. First, we discriminate between pedestrians and bicyclist-like objects using histograms of oriented gradients (HOG) based classifiers. We implemented a cascade classifier using generic HOG and our original local feature descriptor called co-occurrence semantic HOG. Bicyclist-like objects mainly consist of bicyclists and motorcyclists. We focused on the objects’ leg motions and classify them using the hidden Markov models (HMM)-based motion models. We conducted experiments with real traffic scenes to evaluate the performance of our framework. The experiments for pedestrian-bicyclist classification and bicyclist-motorcyclist classification are conducted independently and both methods achieve nearly 90% on classification.

Magelmose, Andreas Aalborg Univ.
Prioletti, Antonio Univ. of Parma
Trivedi, Mohan M. Univ. of California at San Diego
Broggi, Alberto Univ. of Parma
Moeslund, Thomas B. Aalborg Univ.

This paper introduces a part-based two-stage pedestrian detector. The system finds pedestrian candidates with an AdaBoost cascade on Haar-like features. It then verifies each candidate using a part-based HOG-SVM doing first a regression and then a classification based on the estimated function output from the regression. It uses the Histogram of Oriented Gradients (HOG) computed on both the full, upper and lower body of the candidates, and uses these in the final verification. The system has been trained and tested on the INRIA dataset and performs better than similar previous work, which uses full-body verification.

MA3.5 Two-Stage Part-Based Pedestrian Detection, pp. 73-77

MA4.3 Vision-Based Lateral Position Improvement of RADAR

Driver assistance systems support overstrained and affected drivers and become more and more essential for series-production vehicles. In this paper a procedure for detection of a misaligned or blocked sensor system, including a radar and a camera sensor, will be introduced. It is important to inform the driver if an automatic headlight control is working reliable, in other words without limitations caused by external influence (e.g. dirt on the windscreen). The blockage detection algorithm is based on the fusion result of electronic radar measurements and a vision based head- and taillight detection algorithm. Results of the blockage detection algorithm are evaluated on misaligned measurements and online in a vehicle test system.

Magelmose, Andreas Aalborg Univ.
Prioletti, Antonio Univ. of Parma
Trivedi, Mohan M. Univ. of California at San Diego
Broggi, Alberto Univ. of Parma
Moeslund, Thomas B. Aalborg Univ.

This paper describes a new and unique merger of radar technology to automotive powertrain control systems, in particular, with the goal of increasing fuel efficiency in hybrid electric vehicles. The power management system can make more intelligent decisions impacting fuel consumption and emissions if it has knowledge of objects surrounding the vehicle. Furthermore, this paper proposes a scheme for creating a cost effective radar sensor. Discussed in detail is how such a system capable of providing the necessary information for powertrain control applications may be designed specifically to minimize cost and complexity. Finally, an evaluation and prototyping platform consisting of both hardware and software is described, which allows for evaluation and verification of the design tradeoffs. The same platform will also provide the future possibility of the powertrain control algorithm verification on the road as a later step of this research.
Detecting vehicles in front by sensors mounted on an ego-vehicle is an essential element of Advanced Driver Assistance Systems (ADAS). Although millimeter-wave radar sensors are very robust at detecting vehicles, the lateral position resolution is very low. However, a more precise lateral position would not only improve the performance of existing ADAS but it would also enable a wide range of additional applications. In this paper, we propose a method for improving the lateral position of radar sensor detections by fusing these with a vision sensor. Our method is based on a robust symmetry axis detection of vehicles rear sides. In contrast, to the typical approach of detecting symmetry by means of edges, we use a patch-matching-based approach together with a robust cost function. The initial lateral position of the radar detection is improved by conducting a local symmetry search in the image region corresponding to the objects detected by the radar. The experimental results show that the proposed method is able to improve the lateral position accuracy by a factor of seven. Furthermore, additional consistency checks discover miss-detections of the symmetry axis thus ensuring that the lateral position never drops below the accuracy of the radar detection.

This paper presents a rear obstacle detection system based on depth information obtained from Kinect sensor. The proposed system can be used for parking assistance applications and backup aid. It improves the false detection rate in single view based algorithms by using depth information. In addition, real distance to obstacles can be calculated using depth information. It is possible to alert the driver effectively according to distance. Although the proposed system is based on conventional edge detection algorithm, we confirm the feasibility of combining depth map with color image by improving the accuracy of detection. Experimental results show that depth fusion based obstacle detection algorithm is more accurate than single view based algorithms in terms of false detection rate.

In the field of traffic simulation, the calibration of uncertain inputs against real data is usually taken to cover the epistemic uncertainty regarding the un-modeled details of the phenomena and the aleatory not predicted by the models. For this reason, model parameters are usually indirectly derived by means of an optimization framework, which tries to maximize the fit between real and simulated measures of the traffic system. This is the case, for example, of the calibration of car-following models' parameters against vehicle trajectory data. Only recently, it has been proven that the capability of the optimization framework to provide the parameters' values that allow the car-following model reproducing real trajectories at its best is strictly connected to the setup of the optimization framework itself. This, in particular, entails the necessity to carefully choose an appropriate combination of optimization algorithm and measure of goodness of fit (GOF). In this study, the authors focus the attention on this latter element of the problem. Specifically, it is claimed here that the commonly used GOFs are not able to capture the dynamics of the time-series which calibration is performed against. Therefore, a spectral analysis based approach to evaluate the overall performance of the simulation model in the objective function is proposed. The new measure of goodness of fit is tested in the calibration of the Intelligent Driver Model against synthetic trajectory data. Result

**IEEE ITSC 2012 PROGRAM**
Microscopic traffic simulation models have become very popular in the evaluation of transportation engineering and planning practices in the past few decades. To achieve high fidelity and credibility of simulations, a model calibration and validation must be performed prior to deployment of the simulator. In this paper, we proposed an effective calibration method of the microscopic traffic simulation model. The model is based on the cellular automaton, which allows fast large-scale real-time simulation. For its calibration, we utilized a genetic algorithm which is able to optimize different parameters much better that a human expert. Furthermore, it is possible to readjust the model to given field data coming from standard surveillance technologies such as loop detectors in our case. We have shown that the precision of simulations can be increased by 20% with respect to a manually tuned model.

The objective of this study is to analyze the effectiveness of speed measures to improve capacity at the roundabouts under near saturation level. Alaska Department of Transportation and Public Facilities introduced measures of using speed humps on multilane roundabout to slow down vehicular traffic entering the roundabout which might improve safety and capacity. Spot speed, vehicular volume and queued data have been collected and analyzed before and after the speed measures. Results show use of speed humps bring insignificant change in speed profiles through the roundabout with little or no effect on capacity. In addition, measured and calculated queue lengths also show no significant change.

The London Congestion Charging (LCC) scheme was initially introduced on 17 February 2003. Being the largest of its kind and employing advanced technology, it marked a major innovation in the field of urban road user charging and provided inspiration to several other cities worldwide. Nine years on, and following a number of operational changes that have taken place, this study analyzes successes and pitfalls, and identifies potential future opportunities in the light of latest technological developments in the field of cooperative Intelligent Transport Systems (ITS). The analysis concentrates primarily on the LCC scheme itself, but draws broader conclusions about the future of urban road charging in general.

Modern societies rely on efficient transportation systems for sustainable mobility. In this paper, we perform a large-scale and empirical evaluation of a dynamic and distributed taxi-sharing system. The novel system takes advantage of nowadays widespread availability of communication and computation to convey a cost-efficient, door-to-door and flexible system, offering a quality of service similar to traditional taxis. The shared taxi service is assessed in a real-city scenario using a highly realistic simulation platform. Simulation results have shown the system's advantages for both passengers and taxi drivers, and that trade-offs need to be considered. Compared with the current taxi operation model, results show a increase of 48% on the average occupancy per traveled kilometer with a full deployment of the taxi-sharing system.
The superior performance of the proposed mechanism is demonstrated on several simulated routing experiments in comparison to user equilibrium and system optimum.

11:54-12:12 MA6.4
Assessing Economic Impacts of Implementing a Vehicle of Miles Traveled Fee in Nevada, pp. 155-159
Paz, Alexander  Univ. of Nevada, Las Vegas
Nordland, Andrew  Univ. of Nevada, Las Vegas
Khan, Alauddin  Nevada Department of Transportation

This study develops a regression model to estimate the number of miles driven by households in Nevada, using data from the 2009 National Household Travel Survey. The regression model is designed to be sensitive to changes in the cost to drive. Hence, the model is used to evaluate different mechanisms used to charge for the use of the highway system. In particular, two alternative Vehicle Miles of Travel (VMT) Fees are compared with the existing fuel tax system. In each case, it was estimated how different houses experience different effects on charges as a consequence of different fuel efficiencies. The analysis performed considers the average changes in the household tax burden and VMT as well as the aggregated change in VMT and the corresponding change in revenue collected.

12:12-12:30 MA6.5
TruCentive: A Game-Theoretic Incentive Platform for Trustworthy Mobile Crowdsourcing Parking Services, pp. 160-166
Hoh, Baik  Nokia Res. Center
Yan, Tingxin  Univ. of Massachusetts, Amherst
Deepak, Ganesan  Univ. of Massachusetts, Amherst
Ken, Tracton  Nokia Res. Center
Toch, Iwuchukwu  Nokia Res. Center
Juong-Sik, Lee  Nokia Res. Center

The shortage of parking in crowded urban areas causes severe societal problems such as traffic congestion, environmental pollution, and many others. Recently, crowdsourced parking, where smartphone users are exploited to collect real-time parking availability information, has attracted significant attention. However, existing crowdsourced parking information systems suffer from low user participation rate and data quality due to the lack of carefully designed incentive schemes.

In this paper, we address the incentive problem of trustworthy crowdsourced parking information systems by presenting an incentive platform named TruCentive, where high utility parking data can be obtained from unreliable crowds of mobile users. Our contribution is three-fold. First, we provide hierarchical incentives to stimulate the participation of mobile users for contributing parking information. Second, by introducing utility-related incentives, our platform encourages participants to contribute high utility data and thereby enhances the quality of collected data. Third, our active confirmation scheme validates the parking information utility by game-theoretically formulated incentive protocols. The active confirming not only validates the utility of contributed data but re-sells the high utility data as well. Our evaluation through user study on Amazon Mechanical Turk and simulation study demonstrate the feasibility and stability of TruCentive incentive platform.

11:00-11:18 MA7.1
Prediction of Freeway Traffic Incident Delay Based on Simulation, pp. 167-171
Zhang, Hongbin  Southeast Univ.
Ni, Fujian  Southeast Univ.
Yang, Shunxin  Southeast Univ.

In order to study the influence of different vehicles to incident delay, traffic simulation is applied to make the delay predictions. Three major parts, respectively the establishment of simulation platform and parameter calibration, survey and calculation of traffic data, and case study, are described in the paper. For the establishment of simulation platform and parameter calibration, at first, the local parameter and the global parameter, which need to be calibrated while making the delay simulation, are chosen. Then, the performance evaluation index and the performance evaluation target are proposed and the minimum simulation times are determined based on the statistical analysis. Finally, the flow of parameter calibration is designed, which first calibrates the local parameter and then calibrates the global parameter. For the survey and calculation of traffic data, at first, based on the toll data, the calculation method of the vehicle data, the evaluation index data and the incident delay data, are proposed. Then, these data are taken as the true values to calibrate the parameters and validate the simulation delay. At the same time, the incident duration is predicted. For case study, this paper takes six traffic incidents which took place in link 170002 of Nanjing-Nantong freeway (hereinafter as Ning-Tong freeway) in 2010 as sample data to calibrate the parameters and simulate the delay, and further compares the simulation delay with the true delay. The simulation result

11:18-11:36 MA7.2
An Unsupervised Feature Learning Approach to Improve Automatic Incident Detection, pp. 172-177
Ren, Jimmy SJ.  City Univ. of Hong Kong
Wang, Wei  City Univ. of Hong Kong
Wang, Jiawei  USTC-CityU Joint Advanced Res. Centre
Liao, Stephen  City Univ. of Hong Kong

Sophisticated automatic incident detection (AID) technology plays a key role in contemporary transportation systems. Though many papers were devoted to study incident classification algorithms, few study investigated how to enhance feature representation of incidents to improve AID performance. In this paper, we propose to use an unsupervised feature learning algorithm to generate higher level features to represent incidents. We used real incident data in the experiments and found that effective feature mapping function can be learnt from the data crosses the test sites. With the enhanced features, detection rate (DR), false alarm rate (FAR) and mean time to detect (MTTD) are significantly improved in all of the three representative cases. This approach also provides an alternative way to reduce the amount of labeled data, which is expensive to obtain, required in training better incident classifiers since the feature learning is unsupervised.

11:36-11:54 MA7.3
Advanced Method of Detection of Unnecessary Conflicts of Traffic Flows, pp. 178-181
Dadic, Ivan  Faculty of Traffic and Transportation Sciences
Relations between the traffic flows in intersections are one of the causes of reduced throughput. Avoiding the unnecessary conflicts and reduction of breakage of traffic flows are one of the possible significant factors that may favorably affect the increase in intersection capacity. Relationships among the traffic flows in the form of unnecessary conflicts occur mainly at intersections, and also on roads between intersections, and are caused by the organization and direction of traffic flow in the network. For advanced identification of unnecessary intersections, modern IT solutions are used as a novelty approach in research and visualisation of this phenomenon. The goal of this research is to create a computer tool based on open source technologies that use data stored in a GIS environment about the movement of the users within the transport network for identification of unnecessary conflicts by monitoring the flow of vehicles and deviations in speed. Further development and research will be focused on creating algorithms for automatic identification of unnecessary conflicts based on gathered input data.

As part of a number of Intelligent Transportation (ITS) applications aimed at providing an environmental benefit, eco-approach technology is one that is feasible in the near-term. An eco-approach application uses Signal Phase and Timing (SPaT) and intersection map information of signalized intersections to provide drivers with recommendations in order to encourage “green” driving while approaching, passing through, and departing the intersections. Upon receiving SPaT information, in-vehicle systems calculate and provide speed advice to the driver, allowing the driver to adapt the vehicle’s speed to pass through the upcoming signal on green or to decelerate to a stop in the most eco-friendly manner. Eco-approach methods have been proposed and simulated showing promising results. In this study, both simulation experimentation and field operational testing have been carried out to demonstrate the eco-approach application and to quantify its potential fuel and carbon dioxide (CO2) savings. Furthermore, it has been shown that a communication platform based on a 4G/LTE network link and a cloud-based server infrastructure is effective and sufficient for this kind of application. It was found in both the simulation experiment and the field operational testing that on average 14% fuel and CO2 savings can be achieved.

This paper proposed a traffic incident detection system that can report the occurrence of traffic incidents, which occur between detectors. Based on the previously proposed dynamic time warping algorithm, this incident detection system monitors and assesses changes at upstream and downstream sites. Then, if the upstream-downstream changes are associated with traffic incidents, the system raises an alarm and report CCTV images on site, which are sent to traffic operators to further response. Performance evaluations are conducted using real-world traffic data where it is shown that the incident detection algorithm used in the proposed system achieves 94% detection rate and low false alarm rate. We also show that the proposed incident detection system outperforms a previously proposed incident detection system algorithm.

The concept of Eco-driving is proposed to reduce the fuel consumption of vehicles while maintaining dynamic performance. MPC controller has been introduced to achieve comprehensive goals including safety, fuel consumption and comfort of driving. Yet the information of the surrounded vehicles and road conditions have not been fully utilized. An enhanced algorithm taking the driving style of preceding vehicle, host vehicle drivers and road information into account is proposed in this paper. It is tested by the results of simulation that the controller becomes more flexible and can reduce the fuel consumption of the controlled vehicle in different working conditions with the help of the enhanced

- Hiriotappa, Kittipong
- Thajchayapong, Suttipong
- Likikhajorn, Chakrit
- Poolsawat, Anurak

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**Enhanced Eco-Driver System Based on V2X Communication**, pp. 200-205
- Chen, Yuxiao
- Zhang, Dezhaol
- Li, Keqiang

The concept of Eco-driving is proposed to reduce the fuel consumption of vehicles while maintaining dynamic performance. MPC controller has been introduced to achieve comprehensive goals including safety, fuel consumption and comfort of driving. Yet the information of the surrounded vehicles and road conditions have not been fully utilized. An enhanced algorithm taking the driving style of preceding vehicle, host vehicle drivers and road information into account is proposed in this paper. It is tested by the results of simulation that the controller becomes more flexible and can reduce the fuel consumption of the controlled vehicle in different working conditions with the help of the enhanced
We present two approaches to solve the problem of intersection detection in an unstructured outdoor setting. The first is a natural extension of the popular VFH obstacle avoidance algorithm. It detects intersections and tracks, over a period of time, the angles at which gaps in the robot's certainty grid (CG) are first observed. The second approach uses techniques from image processing and computational geometry on the certainty grid image, to extract a skeleton of the navigable region, thus providing the intersections. We show experimental results portraying intersection detection due to both methods and show the results. On the whole, we found that the robot was able to detect all possible intersections.

Fuel Efficiency Driver Assistance System for Manufacturer Independent Solutions, pp. 212-217

Energy efficiency has become a major issue in modern trade, business and environmental perception. While the next generation of zero emission propulsion systems are still under development, it is already possible to increase fuel efficiency in regular vehicles by applying a more fuel efficient driving behaviour. This particularly holds true for transport companies, where even small percentage savings can accumulate to huge absolute savings. Although there are common fuel efficiency guidelines, they are often imprecise and not adapted to a specific vehicle. Furthermore drivers may not even know the fuel efficiency rules or lack the motivation to apply them in practice. In this paper, an online driving assistance system is presented that assist drivers during their journeys by giving them fuel efficiency guidelines that are suited for the current situation and vehicle. The driver assistance system uses an internal manufacturer independent model that can adapt to the current vehicle solely based on online CAN-Bus data.

The paper introduces an active way to detect vegetation which is at front of the vehicle in order to give a better decision-making in navigation. Blowing devices are to be used for creating strong wind to effect vegetation. Motion compensation and motion detection techniques are applied to detect foreground objects which are presumably judged as vegetation. The approach enables a double-check process for vegetation detection which was done by a multi-spectral approach, but more emphasizing on the purpose of passable vegetation detection. In all real world experiments we carried out, our approach yields a detection accuracy of over 98%. We furthermore illustrate how the active way can improve the autonomous navigation capabilities of autonomous ground vehicles.
Autonomous driving in urban environments is potentially dangerous since a malfunction of vehicle guidance systems can lead to severe situations for passengers inside the autonomous vehicle and other road users. Therefore both, monitoring the current system operation state by a surveillance system, which is able to detect failures of software and hardware modules, and a safety system, which reacts on these failures immediately, is necessary.

In this paper an approach based on performance criteria and functional degradation is proposed, which is used in the autonomous vehicle Leonie developed within the Stadtmitigate project. The surveillance part of the system collects data from sensors, software modules, hardware, and the vehicle to combine this data with heuristics to performance criteria. Based on these criteria degradation actions are executed to keep the operation of Leonie in a safe state. The safety system can influence driving maneuvers like lane changes and turning maneuvers, modify driving parameters like maximum speed and safe time headway and even force driving maneuvers like emergency stops and controlled stops at the side of the road.

Currently, the safety driver onboard of Leonie is the fallback solution in case of a system malfunction. Using the proposed safety system should reduce the number of situations where the safety driver has to take control over the vehicle though.

This paper discusses the IVC (Inter Vehicle Communication) system for ITS. DS-SS (Direct Sequence Spread Spectrum) is used for the IVC because it has CDMA (Code Division Multiple Access) capability. However, efficient PN code allocation scheme is a problem to solve because the vehicles communication directly without base stations. In this paper, the location oriented PN code allocation scheme is adopted for the DS-SS IVC system. The influence of the positioning error for the communication performance is evaluated. The improved performance is shown even when the positioning error exists in the IVC system. To improve the performance, the positioning error correction scheme is proposed. The distance between the vehicles are estimated by using the received signal strength after de-spreading. From the simulation result, the positioning error can be mitigated by using proposed technique.

Continuous Broadband Communication System Based on Existing Open Source Network Tools for Vehicular Environments

Due to the widespread adoption of Intelligent Transportation Systems, the number of applications used in vehicular environments is growing very quickly. This fact implies a greater consumption of network bandwidth and a competition for network use. Consequently an exhaustive control of the bandwidth consumption is needed to provide Quality of Service according to the demands of certain applications, giving priority to the most relevant data traffic. Moreover, to guarantee the continuous communication in mobile environments (between vehicles and ground control centers) is another target to be tackled. In this paper a software system to provide continuous broadband communication in vehicular environments, as well as other capabilities such as the management of the Quality of Service and priority of applications, transparent change of the active communication link and security of the data transmission, is presented. The remarkable challenge that has been addressed a solution to this problem not based on a proprietary software development, but by reusing already implemented and tested software utilities, originally designed to be used in several non-mobile environments.

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14:36-14:54 MB2.3
Improving Performance of Inter-Vehicle Communication Scheme Using Location Oriented PN Code Allocation Technique, pp. 254-259

Ogata, Satoshi
Tokyo Univ. of Science

Sakakibara, Sho
Tokyo Univ. of science

Ohno, Kohei
Tokyo Univ. of Science

Itami, Makoto
Tokyo Univ. of Science

In this paper, improvement of the performance of the IVC system using the location oriented PN code allocation is studied. In this system, allocation of PN codes for each vehicle is easy. However interference problem occurs when multiple vehicles are located in the area where the equivalent PN code is allocated. In order to mitigate the interference, MCS scheme is adopted under asynchronous transmission and time-slot allocation is adopted under synchronous transmission. In this paper, DS-CDMA scheme is evaluated by computer simulation. As the result, the effectiveness of the proposed IVC system is confirmed under several situations.

14:54-15:12 MB2.4
CANOPNR: CAN-OBD Programmable-Expandable Network-Enabled Reader for Real-Time Tracking of Slippery Road Conditions Using Vehicular Parameters, pp. 260-264

Enriquez, Dj
Univ. of Alaska, Anchorage; Honeywell HPS

Bautista, Alexander
Univ. of Alaska Anchorage

Field, Paloma
Univ. of Alaska Anchorage

Kim, Sun-Il
Univ. of Alaska, Anchorage

Jenson, Sean
Univ. of Alaska Anchorage

Ali, Muhammad
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Miller, Jeffrey
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We describe the design and implementation of a programmable and expandable OBD-device that is capable of not only reading the various vehicular parameters from the

IEEE ITSC 2012 PROGRAM
Commercially available tools are limited to specific functionalities and do not allow customization by the end-user. Furthermore, the ABS data (which can be used to detect vehicle slippage without the need for adding special sensors), available through the ECU, is tightly guarded by the vehicle manufacturers and is not readily accessible. Our device allows for customization by the user and is capable of reading the ABS information. We also present a solution that allows the end-user to obtain the ABS equivalent information using a combination of other readily available parameters for vehicles that are not equipped with ABS. Our goal is to provide an open-source tool for the research community, such that anyone can build the device and tailor it to the needs of his or her application(s). Our software is tuned and optimized to allow low power consumption, error-checking, and transmission of data at a settable time interval. Our experiments show that the vehicle slippage information obtained through the CANOPNR is accurate and reliable.

**MB3**

**Lane Detection and Lane Keeping** (Regular Session)

14:00-14:18 MB3.1

_Dynamic Delay Compensation for Lane Departure Warning System_, pp. 265-269

Zhang, Sumin - Jilin Univ.
Deng, Weiwen - General Motors Corp.
Wang, Ye - Jilin Univ.
Zhao, Qingrong - General Motors Company

Vision-based active safety and driver assistance systems, such as lane departure warning (LDW) system, have increasingly gained popularity in automotive applications, due to its fairly good performance at relatively low cost. However, the excessive time delay caused by slow image capturing and image processing can greatly impact the performance of the system. The LDW system as discussed in this paper may consequently produce inaccurate value of time-to-lane-crossing (TLC), which can lead to false alarm or warning at inappropriate time to driver of potential danger of lane departure. This paper presents a method that dynamically compensates the time delay, and thus, improves the accuracy of the TLC calculation, which in turn leads to reduced false alarm rate. Simulation has been conducted and the results have shown that the proposed method is effective in compensating the excessive time delay for improved TLC computation.

14:18:14:36 MB3.2

_A Random Finite Set Approach to Multiple Lane Detection_, pp. 270-275

Deusch, Hendrik - Univ. of Ulm
Wiest, Juergen - Univ. of Ulm
Reuter, Stephan - Univ. of Ulm
Szczer, Magdalena - Univ. of Ulm
Konrad, Marcus - EvoBus GmbH - Daimler Buses
Dietmayer, Klaus - Univ. of Ulm

Robust lane detection is the precondition for advanced driver assistance systems like lane departure warning and overtaking assistants. While detecting the vehicle's lane is sufficient for lane departure warning, overtaking assistants or autonomous driving functions also need to detect adjacent lanes. In this contribution, a novel approach to multiple lane detection based on multi-object Bayes filtering is presented. This method allows for directly considering the dependencies between multiple lanes without explicit data association in post processing. Furthermore, the proposed lane detection algorithm is applied to a challenging scenario of a rural road.

14:36:14:54 MB3.3

_A Global and Local Condensation for Lane Tracking_, pp. 276-281

Yao, Wentao - Tsinghua Univ.
Deng, Zhidong - Tsinghua Univ.
Chen, Zhenhua - Tsinghua Univ.

In this paper, we present a new condensation filtering algorithm that combines local and global information for tracking of lane markings. Local model is used for condensation particle filtering while global one for resampling of local filters and vehicle control command. The detection and tracking process is done based on bird's-eye images in real-time. Unlike most of the state-of-art systems, in our system, with the help of a 3D lidar mounted on the vehicle, the computation of bird's-eye image and the dynamic pitch estimation could be readily and accurately accomplished through joint calibration of camera and 3D lidar. In addition, multiple image features are fused to weight particles. The experimental results on various road environments demonstrate the robustness of our approach.

14:54:15:12 MB3.4

_A Unified Framework of the Automated Lane Centering/Changing Control for Motion Smoothness Adaptation_, pp. 282-287

Lee, Jin-Woo - General Motors, Res. and Development Litkouhi, Bakhtiar - General Motor R&D Center

This paper describes an automated lane centering/changing control algorithm that was developed at General Motors Research and Development. Over the past few decades, there have been numerous studies in the autonomous vehicle motion control. These studies typically focused on improving the control accuracy of the autonomous driving vehicles. In addition to the control accuracy, driver/passenger comfort is also an important performance measure of the system. As an extension of authors' prior study, this paper further considers vehicle motion control to provide driver/passenger comfort based on the adjustment of the lane change maneuvering time in various traffic situations. While defining the driver/passenger comfort level is a human factor study topic, this paper proposes a framework to integrate the motion smoothness into the existing lane centering/changing control problem. The proposed algorithm is capable of providing smooth and aggressive lane change maneuvers according to traffic situation and driver preference. Several simulation results as well as on-road vehicle test results confirm the effectiveness of the proposed algorithm.

15:12-15:30 MB3.5

_Spatial Ray Features for Real-Time Ego-Lane Extraction_, pp. 288-293

Kühnl, Tobias - Bielefeld Univ.
Kummert, Franz - Bielefeld Univ.
In order to support driver assistance systems in unconstrained environments, we propose to extend local appearance-based road classification with a spatial feature generation and classification. Therefore, a hierarchical approach consisting of multiple low level base classifiers, the novel spatial feature generation, as well as a final road terrain classification, is used. The system perceives a variety of local properties of the environment by means of base classifiers operating on patches extracted from monocular camera images, each represented in a metric confidence map. The core of the proposed approach is the computation of spatial ray features (SPRAY) from these confidence maps. With this, the road-terrain classifier can decide based on local visual properties and their spatial layout in the scene. In order to show the feasibility of the approach, the extraction and evaluation of the metric ego-lane driving corridor on an inner city stream is demonstrated. This is a challenging task because on a local appearance level, ego-lane is not distinguishable from other asphalt parts on the road. However, by incorporating the proposed SPRAY features the distinction is possible without requiring an explicit lane model. Due to the parallel structure of this bottom-up approach, the implemented system operates in real-time with approximately 25 Hz on a GPU.

**Attachment**: The video shows the ego-lane detection performance of the proposed system using SPRAY features in exemplary scenes. It contains typical situations with bad lane-markings and curbstones delimiting the road.

**MB4 Vision Sensing and Image Processing -1 (Regular Session)**

14:00-14:18 MB4.1

**Track and Turnout Detection in Video-Signals Using Probabilistic Spline Curves**, pp. 294-299

Ross, Ralph Werner  
Karlsruhe Inst. of Tech.

Track selective localization for rail vehicles is a task that is not yet solved completely as far as autonomous localization methods are concerned. Satellite-based navigation can not fulfill all demands as the signal might not always be available. The localization information might be corrupted as well. So, a fusion with other sensors can be useful to enhance availability. In this paper a monofocal camera based turnout detection is described. It can be used for localization when used together with a digital map. The tracks are represented by spline curves that are adjusted in every frame by a recursive estimation algorithm. The efficiency of the algorithm is shown through experimental results.

14:18-14:36 MB4.2

**Trinocular Optical Flow Estimation for Intelligent Vehicle Applications**, pp. 300-306

Kitt, Bernd  
KIT

Lategahn, Henning  
Inst. of Measurement & Control

Motion is an important clue for many tasks in visual scene perception. In this paper, we present a new matching-based algorithm to estimate nearly dense optical flow fields for the static parts of the scene, i.e. those parts whose motion is induced by the moving observer only. Our algorithm is designed for applications in intelligent vehicles usually equipped with stereo camera rigs. To address the computational effort of matching-based approaches we use constraints arising from the geometry between multiple views.

To this end, we compute both an approximated optical flow field and an approximated disparity field between left and right image. Hence, we can predict the position of the corresponding candidate and limit the search space to a small neighborhood around the predicted position leading to near real-time capabilities. Experiments on different challenging real world images show the accuracy and efficiency of the proposed approach.

14:36-14:54 MB4.3

**Tomographical Scene Reconstruction in the Active Safety Car Project**, pp. 307-312

Velten, Joerg  
Univ. of Wuppertal

Schauland, Sam  
Riedel Communications

Gavrilidis, Alexandros  
Univ. of Wuppertal

Schwerdtfeger, Tim  
Univ. of Wuppertal

Boschen, Fritz  
Univ. of Wuppertal

Kummer, Anton  
Univ. of Wuppertal

Tomographical reconstruction algorithms can be applied to camera based measurements and thus reconstruct the scenery without knowledge about included objects. The latter is interesting in the domain of driver assistance systems that have to monitor the driveway independently from a priori knowledge about possibly appearing objects. The paper presents tomographical background information, the transfer from radiographing to visual light rays and its negative impacts, and some first result obtained by applying the presented algorithm to images of a front view camera.

14:54-15:12 MB4.4

**Multiresolution Based Sigma-Delta for Motion Segmentation**, pp. 313-318

Mukherjee, Dibyendu  
Univ. of Windsor

Saha, Ashirbani  
Univ. of Windsor

Wu, Q. M. Jonathan  
Univ. of Windsor

Motion segmentation is an important research field as it forms the stepping stone for traffic monitoring, video surveillance, activity analysis, gait recognition and many other automatic imaging applications. In this work, a novel generic multiresolution (MR) based framework has been proposed in conjunction with Sigma-delta based motion segmentation algorithm. The framework provides a general platform to use any MR analysis method to 1) incorporate subbands information containing varying features for enhanced motion extraction and 2) combine the information obtained to incrementally form the background using Sigma-delta method and upscale to original frame resolution. The validity of the proposed method is demonstrated using four popular MR analysis methods. Comparison of the proposed framework with sigma-delta and wavelet based change detection reflects several improvements over these methods.

**Attachment**: The video contained in the supplementary section is the comparative result of the following algorithms in order - Original frame, Wave-Change, Sigma-delta, WaveSigma-delta, CurveSigma-delta, ContSigma-delta and MRSVDSigma-delta. The frame rate is kept at 10 fps for clarity. VID1.mpg contains 151 frames. VID1 shows an outdoor scene with very noisy background and fast moving small object.

**MB5 Agent-Based Methods for Modeling and Analysis (Regular Session)**

Iliamna
Multi-Agent Reinforcement Learning for Integrated Network of Adaptive Traffic Signal Controllers (MARLIN-ATSC), pp. 319-326

El-Tantawy, Samah
Abdulhai, Baher
Univ. of Toronto

Traffic congestion in Greater Toronto Area costs Canada $6 billion/year and is expected to grow up to $15 billion/year in the next few decades. Adaptive Traffic Signal Control (ATSC) is a promising technique to alleviate traffic congestion. For medium-large transportation networks, coordinated ATSC is becoming a challenging problem because the number of system states and actions grows exponentially as the number of networked intersections grows. Efficient and robust controllers can be designed using a multi-agent reinforcement learning (MARL) approach in which each controller (agent) is responsible for the control of traffic lights around a single traffic junction. This paper presents a novel, decentralized and coordinated adaptive real-time traffic signal control system using Multi-Agent Reinforcement Learning for Integrated Network of Adaptive Traffic Signal Controllers (MARLIN-ATSC) that aims to minimize the total vehicle delay in the traffic network. The system is tested using microscopic traffic simulation software (PARAMICS) on a network of 5 signalized intersections in Downtown Toronto. The performance of MARLIN-ATSC is compared against two approaches: the conventional pretimed signal control (B1) and independent RL-based control agents (B2), i.e. with no coordination. The results show that network-wide average delay savings range from 32% to 63% relative to B1 and from 7% to 12% relative to B2 under different demand levels and arrival profiles.

A Survey of Urban Traffic Signal Control for Agent Recommendation System, pp. 327-333

Chen, Cheng
Inst. of Automation,
Chinese Acad. of Sciences

Zhu, Fenghua
Inst. of Automation,
Chinese Acad. of Sciences

Ai, Yunfeng
Inst. of Automation,
Chinese Acad. of Sciences

Dynamic changes and uncertainty in traffic environments directly spawned lots of strategies about traffic signal control (TSC). Meanwhile, the differences in the traffic environment and demand of control have a significant impact on the performance of strategies about TSC. In order to enable dynamic selection of the most appropriate TSC agents for each specific traffic state in urban traffic transportation system, we firstly propose a survey about urban TSC, which helps us to understand the characteristics of TSC strategies. This survey focuses on the traffic environment about the application of TSC and the demand of TSC. Then, based on the aforementioned survey, we propose one recommendation mechanism for agent-based distributed and adaptive platform for transportation systems to adapt to traffic dynamic characteristic.

Approximately Orchestrated Routing and Transportation Analyzer: Large-Scale Traffic Simulation for Autonomous Vehicles, pp. 334-339

Carlino, Dustin
Univ. of Texas at Austin

Depinet, Michael
Univ. of Texas

Khandelwal, Piush
Univ. of Texas at Austin

Autonomous vehicles have seen great advancements in recent years, and such vehicles are now closer than ever to being commercially available. The advent of driverless cars provides opportunities for optimizing traffic in ways not possible before. This paper introduces an open source multiagent microscopic traffic simulator called AORTA, which stands for Approximately Orchestrated Routing and Transportation Analyzer, designed for optimizing autonomous traffic at a city-wide scale. AORTA creates scale simulations of the real world by generating maps using publicly available road data from OpenStreetMap (OSM). This allows simulations to be set up through AORTA for a desired region anywhere in the world in a matter of minutes. AORTA allows for traffic optimization by creating intelligent behaviors for individual driver agents and intersection policies to be followed by these agents. These behaviors and policies define how agents interact with one another, control when they cross intersections, and route agents to their destination. This paper demonstrates a simple application using AORTA through an experiment testing intersection policies at a city-wide scale.

A Reconsider Your Strategy - an Agent-Based Conceptualisation of Compensatory Driver Behaviour, pp. 340-346

Lützenberger, Marco
Tech. Univ. Berlin

Ahndt, Sebastian
Tech. Univ. Berlin

Hirsch, Benjamin
Khalifa Univ.

Masuch, Nils
Tech. Univ. Berlin

Heßler, Axel
Tech. Univ. Berlin

Albayrak, Sahin
Tech. Univ. Berlin

Currently, there are many models available which can be used to describe a driver’s behaviour for a traffic simulation. Despite the number of available formalisms it is our opinion that existing approaches neglect the interplay between the simulation topology and strategic decisions of simulated drivers. Existing models either disregard strategy updates or focus on short-term strategies only. In this paper we tackle this problem and propose a model which incorporates long-term strategic reactions of simulated drivers to influences of the surrounding infrastructure. In doing so, we formalise a certain type of human behaviour which is commonly known as strategic-level compensation.

Traveler Information (Regular Session)

An Integrated Architecture for the Development and Assessment of ADAS, pp. 347-354

Noth, Sebastian
NISYS GmbH

Edelbrunner, Hannes
NISYS GmbH

lossfildis, Ioannis
HRW Univ. of Applied Sciences

Advanced Driver Assistant Systems act, by definition in natural, often poorly structured, environments and are supposed to closely interact with human operators. Both, natural environments as well as human behaviour have no inherent metric and can not be modelled/measured in the classical way physically plausibly behaving systems are described. This makes the development of a new methodology and
especially the development of an experimental environment necessary, reflecting all constraints of the task to be observed, incorporating the influence of each single component and the generation of variations over scenes and behaviours.

In this contribution we focus on the development of an integrated architecture based on a simulated reality framework incorporating simple behavioural models of autonomous acting humans, physical plausible behaving scene objects, a dynamic scene generator and an advanced recording and analysing system, operating on-line on all data streams. The architecture allows to develop, assess and benchmark embedded components, as well as whole ADAS.

Weiki, Simone Univ. of Federal Armed Forces Munich
Dr. Bogenberger, Klaus Univ. of Federal Armed Forces Munich

During the last two years so-called free-floating Car Sharing Systems became very popular. These systems in comparison to the conventional Car Sharing Systems allow short one-way trips. Today, the spatial distribution of vehicles within free-floating Car Sharing Systems is either self-organized, which means it is only dependent on the customer's demand or in a few cases the positioning is manually controlled by system operators. None of the known free-floating Car Sharing Systems has a clear defined relocation strategy or is online optimized based on the current demand. Within this paper several relocation strategies are introduced and categorized. For each category a relocation algorithm is described and evaluated. Also a new integrated two-step algorithm for optimal positioning and strategy selection is described in detail. This new approach consists of an offline demand clustering that allows for strategy pre-selection. The online module of the approach measures the differences between optimal vehicle positioning and current positioning and selects the best relocation strategy for implementation.

14:36-14:54 MB6.3 Contextual Information in User Information Systems in Public Transportation: A Systematic Review, pp. 361-366
Borgiani, Felipe Silveira Mello Federal Univ. of Pernambuco
Tito, Adriano Univ. Federal de Pernambuco
Santos, Rodolfo Federal Univ. of Pernambuco
Tedesco, Patricia Cabral de Azevedo Restelli Federal Univ. of Pernambuco
Salgado, Ana Carolina Federal Univ. of Pernambuco

The accelerated urbanization rates have brought along an ever-increasing number of vehicles, which, in their turn, causes serious delays in people's daily travels. Users of public transportation, in particular bus passengers, have suffered the most, due to the lack of information about transportation means and traffic conditions. This creates anxiety and uncertainty about the travel, especially on metropolitan regions in developing countries. In this light, User Information Systems (UIS) aim to provide precise information, taking into account the context of the passenger and of the traffic. Hence, it is possible to better support users decisions and increase users’ trust on the transportation means reliability. This work presents a systematic literature review, which aims to identify how (if at all) contextual information is used by Public Transportation User Information Systems.

Li, Caixia the Univ. of New South Wales
Anavatti, Sreenatha Univ. of New South Wales

This paper presents a systematic approach to adaptively realize the vehicle routing with the real-time traffic information during the whole time period of day. This paper focuses on the route planning procedures for determining the optimal route based on analytical hierarchy process (AHP) and fuzzy logic theory. This approach can adaptively switch from pre-routing to real-time routing based on real-time traffic information to find an optimal route for each OD pairs. The AHP-FUZZY approach is a multi-criteria combination system, which can greatly simplify the definition of decision strategy and represent the multiple criteria explicitly. A simulation is implemented to compare with the traditional route guidance system and the results are validated.

15:12-15:30 MB6.5 A Model for Automatic Collection and Dynamic Transmission of Traffic Information Based on VANET, pp. 373-378
Zhang, Qi Univ. of Science & Tech. Beijing
Zhao, JianHao Univ. of Science & Tech. Beijing

As the existing traffic information system based on the fixed traffic information center needs high cost for construct, and the other traffic information system based on inter vehicle communication pays more attention to safe driving information but pays less attention to traffic congestion information, especially for the traffic congestion information in the road network. This paper studies and puts forward a pattern for automatic traffic information service which realizes the function of automatic collection and dynamic transmission of traffic information in the road network on the basis of VANET, and with no need for fixed traffic information center. According to this pattern, we build the models for automatic collecting, integrating and processing, transmitting of traffic information, and automatic generating and dynamic updating of traffic information which covers the whole road network. Finally, in this paper, we also carry out traffic simulation for these models, analyze and evaluate rationality of these models and transmission effect.

MB7 14:00-14:18 King Salmon Traffic Management and Control 1 (Regular Session)

15:30-15:45 MB7.1 Evaluations of Intelligent Traffic Signal Control Algorithms under Realistic Landmark-Based Traffic Patterns Over the NCTUns Network Simulator, pp. 379-384
Wang, Shie-Yuan National Chiao Tung Univ.
Li, Yu-Wei National Chiao Tung Univ.

In this paper, we use the NCTUns network simulator to study intelligent traffic signal control algorithms. NCTUns is both a microscopic traffic simulator and a network simulator. We imported the real-life map of a district of the Taipei city into
NCTUns to let simulated vehicles move on the roads of the imported map. Then, we used a new and unique feature of NCTUns -- each simulated vehicle moves towards its assigned landmark on the map as its destination, to create more realistic traffic patterns in the studied district. With these realistic settings, we studied an intelligent traffic signal control algorithm that has been proposed in the literature. We found that this algorithm has unfairness problems and thus we proposed two mechanisms to improve it. Our simulation results show that, when compared with the original algorithm, the improved algorithm can further reduce the average time needed for a vehicle to reach its destination. In addition, the improved algorithm can mitigate the unfairness problem.

This paper mainly focuses on different influences on traffic flow in large traffic flow conditions, caused by different distances between off-ramp and on-ramp on expressways. In addition, a signal control strategy on side road is proposed and discussed. Our research is based on traffic simulation software (VISSIM). In this research, the characteristics to describe traffic features include average travelling speed and density. Specifically, we simulate 5 scenarios with different on-ramp and off-ramp distances from 200m to 600m and analyze features of traffic flow and their relations with the distance. When the distance decreases to 200m, traffic states deteriorate significantly. Therefore, the scenario with the distance of 200m is focused, and a signal control strategy on side road is used to alleviate congestions on side roads and expressways. After simulation with the strategy, comparisons and analyses are also given in this paper.

This paper presents two adaptive two-stage fuzzy controllers for traffic signals at isolated intersections. Firstly, a two-stage combination fuzzy controller is designed. For traffic status variables in two-stage controller leading to the inefficiency of traffic states weakening under low traffic flow, the controller introduces 0-1 combination and determines the combination of traffic status variables of fuzzy controller’s inputs from the perspective of structural optimization. Secondly, aiming at the problems of fuzzy controller parameter empirical setting and functional disability of learning, a two-stage fuzzy logic traffic signal controller with online optimization is proposed; this controller introduces the rolling horizon framework and optimizes the parameters of membership functions and controller rules by using hybrid genetic algorithm. The performance of two proposed models is validated via online Paramics-based simulation platform, and extensive simulation tests have demonstrated the potential of developed controllers for adaptive traffic signal control.

In this paper, we analyze the delay performance of three traffic signal control algorithms that can attain maximum system throughput, for a single four-way intersection. The first is a static (state-independent) fixed-time scheduling (FTS) policy which is followed in current practice. The second is a dynamic maximum weight (backlog) scheduling (MWS) policy that determines the traffic signal phase (the set of collision-free lanes chosen to be scheduled) based on the backlogs (number of queued vehicles) in the different lanes at the intersection, but the schedule length (green time) is kept fixed. The third is adaptive length MWS (aMWS), a variant of MWS in which the schedule length (green time of the phase) is also adjusted based on the backlogs, in addition to the phases. We show that while the dynamic signal control policies (MWS and aMWS) outperform the static (FTS) policy in general, the performance of a fixed-length schedule like MWS can be seriously affected when loss of scheduling time due to “lag effects” is considered. However, with adaptive adjustment of the schedule lengths (green times), a dynamic signal control policy (like aMWS) can outperform the FTS policy at all traffic loads.

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Hrazdira, Adam  Brno Univ. of Tech.
Cela, Arben  ESIEE Paris
Hamouche, Redha  ESIEE Paris
Reama, Abdellatif  ESIEE Paris
Rezende, Bernardo  Univ. Federal de Minas Gerais
Niculescu, Silviu-Iulian  Lab. de Signaux et Systemes (L2S, UMR CNRS 8506)
Villedieu, Christophe  AKKA Tech.

Abstract—In this paper we present an Optimal Real Time Navigation System (ORTNS) implemented on an Android Smart Device capable of calculating the route to destination based on a permanent Internet connection and information flow obtained from SYTADIN, a traffic Information System. A multi-objective criterion is defined in order to offer the drivers different route to destination parameterization. The ORTNS is not only capable of optimal route to destination calculation with respect to traffic state but also makes the vehicle On-Board energy optimization and/or gas emission reduction possible. As an application example we propose a real time energy management for a Hybrid Electrical Vehicle (HEV) composed of batteries and Super-Capacitors (SC). Based on calculated 3D route to destination and average speeds for each road segment the state of charge (SOC) for batteries and Super-Capacitors (SC) for each receding horizon are optimally predicted and modified in real time.

14:18-14:36  MB8.2
Comparison of VSP Profiles for Three Types of Intersection Control and Implications for Emissions, pp. 415-420
Hallmark, Shauna  Iowa State Univ. USA
Mudgal, Abhisek  Iowa State Univ.

Roundabouts have generally been considered to have lower emissions as compared to signal controlled and 4-way stop-control intersections since they improve traffic flow and average speed. However, roundabouts slow all vehicles to speed ranges where emissions are higher, while signals stop and delay only a portion of vehicles. Roundabouts have the potential to increase the amount of acceleration and deceleration for all vehicles. Emissions are correlated to these modal events, therefore the impacts should be considered in the evaluation of roundabouts.

Vehicle activity (instantaneous speed and acceleration) are key inputs to modal emission models such as the US Environmental Protection Agency's MOVES. The objective of this paper was to compare the vehicle activity of a roundabout to 4-way stop control and signal controlled intersections. The paper presents result of a study which collected second-by-second vehicle activity on-road along a corridor in Urbandale, Iowa. Vehicle activity for the three different types of traffic control was compared.

14:36-14:54  MB8.3
Umedu, Takaaki  Osaka Univ.
Togashi, Yui  Osaka University
Higashino, Teruo  Osaka Univ.

A large part of CO2 emission comes from road transportation. The amount of CO2 emission from vehicles can be reduced by controlling traffic flows using traffic signals, because it is strongly affected by vehicular behavior. Although there are a number of traffic signal control systems to reduce travel time, such systems might not be effective to reduce vehicular emission because of the trade-off between stop duration and stop frequency at signals. In this paper, we propose a decentralized signal control technique for reduction of vehicle stops using vehicle arriving information collected by inter-vehicle communication. The proposing technique controls signals based on an evaluation function to predict CO2 emission amount. The function is gradually improved by an unsupervised learning technique. Through simulation based evaluation, we show that the proposing technique is efficient to reduce CO2 emissions from vehicles without increasing the average travel time not so much.

14:54-15:12  MB8.4
Gu, Qing  Beijing Jiaotong Univ.
Cao, Fang  state key Lab. of rail traffic control and safety, Beijing
Tang, Tao  Beijing Jiaotong Univ.

This paper focus on energy efficient driving strategy for MRT trains. In MRT systems, Automatic Train Operation (ATO) has been widely used. The calculation of a reference trajectory seems more important, since it could improve the performance of ATO. The operation demands for MRT trains are different from freight trains, such as energy saving demand and the characteristic of traction. In this paper, based on the characteristic of traction and some results got by the former researchers, a new energy efficient strategy model is proposed by using nonlinear programming method. It is the first time to combine the analytical and numerical method together in this area. By applying the new method, it is unnecessary to pre-given any key value. Moreover, since it is easy to solve, it could be used in real-time operation adjustment. The feasibility and effectiveness are verified through simulation.

15:12-15:30  MB8.5
An Analysis on Excursion Characteristics of Electric Assist Bicycles by Travel Behavioral Comparison Based on Trajectory Data, pp. 433-437
Inagaki, Tomoyuki  Seikei Univ.
Mimura, Yasuhiro  Toyota Transportation Res. Inst.
Ando, Ryosuke  TTRI (Toyota Transportation Res. Inst.

Electric assist bicycles which are becoming a part of modern life have the possibility to promote bicycle's excursion and the potentiality for the new travel mode responsive to the hilly landform and the aged society, so that it is important to verify practical effectiveness of them. In this paper, an analysis of effects of electric assist facilities on the excursion of bicyclists is conducted by comparing the travel behavior of the electric assist bicycles with that of the normal bicycles, using the trajectory data of the users of rent-a-bicycle in the urban area. As a result, it is shown that the use of the electric assist bicycle increases the travel distance and the coefficient for the utilization of slopes and this tendency is particularly true respect with the elderly, and that the running speed is less influenced by the longitudinal gradient value of the slopes.

Meadows, Alex  Indiana Univ. Univ. Indianapolis
Li, Lingxi  Indiana Univ. Univ. Indianapolis
Chen, Yaobin  Purdue School of Engineering and Tech. IUPUI
Widmann, Glenn  Delphi Electronics and Safety

The parameters of an adaptable cruise control system may change considerably during the course of operation. The addition of passengers, the increased friction as parts wear and the reduction in mass as fuel is consumed all provided changes to the load of the system. These variations and many others may be modeled as non-perfect plant, called an uncertain or corrupted plant. In initial control analysis, the adaptive cruise control systems are assumed to have a perfect plant; that is to say, the plant always behaves as commanded. Plant corruption may come from a variation in performance through use or misuse, or from noise or imperfections in the sensor signal data. A model for plant corruption is applied and methods for analysis and compensation are explored. To facilitate analysis, system identification has been employed to produce a reduced-order model.

Semantic-Based Road Environment Recognition in Mixed Traffic for Intelligent Vehicles and Advanced Driver Assistance Systems (I), pp. 444-450

Guo, Chunzhao  Toyota Central R&D Lab. Inc.
Mita, Seiichi  Toyota Tech. Inst.

Comprehensive situational awareness is paramount to the effectiveness of higher-level functions of the intelligent vehicles and advanced driver assistance systems (ADASs). This paper addresses a hierarchical vision system designed for recognizing a number of objects of interest in mixed traffic, in which, the host vehicle have to drive inside the road boundary and interact with other road users. In the proposed system, the semantic knowledge of the scene is utilized to construct a graph. Stereo vision associated with the semantic graph is employed to seek the drivable road boundary in a Hidden Markov Model (HMM). The results are then used as the road contextual information for the following procedure, in which, particular objects of interest, including vehicles, pedestrians, motorcycles and bicycles, are recognized by using a multi-class object detector. Experimental results in various typical but challenging scenarios show the effectiveness of the proposed system.

Automatic Categorization-Based Multi-Stage Pedestrian Detection (I), pp. 451-456

Yang, Kai  Indiana Univ. Univ. Indianapolis
Du, Eliza  Indiana Univ. Univ. Indianapolis
Jiang, Pingge  Indiana Univ. Univ. Indianapolis
Chen, Yaobin  Purdue School of Engineering and Tech. IUPUI
Sherony, Rini  Toyota Motor Engineering and Manufacturing North America
Takahashi, Hiroyuki  Toyota Motor Corp.

Pedestrian safety has become an important issue for automobile design. Although a lot of research has been done or is ongoing in developing in-car camera-based pedestrian protection systems, robust and reliable in-car camera based pedestrian analysis is still very challenging, especially for real-time systems or large scale dataset analysis. In this paper, we propose a new pedestrian detection and analysis system based on automatic categorization. A category-based multi-stage pedestrian detection and data analysis approach is developed to efficiently process the extremely large scale driving data collected in this research. The experimental results on part of the collecting dataset show that the proposed method is promising.


Johnson, Jeffrey  Indiana Univ.
Zhang, Yajia  Indiana Univ.
Hauser, Kris  Indiana Univ.

Automated emergency maneuvering systems can avoid or reduce the severity of collisions by taking control of a vehicle away from the driver during high-risk situations. To do so, these systems must be capable of making certain decisions: there is the choice of when to interfere in the driver’s control, which is made challenging in the presence of dynamic obstacles and uncertain information (such as that provided by imperfect sensors), and there is the choice of how to interfere, since, in general, controls that mitigate collisions will not be unique. We address both of these questions with a probabilistic decision threshold framework that overrides the driver’s control only when safety drops beneath a problem-specific threshold, and minimizes the magnitude of the interference. We demonstrate its application to two scenarios: collision-imminent braking for obstacles traveling along the vehicle’s path, and braking and accelerating for unprotected lane crossings.
This article presents a new radar sensor modelling for the simulator SIVIC. Lots of simulator exists already for this issue, but none of them have been designed to match objectives such as real-time computing, signal generation and hardware in the loop development. It has lead the LIVIC to developed its own simulator to manage both ADAS development by simulation and signal processing for radar. Different technologies of radar sensors are described before focusing on those used in automotive. The global sensor model is explained and each sub model is detailed with electromagnetic waves and environmental objects modelling and the hypothesis done to realize it. A simple FSK radar is presented as illustration for the defined architecture and initial results are presented. Finally, the next stage of model is described such as issues encountered during development.

Emerging vehicular communications are a key to combat several mobility issues, like road safety and efficiency. Dedicated short range communications (DSRC) is a wireless technology, operating at 5.9GHz, designed for automotive use. To operate, this technology has two types of devices, one for vehicles and another for roadside. This paper presents the design of an antenna for the vehicle unit of the DSRC system. High bandwidth, omnidirectional radiation pattern with circular polarization and reduced dimensions make this antenna particularly suitable for this application.

We consider a dual-hop vehicle to vehicle (V2V) relay channel, where a source vehicle communicates with a destination vehicle using a third vehicle as a relay node. The inter-vehicle relay channel is the product of two independent fading processes generated by two independent groups of scatterers. A novel MMSE estimator is proposed for the aforementioned dual-hop relay channel. The fading process at each hop is modeled as Rayleigh fading as well as Nakagami-m fading. The latter is widely used for modeling severe fading in V2V channels.

This paper presents a suitable algorithm to classify vehicles detected by a multiple inductive loop system, developed for measuring traffic parameters in a heterogeneous and no-lane disciplined traffic. The proposed classification scheme employs Random Forest (RF) algorithm. This scheme is suited not only for classifying the detected vehicles as bicycle, motorcyle, scooter, car and bus but also for counting them accurately under a mixed traffic condition. The algorithm has been implemented and tested. Its performance has also been compared with other algorithms based on threshold values and signature patterns. The threshold, signature and RF based algorithms use the number of loops a vehicle occupies and signature patterns. The threshold, signature and RF based algorithms use the number of loops a vehicle occupies as an important factor for classification. Result from a prototype system developed show that the RF based algorithm provides better accuracy compared to the threshold based and signature based methods.

Accurate data reporting ensures suitable roadway design for safety and capacity. Currently, vehicle classifier devices employ inductive loops, piezoelectric sensors, or some combination of both to identify 13 different FHWA vehicle classifications. Systems using inductive loops have failed to...
accurately classify motorcycles and record relative pertinent data. Previous investigations have focused on classification techniques utilizing inductive loop signal output, magnetic sensor output, with neural networks, or the fusion of several sensor outputs. This paper presents a novel vehicle classification setup that uses a single piezolectric sensor placed diagonally across the traffic lane to accurately identify motorcycles from among other vehicles by detecting the number of vehicle tires. A vehicle classification algorithm based on number of tires detected and axle/tire spacing was formulated and deployed in an embedded system for field testing.

16:54-17:12

**Approaching Car Detection Via Clustering of Vertical-Horizontal Line Scanning Optical Edge Flow**, pp. 502-507
Karaduman, Ozgur
Eren, Haluk
Kurum, Hasan
Celenk, Mehmet

Here, we describe a method that detects vehicle(s) approaching from behind to a commuting car in the lane in which both are travelling. This research contributes to the development of driver assistance systems by means of informing them about the approaching traffic from behind and warn the drivers in case they are drowsy or not alert and the driving conditions are hazardous. We use the image pairs extracted from a video clip obtained from a video camera mounted on the back side of the car. This allows detection of the moving objects from the video image pairs using optical flow. Objects which are determined as not cars or vehicles have been eliminated by edge extraction. In turn, this approach leads to lessen the operation processing cost. Then, Density Histogram of Cluster Rows (DHCR) and Density Histogram of Cluster Columns (DHCC) are generated for the purpose of classification of motion vectors (MVs). Consequently, approaching vehicles and cars are detected by localizing the place of the motion vector clusters using Vertical Horizontal Line Scanning (VHLS) as experimental results demonstrate.

16:00-16:18

**MC4**
**Vision Sensing and Image Processing 2 (Regular Session)**

**A Smart Vision Systems for Advanced LGV Navigation and Obstacle Detection**, pp. 508-513
Bertozzi, Massimo
Bombini, Luca
Broggi, Alberto
Coati, Alessandro

This article presents the VisLab solution for obstacle detection and navigation support for unmanned vehicles in industrial environments. Although the literature contains many examples to tackle this problem, this solution can be considered innovative as it improves traditional laser-based systems. The proposed system is composed by two sub-systems. The first one in an obstacle detection system, which also allows the detection of hanging obstacles, within a 3D monitored area. This solution outperforms the original laser scanner based system used for safety which was limited to bi-dimensional areas only. Another vision system is used for tracking a guideline on the ground, that solves problems of localizations and drifts that sometimes can happen using the laser and vehicle odometry only. After a long testing phase, the system is actually installed in a modern industrial warehouse in Parma in order to finally estimate its robustness and reliability.

16:36-16:54

**Real-Time 3D Visual Perception : Detection and Localisation of Static and Moving Objects from a Moving Stereo Rig**, pp. 522-527
Lefaudeux, Benjamin
Hashashibi, Fawzi

Perception of the surrounding environment is one of the many tasks an automated vehicle has to achieve in a complex and ever-changing playground. This includes several distinct sub-tasks, such as map-building, localisation, static obstacles detection, pedestrian detection or classification. Some of these tasks are nowadays very well known, such as map-building, whereas the perception, localisation and classification of moving objects from a moving vehicle are still very much a work in progress. In this paper, we propose a vision-based approach built on the extensive tracking of numerous visual features over time from a stereo-vision pair, without any other
information as regards vehicle displacement. Through on-the-fly environment 3D reconstruction, we propose an integrated method to detect and localise static and moving obstacles, whose position, orientation and speed vector is estimated. Our implementation runs at the moment in a slow real-time (9fps) and should in the future be enclosed in a more complete, probabilistic pipeline.

16:54-17:12 MC4.4

**Scale Change and TTC Filter for Longitudinal Vehicle Control Based on Monocular Video**, pp. 528-535

Sterlin, Susanne Robert Bosch GmbH
Dietmayer, Klaus Univ. of Ulm

This paper presents a filter algorithm that derives robust input values for longitudinal control of driver assistance systems, based on noisy scale change measurements from a monocular video system. In particular, we calculate filtered scale change and reliable Time-To-Collision (TTC), two values that can be applied for video based Active-Cruise-Control and Forward-Collision-Warning systems. We exploit the fact that TTC is directly related to scale change and the calculation can be performed without accurate distance measurements. To meet the requirements of an automotive environment, where high dynamic driving maneuvers may occur, TTC calculation has to consider relative velocity and relative acceleration between the ego vehicle and the target. We do this by applying an Interacting-Multiple-Model filter, which directly processes the noisy scale change measurements and estimates normalized motion parameters. For better smoothing during accelerated driving situations, we propose an extended IMM configuration. Results presented are based on the evaluation of NCAP test sequences.

16:00-16:18 MC5.1

**A Short-Term Freeway Traffic Flow Prediction Method Based on Road Section Traffic Flow Structure Pattern**, pp. 534-539

Zhang, Ping Peking Univ.
Xie, Kunqing Peking Univ.
Song, Guojie PKU

Accurate short-term traffic flow prediction is the foundation of the efficient and proactive management of freeway networks, especially on the abnormal traffic states. The relationship between traffic flow on the current section and the upstream stations can be utilized to predict short-term traffic flow. In this paper, we reveal this relationship by the traffic flow structure pattern. The structure pattern can be drawn from real freeway toll data and a few video detective cameras on the freeway segments. Based on the stability pattern, a new traffic flow prediction algorithm has been proposed; Experimental based on real data showed that the prediction method based on structure pattern was a promising and effective approach for traffic flow prediction, especially on the abnormal traffic state.

16:54-17:12 MC5.4

**Microscopic Traffic Simulation Tool for Intelligent Transportation Systems**, pp. 552-557

Jaworski, Pawel MIRA Ltd
Edwards, Tim MIRA Ltd
Burnham, Keith Coventry Univ.
Haas, Olivier Coventry Univ.

This paper describes a microscopic traffic simulation tool for assessing the performance of ITS traffic and vehicle control systems. The scope of simulation is very broad. The traffic network is simulated in microscopic scale with nanoscopic components being available as well. The vehicles can be simulated down to basic physical properties including throttle and brake settings, fuel consumption and others. This allows for in-depth behavioural analysis of both individual vehicles and the whole traffic flow as a result of use of different traffic management systems. The simulator also allows investigating inter-vehicle interactions including platooning behaviour and its consequences such as the string stability problem. The simulator has been designed to be modular and easily extensible to allow for new functionality in future.
This paper proposes a macroscopic traffic flow model for urban traffic road network. First, dynamic digraph is used to model the urban traffic road network's topological structure. Then, traffic flow data which is based on an extended cell transmission model and the traffic shock wave theory are endowed to the dynamic digraph to construct a weighted dynamic digraph model. Finally, the modeling method is applied to a local road network to illustrate the availability of the modeling method when compared with real data.

The paper proposes a new approach to construct vehicle trajectories using real-time and historical traffic data for the prediction of dynamic travel times. The purpose of this paper is to predict travel times considering the transportation system evolution. The approach combines real-time and historical data within a particle filter framework to dynamically predict future traffic state maps. The future travel trajectory is then constructed using the velocity map and thus travel time is predicted. Based on the nature of particle filters, the variance of each speed grid traversed during the trip can be calculated and then used to compute the travel time variance. The proposed approach is tested using simulated data along a section of I-66. The results demonstrate the effectiveness of the proposed algorithm in predicting travel times.

Travel time information is a fundamental component in Advanced Traveler Information System. In this paper, we propose a short-term travel time estimation and prediction framework for long freeway corridor, considering measurements from vehicle detectors (VD) and floating car data (FCD). The modeling approach is based on a modified Nearest-Neighborhood (NN) model with threshold and a Neighborhood (NN) model with threshold and a

Travel time methodology should be used to obtain the information to be disseminated. However, an important part of the literature either uses instantaneous travel time assumption, and sums the travel time of roadway segments at the starting time of the trip, or uses statistical forecasting algorithms to predict the future travel time. This study benefits from the available traffic flow essentials (e.g. shockwave analysis, bottleneck identification), and makes use of both historical and real time traffic information to provide travel time prediction. The experimental results based on the loop detector data on Californian freeways indicate that the proposed method provides promising travel time predictions under varying traffic conditions.
Traffic Signal Control Using Reinforcement Learning and the Max-Plus Algorithm As a Coordinating Strategy, pp. 596-601

This paper explores the performance of decentralized reinforcement learning agents with communication capabilities for the operation of traffic signals in an oversaturated network. An explicit coordinating mechanism is implemented as part of the reward structure of the agent using the max-plus algorithm, aiming at improving the network-wide performance. Results from a simulated network with realistic features showed that Q-learning agents could process a greater number of vehicles than optimized signal timings from state-of-practice simulation software TRANSYT7F, even under varying oversaturation conditions. The effect of adding the max-plus algorithm was limited, but towards improved performance in terms of both total throughput and reduced number of stops per vehicle. Ongoing research evaluates potential conditions where the coordination should be emphasized to further enhance results, as well as alternative implementations of the max-plus algorithm.

Signal Timing for Fleeting Multiple Intersecting Roadways, pp. 602-607

Increasing transportation efficiency by expanding roadway infrastructure is limited by maintenance costs, real estate, and lengthened commutes. An alternate solution has been optimizing traffic flow by fleeting traffic signals. A roadway is fleeted when its signal sequence allows a platoon of vehicles to travel its length without being stopped by a red light, which in turn reduces congestion. The advantages of fleeting could be increased by fleeting multiple intersecting roadways. Our research examines the conditions necessary to accomplish fleeting traffic signals in intersecting directions so that both directions can have platooned vehicles simultaneously. The traffic signals at the intersecting roadways must be synchronized to maintain the fleeting sequences for both roadways. Through our analysis, we conclude that the time to travel along the roadways between traffic signals that are timed for platooning in multiple directions must be equivalent. Since many roadway distances are already known (unless a new road is being constructed), the only variable affecting the time to travel along a roadway is the speed limit. If variable speed limits are used, traffic signals on intersecting roadways are able to be fleeted.

Adaptive Control of Hyperbolic PDE System with Uncertain Parameters, pp. 608-612

The main contribution of this paper is the stability analysis and adaptive control design of a hyperbolic Partial Differential Equation (PDE) system model for crowd dynamics. The feedback control of crowd dynamics has become an important area of research and has been under investigation in recent years. The control of such systems is difficult to achieve as the dynamics are governed by hyperbolic PDEs. This paper presents the design of a nonlinear adaptive controller for a hyperbolic partial differential equation model representing crowd dynamics. Most of the adaptive control in literature is studied for parabolic PDEs. The major contribution of this paper is the study of adaptive control for hyperbolic PDEs. The feedback control is designed in the presence of uncertainties due to unknown parameters. The controller is designed using the Lyapunov method. The controller designed is shown to achieve uniform boundedness.

Simulation of the Impact of Traffic Lights Placement on Vehicle's Energy Consumption and CO2 Emissions, pp. 620-625

This paper proposes a method to estimate the impact of traffic light placement policies in terms of vehicles’ fuel consumption and CO2 emissions. The method comprises two steps. First, speed profiles are generated representing vehicle's behavior. Then, the mechanical energy spent by the vehicle is...
computed. The estimation is then used to compare different policies of traffic light placement. Simulations have been carried out to analyze the impact of semaphores distributed into a real road. The relation between the number of traffic lights and the energy spent is quantified. Finally, a sensitivity analysis is provided considering different classes of vehicles travelling on urban roads.

16:36-16:54
Vehicle's Energy Estimation Using Low Frequency Speed Signal, pp. 626-631
Corti, Andrea
Manzoni, Vincenzo
Savaresi, Sergio
Pol. di Milano
Pol. di Milano
Pol. di Milano

Everyday vehicles' fleets positions and speeds are collected by private companies and public authorities, stored in servers and used for vehicle's tracking and diagnostic.

These data are usually sampled and transferred over the long-range wireless network with low sampling rates for cost savings in term of network bandwidth and storage. This policy limits the use of the data for fine-grained estimation of vehicle energy, and therefore of fuel consumption and CO2 emissions.

This paper analyzes the effect of a low-frequency sampling rate of inertial variables on vehicle's energy estimation. It statistically quantifies the error with respect to accurate signals. An experimental campaign carried out on different vehicles in different days supports the analysis. Experimental results show that the estimation error mean and variance depends on the sample rate and the time window size and that they do not significantly varies within vehicles of the same class.

16:54-17:12
Estimation of Missing Values in Traffic Density Maps, pp. 632-637
Petrilík, Jiri
Korcák, Pavol
Fucík, Otto
Beszédés, Marian
Sekanina, Lukas
Brno Univ. of Tech.
Camea spol. s r.o.
Brno Univ. of Tech.
Camea spol. s r.o.
Brno Univ. of Tech.

The traffic density map (TDM) represents the density of road network traffic as the number of vehicles per a specific time interval. TDMs are used by traffic engineers as a base documentation for planning a new infrastructure (longterm) or by drivers for showing a current traffic status (shortterm). We propose two methods for estimation of missing density values in TDMs. In the first method, the problem is formulated relatively strictly in terms of quadratic programming (QP) and a QP solver is utilized to find a solution. The second, more general method is based on a multiobjective genetic algorithm which allows us to find a reasonable compromise among several objectives that a traffic expert may formulate. These two methods can work automatically or they can be used by a traffic expert for an iterative density estimation. Results of experimental evaluation based on real and randomly generated data are presented.

Technical Program for Tuesday September 18, 2012

TPL1.1
Train Operation Control Systems for High Speed Railways in China*
Ning, Bin
Beijing JiaoTong Univ.

According to the standardization of Chinese Train Control System (CTCS), there are the two train operation control systems for high speed railways in China: CTCS2 and CTCS3. The two systems are widely applied in high speed railways in China to ensure the safety and efficiency of operation for high speed trains.

Professor Bin Ning, President of Beijing Jiaotong University, will provide an overview of the train operation control systems for high speed railways in China. Bin Ning will discuss about the operation principle of CTCS2 and CTCS3 and the challenges train operation control systems face. He will discuss about the further developments of the two systems for high speed railway network in China.

09:45-10:30
ITS Wireless Communication Systems in Japan*
Itami, Makoto
Tokyo Univ. of Science

Recently, ITS systems are widely being developed and deployed in order to realize a safe and comfortable traffic environment. In ITS systems, wireless communication technology is one of the most important technologies. Dr. Makoto Itami, Professor of Tokyo University of Science, will discuss about the development and deployment of ITS wireless communication systems in Japan such as VICS (Vehicular Information and Communication Service, ETC(Electronic Toll Collection) and ITS spot based on DSRC. In addition, the Japanese standard for inter-vehicle communication using the UHF band and its use in safety applications are also introduced.

TPL2.1
Smart Maintenance and Operations Vehicles*
Adams, Ocie
Alaska DOT

The Alaska Department of Transportation and Public Facilities partnered with the University of Minnesota to deploy the Smart Maintenance and Operations Vehicles in 2005 in Thompson Pass Alaska. Thompson pass receives an average snow fall of around 250 inches and winds in excess of 122 MPH. The port of Valdez is a primary shipping and resupply line for Eastern Alaska and the termination point of the Alaska Oil Pipeline. Closure of the Richardson Highway can result in emergency services and commercial operators not being able to deliver critical medical services, fuel, groceries, and pipeline maintenance supplies to the Richardson and Alaskan Highways.
With frequent zero visibility conditions in Thompson Pass the department needed a system that could assist the operators with snow removal and ice control duties. The University of Minnesota offered the best solution to our question. How do we give our operators tools that will help them stay on the road when the visibility would otherwise curtail snow and ice control operations. The University of Minnesota’s solution was technology similar to that used in a fighter aircraft. Attend the Smart M&O Vehicles presentation to hear the solution.

09:45-10:30  TPL2.2
Towards Swarms of Self-Driving Automobiles*
Stiller, Christoph  Karlsruhe Inst. of Tech.

This presentation focuses on key technologies for automobiles that perceive their environment and based on this knowledge automatically navigate through everyday traffic in an autonomous and cooperative manner. Methods for 3D machine perception based on lidar, radar, and video sensors are outlined. The possible contribution of prior knowledge from digital maps is elaborated. Beyond classical metrology the recognition and basic understanding of situations must be accomplished for automated decision-making and trajectory planning. When multiple self-driving automobiles are present they are able to communicate their plans and mutually negotiate their trajectories. Inspired by biological swarms it is shown that a coordinated and homogenized traffic flow can be achieved through cooperative yet distributed planning. Results from autonomous vehicles are shown in real world urban and platooning scenarios including AnnieWAY the recent winner of the Grand Cooperative Driving Challenge.

TA1  Driver Behavior and Safety System (Regular Session)
11:00-11:18  TA1.1
Prediction of Driver Behavior on a Limited Sensory Setting, pp. 638-643
Garcia Ortiz, Michael  Bielefeld Univ.
Kummert, Franz  Bielefeld Univ.
Schmuederich, Jens  Honda Res. Inst. Europe GmbH

We present a system able to predict the future left cut-in behavior of the ego-vehicle on highway, depending on detected information about the preceding vehicles. Our system learns the mapping between the current perceived scene (information about the ego-vehicle and the preceding vehicles) and the future driving behavior of the ego-vehicle.

The main difference to related contributions comes from the fact that we want to perform behavior prediction with a limited sensory setting. On the one hand, we do not perform driver monitoring, and on the other hand, we only use frontal sensors. However, we show that it is possible to predict accurately the cut-in behavior of the driver.

The system is tested on a real world scenario, using 50 minutes of streams recorded on German highways, and the prediction occurs at a horizon of 2s into the future. The quality of the prediction is measured using frame-based as well as event-based evaluation with a cross-validation approach. We compare a system with only front sensing (vision and radar detection) with a system including a simulated rear sensing.

11:18-11:36  TA1.2
Measuring Driver Awareness Based on Correlation between Gaze Behavior and Risks of Surrounding Vehicles
Mori, Masataka  Nagoya Univ.
Miyajima, Chiyomi  Nagoya Univ.
Angkititrakul, Pongtep  Nagoya Univ.
Hirayama, Takatsugu  Nagoya Univ.
Li, Yiyang  Nagoya Univ.
Kitaoka, Norhide  Nagoya Univ.
Takeda, Kazuya  Nagoya Univ.

We investigated a method to estimate the degree of driver awareness of surrounding vehicles based on the correlation between driver gaze direction and the positions of and risks posed by surrounding vehicles. The risks posed by surrounding vehicles were represented by their time to collision (TTC) from the driver’s vehicle. We recorded driving data from five expert and five non-expert drivers while passing other vehicles on expressways, using an instrumented vehicle. We manually labeled the drivers’ gaze directions using video of the drivers’ faces, and detected the positions of surrounding vehicles and calculated TTC using laser scanners mounted on the front and back of the vehicle. We focused on driver’s gaze behavior for five seconds before the driver began moving into the right hand lane at the beginning of the passing maneuver and calculated the correlation index between vectors representing the distribution of gaze resources and risk levels of surrounding vehicles for eight zones around the vehicle. We found that there were individual differences in gaze behaviors, and that expert drivers showed a higher degree of awareness than non-expert drivers.

11:36-11:54  TA1.3
Modeling the Steering Behavior of Intoxicated Drivers, pp. 648-653
M. Shirazi, Mehran  Simon Fraser Univ.
B. Rad, Ahmad  Simon Fraser Univ.

Driver assistance systems and vehicle safety systems are meant to improve the driving performance of a driver. Despite increased efforts in educating public at large on the danger of impaired driving in recent years, the problem is not alleviated and drunk driving is still one of the major causes of fatal accidents. Although different models of sober drivers are available in literature, mathematical modeling of humans under the influence of alcohol / drugs in steering control of a vehicle is open. Using system identification techniques, four different linear models for these drivers are presented here. The parameters and characteristics of these models are compared with the respective models for sober drivers. Larger delay (reaction time), reduced ability of maintaining the car in the center of lane, and aggressive driving style are some of the important features of intoxicated drivers identified here. The proposed models are validated using the data collected from 50 minute driving sessions for both sober and drunk drivers. The parametric uncertainties of the model parameters are also shown.

11:54-12:12  TA1.4
Towards Collision Alarming Based on Visual Motion, pp. 654-659
Killcarslan, Mehmet  IUPUI
Zheng, Jiang Yu  IUPUI

This work models various collision situations that may happen to a driving vehicle on road in probability, and map such events to the visual field of the camera. The identification of dangerous events thus can be carried out based on the
location-specific motion information modeled in the likelihood probability distributions. Depending on the motion flows detected in the camera, our algorithm will identify the potential dangers and compute the time to collision for alarming. With the location dependent motion based on the knowledge of road environment and behaviors of other vehicles, this approach will detect the motion of potential dangers directly for accident avoidance. The mechanism to link visual motion to the dangerous events avoids the complex shape recognition of vehicles so that the system can response without delay.

12:12-12:30 TA1.5

Leveraging Sensor Information from Portable Devices towards Automatic Driving Maneuver Recognition, pp. 660-665

Satyanarayana, Amardeep The Univ. of Texas at Dallas
Sadjadi, Seyed Omid The Univ. of Texas at Dallas
Hansen, John The Univ. of Texas at Dallas

With the proliferation of smart portable devices, more people have started using them within the vehicular environment while driving. Although these smart devices provide a variety of useful information, using them while driving significantly affects the driver's attention towards the road. This can in turn cause driver distraction and lead to increased risk of crashes. On the positive side, these devices are equipped with powerful sensors which can be effectively utilized towards driver behavior analysis and safety. This study evaluates the effectiveness of portable sensor information in driver assistance systems. Available signals from the CAN-bus are compared with those extracted from an off-the-shelf portable device for recognizing patterns in driving sub-tasks and maneuvers. Through our analysis, a qualitative feature set is identified with which portable devices could be employed to prune the search space in recognizing driving maneuvers and possible instances of driver distraction. An absolute improvement of 15% is achieved with portable sensor information compared to CAN-bus signals, which motivates further study of portable devices to build driver behavior models for driver assistance systems.

TA2 Communication Technologies and Protocols 4 (Regular Session)

11:00-11:18 TA2.1

/iPASS: Intelligent Pavement Signaling System, pp. 666-671
Claussen, Heiko Siemens Corp. Res. and Tech.
Aparicio, Juan Siemens Corp. Res. and Tech.
Rosca, Justian Siemens Corp. Res. and Tech.
Tas, Nazif Siemens Corp. Res. and Tech.

Traditional radio frequency based wireless communication/localization suffers from environmental effects such as multipath propagation. We introduce a robust wireless communication methodology which utilizes the physical world itself to convey information. Our proposed intelligent pavement signaling system (iPASS) can intelligently place irregularities on pavement in order to encode different messages that can be deciphered in real time by an application running on e.g., a phone. iPASS utilizes available accelerometers, e.g., in today's smartphones, that can detect even small vibrations from the inside of a car that are produced by driving over irregularities on the road. Our feasibility study illustrates that iPASS can successfully decode a 5 bit message using a conventional smartphone when cruising at various speeds.

11:18-11:36 TA2.2

Increasing the Probability of Timely and Correct Message Delivery in Road Side Unit Based Vehicular Communication, pp. 672-679

Jonsson, Magnus Halmstad Univ.
Kunert, Kristina Halmstad Univ.
Böhmer, Annette Halmstad Univ.

Intelligent transport systems provide a multitude of possibilities when it comes to increasing traffic safety on our roads. Many of the proactive traffic safety applications under development today demand timely and reliable treatment of deadline dependent data traffic. Unfortunately it is not possible to provide any timing guarantees when using the current IEEE 802.11p standard for wireless access in vehicular environments. Additionally, a difficult wireless channel environment makes successful data transmissions very challenging. We suggest adding a real-time layer, comprising a deterministic medium access control protocol and transport layer retransmissions, on top of IEEE 802.11p in order to enable guaranteed real-time behaviour and to improve reliability. In a simulation study we show that the packet error rate can be decreased by several orders of magnitude while being able to guarantee timely treatment of both ordinary transmissions and retransmissions by the help of a real-time schedulability analysis.

11:36-11:54 TA2.3

Person-To-Infrastructure (P2I) Wireless Communication for Work Zone Safety Enhancement, pp. 680-684

Qiao, Yijun The Univ. of Texas at Austin
Qiao, Fengxiang Texas Southern Univ.

There are serious concerns about the injuries and fatalities of highway maintenance and construction workers around work-zone area. One portion of such incidents is directly related to the vehicles approaching work zones. The advance warning of the potential conflicts between vehicles and workers to both vehicle drivers and workers is essential to workers’ safety. This paper proposes a Person-to-Infrastructure (P2I) communication framework aiming to enhance the work zone safety level. The Time Difference of Arrival (TDOA) based emitter location algorithm is identified to constantly monitor the location of an emitter attached to a worker. An engineering implementation procedure is proposed with nine practical steps. The on-going work includes further computer simulation and pilot test of such P2I wireless communication system.

11:54-12:12 TA2.4

A Smartphone-Based Traffic Information Service Platform for Pedestrian and Bicycle Systems, pp. 685-690

Du, Jun Tsinghua Univ.
Zheng, Chenyu Univ. of Colorado
Zeqi, Zhang Tsinghua Univ.
Zhongqiang, Zhai Tsinghua Univ.
Yang, Yu Tsinghua Univ.
Nengqiang, He Tsinghua Univ.
Sicker, Douglas Univ. of Colorado
Ren, Yong Tsinghua Univ.

Currently, the development of urban slow traffic information services is lagging. Numerous issues, such as the lack of
traffic information and deficient information dissemination, restrict the technical and economic development, of such systems. So it is critical and crucial to develop information services for urban pedestrian and bicycle systems. In this paper, a smartphone-based information platform is proposed to provide customized information services ubiquitously for walking and cycling commuters with various characteristics and demands. The platform can provide value-added services like smart tour by cooperating with mobile operators, or promote national information construction and development of related service industries especially for the countries and areas with big populations. Moreover, through taking advantage of portability, the platform is easy to apply to other information services offered by smartphones.

**TA3**

**Detection of Driving Environment 1 (Regular Session)**

**11:00-11:18**

A Generic Map Based Environment Representation for Driver Assistance Systems Applied to Detect Convoy Tracks, pp. 691-696

Weherer, Tobias Tech. Univ. München
Bouzouraa, Mohamed Essayed AUDE AG
Hofmann, Ulrich AUDI AG

Future Advanced Driver Assistance Systems (ADAS) require generic map based representations to process environment information measured by different sensors. In contrast to today’s widespread grid based maps, such environment representations have to be a compact, scalable and easy-to-interpret. In order to fulfill these requirements, we propose a new generic map representation, the two dimensional interval map. One example of information that can be represented in this data structure are convoy tracks. Convoy tracks describe the common motion of vehicles driving in convoys. These tracks can serve as an additional, independent input parameter for longitudinal and lateral control in highly automated ADAS.

Experimental results show the general ability of the new data structure to provide sufficiently precise results at low computation time and memory consumption. The developed methodology to detect convoy tracks is capable of extracting multiple common convoy attributes even in complex scenarios with lane change maneuvers.

**11:18-11:36**

**Simulation Architecture for the Design of Cooperative Collision Warning Systems**, pp. 697-703

Gruyer, Dominique IFSTTAR
Demmel, Sébastien QUT & IFSTTAR
D'Andrea-Novel, Brigitte Mines ParisTech
Lambert, Alain IFSTTAR
Rakotonirainy, Andry Queensland Univ. of Tech.

Simulation has been widely used to estimate the benefits of Cooperative Systems (CS) based on Inter-Vehicular Communications (IVC). This paper presents a new architecture built with the SiVIC simulator and the RTMaps™ multisensors prototyping platform. We introduce several improvements from a previous similar architecture, regarding IVC modelisation and vehicles’ control. It has been tuned with on-road measurements to improve fidelity. We discuss the results of a freeway emergency braking scenario (EEBL) implemented to validate our architecture’s capabilities.

**11:36-11:54**


Zheng, Zihui Beijing Inst. of Tech.
Zhang, Hanxizi Beijing Institute of Tech.
Wang, Bo Beijing Inst. of Tech.
Gao, Zhifeng Beijing Inst. of Tech.

In this paper we propose a traffic sign recognition system using an on-board single camera for Advanced Driver Assistance Systems (ADAS), including detection, recognition and tracking. We combine RGB ratios based color segmentation with automatic white balance preprocessing and Douglas-Peucker shape detection to establish ROIs. Scale and rotation invariant BRISK features are applied for recognition, matching the features of the candidates to those of template images that exist in database. Tracking-Learning-Detection (TLD) framework is adopted to track the recognized signs in real time to provide enough information for driver assistance function. This paper presents lots of experiments in real driving conditions and the results demonstrate that our system can achieve a high detection and recognition rate, and handle large scale changes, motion blur, perspective distortion and various illumination conditions as well.

**11:54-12:12**

**Interacting Multiple Model Road Curvature Estimation**, pp. 710-715

Shen, Truman Takata Holdings Inc

Accurate road curvature estimation is essential to many drive assistance systems and active safety systems, such as curve speed warning, lane departure warning, and lane keeping assistance. To improve the overall performance of road curvature estimation and path prediction, we proposed an interacting multiple model (structure) approach in curvature filtering, so that the curvature estimates for straight road and pure arc can be more accurate while the transitional curvature change between straight and constant radius curve can still be followed promptly.

**12:12-12:30**

**Probabilistic Estimation of Temporary Lanes at Road Work Zones**, pp. 716-721

Graf, Regine Univ. of Ulm
Wimmer, Andreas Univ. of Ulm
Dietmayer, Klaus Univ. of Ulm

Road work zones pose a great challenge for the environmental perception with sensors and the correct modelling of the scenery. Especially the recognition of the valid lane is of great interest for driver assistance systems. At road work zones temporary lanes invalidate the original lanes while the latter are still present on the road. All lines are detected with a greyscale video camera. In this paper we present an approach which generates different hypotheses for the lanes originated from the two different types of lines. A particle filter is applied for smoothing and filtering while a JIPDA algorithm is used for association and with its existence estimation helps to find the most plausible hypothesis of the currently valid lane.
Real-time modeling of dynamic environments is one of the most demanding research problems in the field of driving assistance systems. The representation module may be affected by several factors such as occlusions, unpredictable nature of the traffic participants, wrong associations or noisy measurements. In this paper we propose two different methods for real-time modeling of dynamic environments. Both motion estimation techniques are vision-based and rely on information provided by a Digital Elevation Map. The first approach consists in determining the differences between the previous and current frames. These differences are then used for computing the speeds of the traffic participants. The second motion estimation technique consists in using a fast pairwise alignment of object delimiters that are extracted by radial scanning of the Elevation Map. The final result is a more compact polygonal map with associated static and dynamic features.

Multiple-frame segmentation, also referred to as video segmentation, is an important step in many video analysis applications for identifying and tracking specific features as they move through a scene. In a mobile, resource-constrained environment such as an intelligent vehicle system, video segmentation can be utilized in preprocessing to reduce image information and increase processing efficiency for high-level scene understanding applications. We introduce video segmentations, a highly efficient multiple-frame segmentation approach for use on embedded and mobile platforms where processing speed is critical. The proposed method is demonstrated to successfully track segments across spatial and temporal bounds, generating fast, stable segmentations of images from captured moving-camera video sequences. Video segmentations are applied to the task of rough salient segment transformation detection for alerting potential drivers of critical scene changes that may affect steering decisions. Trial results demonstrate that with little added computation, video segmentations can be utilized for salient region detection in traffic scenes with high accuracy, correctly detecting 80% of salient segment transformations in trial scenes with less than 5% false positives. Reducing high-level processing to salient areas using the proposed approach has the potential to significantly improve the processing efficiency of scene interpretation applications in intelligent vehicle systems.

In this paper, we describe a novel technique for detecting raindrops using in-vehicle camera images. The appearance of raindrops on a car windshield can depend on their background, so it is often difficult to detect them using conventional template matching methods, which are based on image features. Initially, we extract potential raindrop regions from images, before generating a rendered background image using a physical raindrop model based on the refraction of light rays. This rendered image is then used to identify true raindrops based on their similarity to the true background image. We propose a new model that approximates a raindrop shape as a spheroid section. This method can represent different raindrop shapes more adaptively and flexibly than conventional models, which approximate raindrops as a section of a sphere. We also extend the Maximally Stable External Regions algorithm to extract candidate raindrops and we identify three measures of image similarity using a Support Vector Machine algorithm. We conducted experiments that confirmed the effectiveness of the proposed technique.

In the present article our purpose is to share the design and some initial validation test results we have developed with a new extended cellular automata simulation model. Such new model is equipped to simulate both overtaking and two basic driving behaviour rough patterns. Some virtual drivers...
facilitate others drivers’ manoeuvres and some do not do so.

We explain the neighbourhood rules used, that incorporate virtual overtaking and giving way actions. It is achieved by means of a novel two passes per iteration approach which implies no resigning using a linear -- and lightweight -- cellular automata to implement overtaking.

Three different sets of experiments were carried out, using three different traffic network spots, as an initial validation study of the proposed new model. Results are encouraging. For the three situations, the simulated traffic seems to keep quite close to the sampled real traffic.

11:18-11:36 TA5.2
Extended Safety Descriptor Measures for Relative Safety Assessment in Mixed Road Traffic, pp. 752-757
Derbel, Oussama MIPS - UHA
Mourlión, Benjamin MIPS EA 2332 UHA
Basset, Michel Univ. of Haute-Alsace

Mixed traffic denotes the coexistence of two driving styles: human and automated driving. Until now, there has been an ambiguity about the driver’s safety in mixed traffic. Traffic safety studies focus on a synthesis of control laws which help drivers to avoid or mitigate collisions. Classic safety descriptors use only the time to collision, a time criterion for safety assessment. Other assess traffic safety through vehicle distance gap. In this paper, the Dwell Time descriptor is extended to evaluate safety from both time and distance criteria. The goal is to assess the impact of automated vehicles on driver safety.

11:36-11:54 TA5.3
Traffic Simulation Using Activity Related Information Acquisition from the Web, pp. 758-763
Chen, Songhang Chinese Acad. of Sciences
Zhu, Fenghua Inst. of Automation, Chinese Acad. of sciences

Activity related information is critical for traffic simulation based on activity. To replace time-consuming manual acquisition, this paper proposes an information extraction method based on ontology and frequent subtree to acquire place-related information from the Web automatically. A destination selection model based on Nested Logit is established to use this information in traffic simulation. To verify the method and model, information of places within Zhongguancun area is acquired from the Web, and then experiments with uniform design are carried out on artificial transportation systems and regression analysis is done.

11:54-12:12 TA5.4
A Cellular Automata Based Evacuation Model on GPU Platform, pp. 764-768
Miao, Qinghai Graduate Univ. Chinese Acad. of Sciences
Lv, Yisheng Chinese Acad. of Sciences
Zhu, Fenghua Chinese Acad. of Sciences

A simulation model of crowd evacuation based on the cellular automata is introduced. The implementation on GPU is focused in details. This model takes advantage of GPU to complete part of computing by certain allocation. Taking Guangzhou Tianhe stadium as an example, the model shows that the performance of computing has been significantly improved by parallel computing technique of GPU, which obtained nearly 15 times speed-up.

12:12-12:30 TA5.5
Car-Following Model with Multiple Predicting and Controlling Modules Based on Assumptions of Anticipation Behavior, pp. 769-775
Kasai, Makoto Tokyo Univ. of Science

Anticipation of driver actions may be a key factor in car-following behavior. Although many car-following models have been proposed, most of them are regarded as instantaneous feedback controllers. This paper considers taking anticipatory actions into account, as in feed-forward controllers. This paper retrofits this onto a previously proposed model assuming that drivers adjust acceleration to maximize instantaneous utility, adding predicting and controlling modules associated with different target times. The weight of each predicting module is updated depending on the circumstances of the driver over the last few seconds. This paper verifies that the proposed model improves estimation accuracy in terms of the root mean squared error of headway distance by calibration with observed car-following data from probe cars and video images. The goal of this model is future application in exploration of bottleneck phenomena.

TA6 Route Planning and Guidance (Regular Session) 11:00-11:18

11:00-11:18 TA6.1
Goh, Chong Yang Nanyang Tech. Univ.
Dauwels, Justin Nanyang Tech. Univ.
Mitrović, Nikola Nanyang Tech. Univ.
Asif, Muhammad Tayyab Nanyang Tech. Univ.
Oran, Ali SMART
Jaillet, Patrick MIT

In many Intelligent Transportation System (ITS) applications that crowd-source data from probe vehicles, a crucial step is to accurately map the GPS trajectories to the road network in real time. This process, known as map-matching, often needs to account for noise and sparseness of the data because (1) highly precise GPS traces are rarely available, and (2) dense trajectories are costly for live transmission and storage. We propose an online map-matching algorithm based on the Hidden Markov Model (HMM) that is robust to noise and sparseness. We focused on two improvements over existing HMM-based algorithms: (1) the use of an optimal localizing strategy, the variable sliding window (VSW) method, that guarantees the online solution quality under uncertain future inputs, and (2) the novel combination of spatial, temporal and topological information using machine learning. We evaluated the accuracy of our algorithm using field test data collected on bus routes covering urban and rural areas. Furthermore, we also investigated the relationships between accuracy and output delays in processing live input streams. In our tests on field test data, VSW outperformed the traditional localizing method in terms of both accuracy and output delay. Our results suggest that it is viable for low-latency applications such as traffic sensing.

11:18-11:36 TA6.2
Dynamic Optimal Routing Based on a Reverse Stackelberg Game Approach, pp. 782-787
Groot, Noortje Delft Univ. of Tech.
De Schutter, Bart Delft Univ. of Tech.
A game-theoretic approach to dynamic routing is proposed in order to maximize the traffic throughput on a freeway network. While existing methods of informing drivers of the approximate travel times for the alternative routes do not in general yield the system optimum, we can achieve a better performance by introducing a leader-follower game with monetary incentives. In particular, a control strategy is proposed in which the traffic authority (the leader) proposes a function that maps the possible travel times for a certain destination to positive or negative monetary incentives. Based on this function that is communicated via on-board computers, the drivers (followers) will rationally choose those travel times associated with an optimal distribution over the available routes. Finally, in return for the associated monetary value, the drivers are presented with a route that they should follow to the desired destination.

11:36-11:54 TA6.3

Campbell, Patrick
Univ. of Oklahoma
Havlicek, Joseph
Univ. of Oklahoma
Stevenson, Alan
Oklahoma Department of Transportation:
Barnes, Ronald
Univ. of Oklahoma

ITS applications throughout the United States use a variety of mapping technologies to efficiently relay traffic information to both traffic agents and the general public. This paper describes the findings of a nationwide survey of the mapping approaches taken by traveler information websites. The technologies used within the Oklahoma ITS architecture are also presented within the context of this survey. The mapping technologies discussed include ArcGIS, MapServer, HTML-based techniques, Google Maps, Bing Maps, and OpenLayers. The tradeoffs that would be considered when evaluating the use of mapping technologies in new or existing ITS applications are presented for comparison.

11:54-12:12 TA6.4

Azimuth Angle of GPS Data and Its Application in Map-Matching, pp. 796-801
Li, Lan
Hitachi (China) Res. & Development Corp.
Liu, Bo
Hitachi (China) Res. & Development Corp.
Lai, Yimin
Hitachi Beijing Tech. Information Systems Co., Ltd.
Tang, Xiaochun
Res. Center of Transport and Logistics
Ministry of Transport

Map-matching is to snap a series of GPS (Global Position System) points onto the road segments in the digital map, so as to estimate the actual trajectory of a moving object. It is an elementary process step for many applications, such as traffic flow analysis, fleet management, and driver assistance. In many existing approaches, the distance between GPS point and roads is a main factor for the position determination. From the year of 2011, a new feature called azimuth angle, which shows the instant driving direction of a vehicle, started to be utilized in our map-matching algorithm. So in this paper, we first studied the feasibility of azimuth angle in accuracy enhancement and then proposed a method to utilize it in candidate filtering. The experiment result shows that the proposed method can improve the efficiency as well as the accuracy of map-matching.

12:12-12:30 TA6.5

Automated Transportation Transfer Detection Using GPS Enabled Smartphones, pp. 802-807
Stenneth, Leon
Univ. of Illinois Chicago
Thompson, Kenville
The Graduate Center CUNY
Stone, Waldin
The Graduate Center CUNY
Alowibdi, Jalal
Univ. of Illinois Chicago

Understanding the mobility of a traveller from mobile sensor data is an important area of work in context aware and ubiquitous computing. Given a multimodal GPS trace, we will identify where in the GPS trace the traveller changed transportation modes. For example, where in the GPS trace the traveller alight a bus and boards a train, or where did the client stop running and start walking. Using data mining schemes to understand mobility data, in conjunction with real world observations, we propose an algorithm to identify mobility transfer points automatically. We compared the proposed algorithm against the state of the art that is used in the previously proposed work. Evaluation on real world data collected from GPS enabled mobile phones indicate that the proposed algorithm is accurate, has a good coverage, and a good asymptotic run time complexity.

TA7

Parallel Transportation Management Systems (Special Session)

Organizer: Zhu, Fenghua
Inst. of Automation, Chinese Acad. of sciences
Organizer: Rossetti, Rosaldo
Univ. do Porto - LIACC
Organizer: Kong, Qing-Jie
Shanghai Jiao Tong Univ.
Organizer: Li, Lefei
Tsinghua Univ.
Organizer: Miao, Qinghai
Graduate Univ. Chinese Acad. of Sciences

11:00-11:18 TA7.1

Quadtree-Based Domain Decomposition for Parallel Map-Matching on GPS Data (I), pp. 808-813
Xia, Yingjie
Hangzhou Normal Univ.
Liu, Yuncai
Shanghai Jiao Tong Univ.
Ye, Zhoumin
Hangzhou Inst. of Service Engineering, Hangzhou NormalUniver
Wu, Wei
Enjoyor Company
Zhu, Mingzhe
Hangzhou Inst. of Service Engineering, Hangzhou NormalUniver

This paper presents a quadtree-based domain decomposition method for matching Global Positioning System (GPS) data onto the digital map in parallel. The method uses two basic tools, quadtree and interval distance measurement. Quadtree is a structure which can facilitate to decompose massive GPS data in a domain into multiple data pieces in the sub-domains. These data pieces with the underlying boundary-extended maps create the computing tasks, which are assigned to Cyberinfrastructure (CI) resources for parallel map-matching. In the task, each GPS point measures the interval distances between itself and the projected points on the road segments surrounding in its sub-domain, and selects the shortest one to determine the mapped point. The experiments show that this method can achieve efficient speedup in computational time by load balancing, and keep high accuracy on the matching results.

11:18-11:36 TA7.2
A spatial short-term traffic flow prediction method based on the macroscopic urban traffic network (UTN) model is described and compared to the traditional time series forecasting methods. In this paper, a general UTN model is developed by adopting the transfer mechanism of vehicles between road links to represent the future distribution of vehicles in the whole network. Based on the model, we predict the short-term traffic flow without using any historical traffic data, which is completely different from previous approaches. Furthermore, to verify the effectiveness of the UTN-based prediction model, we compare it to four classic models including two parametric and two nonparametric methods with the data produced by CORSIM, a commonly used microscopic traffic simulation software. Finally, the comparative results illustrate that the proposed method can reach the level of classic methods and predict the short-term traffic flow timely and accurately both for the steady or suddenly changed traffic states.

Recently, it has been shown that Macroscopic Fundamental Diagrams (MFDs) existing in large scale urban traffic networks play an important role in dynamic traffic management, traffic signal control and mitigation of urban traffic congestion. A well defined MFD can be derived from a homogeneous urban traffic network with similar traffic conditions. In reality, however, most large scale traffic networks are usually heterogeneous networks with various road types and uneven distribution of congestion. In order to use the MFD concept for controlling the large scale urban traffic network through hierarchical or decentralized methods, it is necessary to exploit a network partition method, which should be both effective in extracting homogeneous sub-networks and fast to compute. In this paper, a new approach to calculate the data produced by CORSIM, a commonly used microscopic traffic simulation software. Finally, the comparative results illustrate that the proposed method can reach the level of classic methods and predict the short-term traffic flow timely and accurately both for the steady or suddenly changed traffic states.

This article presents a new approach to calculate the data produced by CORSIM, a commonly used microscopic traffic simulation software. Finally, the comparative results illustrate that the proposed method can reach the level of classic methods and predict the short-term traffic flow timely and accurately both for the steady or suddenly changed traffic states.

A Dynamic Network Partition Method for Heterogenous Urban Traffic Networks (I), pp. 820-825
Zhou, Zhao Shanghai Jiao Tong Univ.
Lin, Shu Shanghai Jiao Tong Univ.
Xi, Yugeng Shanghai Jiao Tong Univ.

11:36-11:54 TA7.3

12:12-12:30 TA7.5

S Canepa, Edward Esteban King Abdullah Univ. of Science and Tech.
Claudel, Christian King Abdullah Univ. of Science and Tech.

This article presents a new approach to calculate the data produced by CORSIM, a commonly used microscopic traffic simulation software. Finally, the comparative results illustrate that the proposed method can reach the level of classic methods and predict the short-term traffic flow timely and accurately both for the steady or suddenly changed traffic states.

Comparing Urban Traffic Prediction Methods between UTN-Based Spatial Model and Time Series Models (I), pp. 814-819
Xu, Yanyan Shanghai Jiao Tong Univ.
Kong, Qing-Jie Shanghai Jiao Tong Univ.
Liu, Yuncai Shanghai Jiao Tong Univ.

814-819

Zhou, Zhao Shanghai Jiao Tong Univ.
Lin, Shu Shanghai Jiao Tong Univ.
Xi, Yugeng Shanghai Jiao Tong Univ.

11:54-12:12 TA7.4

11:00-11:18 TA8.1

Edwards, Derek Georgia Inst. of Tech.
Elangoan, Arun Kumar RideCell, LLC
Watkins, Kari E. Georgia Inst. of Tech.

851-860
Due to the development of industry and commerce, the percentage of fuel consumptions and emissions of the transport sector is increasing in recent years. As a result, the levels of CO2 and other emissions have worsened the environment, and thus global-warming and air-pollution issues need to be incorporated within the planning and operation of transportation system. This research proposes two energy consumption and emission models for mixed traffic flows under a wide variety of advanced traffic management strategies. These two models are defined as the link-based and the trip-based fuel consumption and emission model. The link-based model is developed based on link characteristics, including static and dynamic attributes of the link, such as link length, number of vehicles, and average speed on links. The trip-based model calculates fuel consumption and emission based on trip characteristics, such as vehicle movement trajectory. These two models are integrated with a simulation assignment model, DynaTAIWAN. Numerical experiments are conducted to illustrate the proposed models. Traffic management strategies, including real-time information and advanced traffic control systems, are evaluated based on the performance of fuel consumption and emission. The experiment results show the models are robust and advanced traffic management strategies can indeed reduce fuel consumption and CO2 emission.

This paper proposes a deceleration intention indicating system, which indicates the shift to braking behavior of the leading vehicle before the brake maneuver is actually started. It aims to improve predictions and expectations by arousing attention for a following driver for a potential risk, and to reduce the risk of a rear-end collision by promoting early decelerating maneuvers. The method with Cover Brake pedal was designed in order to estimate deceleration intention with high certainty. Next, we performed the experiment to clarify effect of the system. The experimental results showed that the system was effective in improving accelerator release time (ART) and brake onset time (BOT) of the following driver.

In order to improve autonomous underwater vehicle's activity and expand the scope of its navigation, contactless power transmission technology has been widely spread in recent years. The contactless power transmission system is loosely coupled coupler connection, making the transmission efficiency of the system is greatly reduced. In this paper, we use soft-switching circuit to improve the transmission efficiency of system. By investigating the passive lossless snubber circuit with non-minimum voltage stress, this paper designs a novel passive lossless snubber circuit based on Buck converter. The experiment results show that the designed circuit can reduce the switching losses effectively and return the energy stored in the buffering process to power supply.

12:12-12:30  TA8.5  Electric Load Forecasting: A Multi-Agent Systems Approach, pp. 863-869
Mohsenian-Rad, Hamed  Univ. of California at Riverside

While electrification of the transportation system will help reduce greenhouse gas emissions and our dependency on imported oil, the growing number of PHEVs can also impose a significant volume of new load on electric grids. In this paper, we develop an agent-based behavioral transportation-model of Plug-in Hybrid Electric Vehicles (PHEVs) for the purpose of electric load forecasting in large urban areas. This model is intended to simulate the temporospatial dynamics of PHEVs' behavior due to the changes in a multitude of internal PHEV-related transportation attributes. The results from simulations highlighted the inverse correlation between PHEVs' charging time and electric load consumption. The proposed model did not attempt to fully explain the very complex behavior of PHEV agents within the transportation infrastructure, but was rather developed to provide a theoretical foundation to investigate any emergent temporospatial outcomes. The developed model is capable of incorporating external attributes such as collisions, and weather conditions for any future research.
This paper tries to present an overall concept and framework on a driver model with the intent to generate realistic traffic flow and motion while reflect the nature of driving characteristics. The proposed driver model is to simulate a driver's driving on the road with proper trajectory planning mechanism that takes into account of the surrounding environment, including lane and road geometry, surrounding obstacles, and traffic infrastructure; and a decision making process that "mentally" assess the situation for potential hazard or threat; “obey” traffic rules, and determine an optimum trajectory to follow safely and comfortably. Some simulation was conducted to demonstrate the concept and framework presented in this paper.

Optical Flow Based Head Movement and Gesture Analysis in Automotive Environment, pp. 882-887

Head gesture detection and analysis is a vital part of looking inside a vehicle when designing intelligent driver assistance systems. In this paper, we introduce an approach termed Optical flow based Head Movement and Gesture Analyzer (OHMeGA) which is user-independent, robust to occlusions from eyewear or large spatial head turns and lighting conditions, simple to implement and set-up, real-time and accurate. The intuitiveness behind OHMeGA is that it segments head gestures into head motion states and no-head motion states. This segmentation allows higher level semantic information such as fixation time and rate of head motion to be readily obtained. Performance evaluation of this approach is conducted under two settings: controlled in laboratory experiment and uncontrolled on-road experiment. Results show an average of 91.5% accuracy for in laboratory experiment and an average of 86.7% accuracy in on-road experiment.

Deciding What to Inspect First: Incremental Situation Assessment Based on Information Gain, pp. 888-893

In order to offer even more sophisticated functionality, future driver assistance systems need the ability to robustly recognize and understand driving situations. Especially in inner-city scenarios the high complexity and variability of situations encountered make their assessment a challenging task. We propose to tackle these challenges by decomposing situations into smaller, more manageable parts. We define such a part as a set consisting of a road user and all entities (e.g. cars, traffic lights) currently affecting its behavior. Though the decomposition alleviates the assessment already, for higher numbers of present entities the recognition of interrelated entities is still computationally expensive if performed in a brute-force fashion. Therefore we employ sensitivity analysis on Bayesian Networks for controlling the recognition process on the basis of information gain. This leads to an active measurement process in which a situation is perceived incrementally, concentrating first on the most meaningful sensor measurements. The proposed method is evaluated on a simulated inner-city scenario where it reliably recognizes the affecting entities of each road user. We show that a recognition process based on information gain can save more than 50% of measurements without significantly impairing the recognition rate.

Driver Behavior Classification Model Based on an Intelligent Driving Diagnosis System, pp. 894-899

This paper considers the problem of characterize the way people drive applied to driver assistance systems and integrated safety systems without using direct driver signals. To make this, is proposed the design of a driver behaviors classifier based on a previous intelligent driving diagnosis system development by us [1]. This, take into account signals that can be acquired by a GPS data logging system: position, velocity, accelerations and steering angle. The proposed classifier presents the structure of an intelligent driver behaviors model based on neural networks and using as inputs statistical transformations of the driving diagnosis time signals: steering profiles, pedals uses, speeding and getting out of the lane and road. The validation of this classifier is developed in two applications: driver identification for security systems and to classify a driver into one of two categories, aggressive and moderate. The proposed approach has been implemented in real environment and its performance tested in simulation runs. Experimental results presented in this paper shows that our intelligent driving diagnosis system is able to classify different kinds of drivers with a high degree of reliability.

On-Ramp Traffic Merging Using Cooperative Intelligent Vehicles: A Slot-Based Approach, pp. 900-906

The merging of main road and on-ramp traffic is known to lead to congestion under heavy traffic conditions. This is mainly due to the underutilization of the road infrastructure and the lack of efficiency in the way the in which the merging manoeuvre is performed by human drivers. We propose a merging algorithm based on our previous work on slot-based driving which employs cooperation between vehicles within the main motorway as well as between motorway and on-ramp vehicles to achieve a highly efficient merging. The results of the evaluation show that our algorithm achieves a very high throughput and low delay on the on-ramp and
clearly outperforms the merging performed by VISSIM's human driver model.

Attachment. The video is showing the VISSIM simulation of on-ramp merging performed by the proposed slot-based algorithm (main video) versus human drivers as emulated by VISSIM (small video appearing after 10 seconds, shown as picture-in-picture on the top right corner). In both cases, a main road flow of 4700 vehicles/hour and on-ramp flow of 2000 vehicles/hour were used. Note that in the human drivers case, a car waiting in the merging queue for more than 30 seconds is dissolved by VISSIM in an attempt to better simulate the overall impact of the merging.

14:18-14:36 TB2.2 Inter-Vehicle Sensor Fusion for Accurate Vehicle Localization Supported by V2V and V2I Communications, pp. 907-914
Conde Bento, Luis Inst. de Sistemas e Robotica
Manuel
Nunes, Urbano Inst. de Sistemas e Robotica
Parafita, Ricardo Jorge Inst. de Sistemas e Robotica - Pedrosa Univ. de Coimbra

Cooperative driving system techniques aim to minimize accidents, traffic congestion and consequently the environmental costs of road traffic. An accurate vehicle's pose is of extreme importance for the inner working of the traffic management systems. A agent based traffic simulator was developed integrating typical automotive sensors, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, vehicle agents and infrastructure agent. In this paper, we propose to further enhance a multi-sensor localization algorithm in environments where V2V and V2I communication is possible. This paper describes a inter-vehicle sensor fusion for an accurate vehicle positioning, where each vehicle is modeled by an agent, and each agent provides information depending on its vehicle sensors. A broad range of sensor were simulated: GNSS, wheel and steering wheel encoders, laser range finder and magnetic markers sensor. In the first fusion stage, data from four wheel encoders and one steering encoder are fused by means of an EKF, providing robust odometric information, namely in face of undesirable effects of wheels slippage. Next, a second fusion stage is processed for integrating odometric and inter-vehicle absolute positioning data. The sensor fusion methodology presented is constrained to an a limited zone on a intersection range.

Attachment. This video shows the simulation of a inter-vehicle sensor fusion algorithm using the ISR-Traffic Simulator (ISR-TFS). A platoon of two vehicles is simulated, to illustrate the algorithm used by the preceding vehicle, to improve its own estimated position. To compute an accurate pose the following vehicle will use its own wheel and steering wheel encoders and detected magnets, in addition to the LIDAR detected preceding vehicle’s accurate position, given by the preceding RTK-GPS and preceding detected magnets. The preceding vehicle information is shared with the following vehicle using V2V. Author contact information:L.C. Bento, R. Parafita and U. Nunes are with the ISR-Institute of Systems and Robotics, University of Coimbra, Portugal.L.C. Bento is also with the Electrical Department, Polytechnic Institute of Leiria, Portugal. email: conde, parafita, urbano@isr.uc.pt.

14:36-14:54 TB2.3 Urban Vehicle-To-Infrastructure Wireless Communications Range Evaluation, pp. 915-920
Hyncica, Ondrej Brno Univ. of Tech.
Honzik, Petr Brno Univ. of Tech.

Kucera, Pavel Brno Univ. of Tech.
Pavlata, Karel Brno Univ. of Tech.

We consider the problem of information propagation for traffic management applications of Intelligent Transportation Systems in urban areas. In this paper is described a system for measurement of communication range of vehicular wireless communications, method for processing and interpreting the measured data and the initial results. The measurement system is designed to provide an estimate on radio propagation and coverage in vehicular applications in urban areas and the focus is on evaluation of the communication coverage for IEEE 802.11 and IEEE 802.15.4 standards based wireless communication systems. The data collected with the described test system are made available online at http://project-bay.eu/v2x-dataset.

14:54-15:12 TB2.4 Mobility-Assisted Fast Handover for Proxy Mobile IPv6 in Vehicle-To-Infrastructure Communications, pp. 921-926
Lu, Henghui Tsinghua Univ.
Zhang, Sheng Tsinghua Univ.
Lin, Xiaokang Tsinghua Univ.

Vehicle-to-infrastructure (V2I) communications enable various applications for transportation, help improve road safety, transportation efficiency and comfort of travel. As vehicles change their point of attachment frequently, seamless handover becomes one of the most challenging research issues for supporting these applications. In this paper, we propose a fast handover for Proxy Mobile IPv6 (PMIPv6) to provide seamless mobility of vehicles. The proposed scheme tackles the spatial and temporal prediction issue in Fast Handover for Proxy Mobile IPv6 (FPMIPv6) with the aid of mobility information, pre-stored access point (AP) placement information and received signal strength (RSS). It also uses a pre-established backup binding and a tunnel between previous mobile access gateway (PMAG) and new mobile access gateway (N MAG) to reduce handover latency and packet loss. Analytical and simulation results show that the overall handover latency and packet loss can be significantly reduced in the proposed scheme compared with other related schemes.

TB3 Detection of Driving Environment 2 (Regular Session)
14:00-14:18 TB3.1 Can Priors Be Trusted? Learning to Anticipate Roadworks, pp. 927-932
Mathibela, Bonolo Univ. of Oxford
Osborne, Michael A. Oxford Univ.
Posner, Ingmar Oxford Univ.
Newman, Paul Univ. of Oxford

This paper addresses the question of how much a previously obtained map of a road environment should be trusted for vehicle localisation during autonomous driving by assessing the probability that roadworks are being traversed. We compare two formulations of a roadwork prior: one based on Gaussian Process (GP) classification and the other on a more conventional Hidden Markov Model (HMM) in order to model correlations between nearby parts of a vehicle trajectory. Importantly, our formulation allows this prior to be updated efficiently and repeatedly to gain an even more accurate model of the environment over time. In the absence of, or in
addition to, any in-situ observations, information from dedicated web resources can readily be incorporated into the framework. We evaluate our model using real data from an autonomous car and show that although the GP and HMM are roughly commensurate in terms of mapping roadworks, the GP provides a more powerful representation and lower prediction error.

14:18-14:36
TB3.2
Generator of Road Marking Textures and Associated Ground Truth Applied to the Evaluation of Road Marking Detection, pp. 933-938

Revilloud, Marc
IFSTTAR
Gruyer, Dominique
IFSTTAR
Pollard, Evangeline
Inria-Rocquencourt

To increase driving safety, many researchers work on Advanced Driving Assistance Systems (ADAS) have been developed and embedded in real prototypes during the last decades. For some of these applications like Lane Keeping System (LKS), lane perception is an essential task. For others applications like Emergency Brake Assist (EBA), lane perception modules provide useful information helping the system to select only the most dangerous obstacles. Proposed solutions to perform lane detection become more and more elaborated, however no generic solution has been proposed to calculate performances of these algorithms. Lots of solutions have been proposed to perform this lane detection. However, no generic solution has actually been proposed to quantify the quality of such applications. It is appearing that this evaluation task is now very important and critical. Most of the existing evaluation stages can be classified in two main parts. In the first case, evaluation is based on natural images databases with ground truth of road marking and/or geometrical truth of lanes. In the second case, evaluation uses virtual data and simulated images. The first one is relatively hard to perform because it is based on manual labeling of natural images. The second one has automatic labeling clustering but a realistic virtual environment is required and more precisely both realistic road bitumen and road marking textures. This paper presents an efficient solution in order to simulate roads enviro

14:36-14:54
TB3.3
Automated Lane Identification Using Precise Point Positioning: An Affordable and Accurate GPS Technique, pp. 939-944

Knoop, Victor L.
Delft Univ. of Tech.
Buist, Peter J.
Delft Univ. of Tech.
Tiberius, Christiaan C.J.M.
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van Arem, Bart
Delft Univ. of Tech.

Nowadays, many vehicles are equipped with GPS navigation systems, that are accurate to approximately 10 meters. This is insufficient to determine the lane a vehicle is driving in. We introduce a new technique, Precise Point Positioning, which is able to get the accuracy of measurement down to approximately half a meter, without having to resort to expensive high-end GPS receivers. This accuracy is possible with a single measurement of position in real-time. We confirm this accuracy in a real-life test with a vehicle driving at motorway speeds. However, even when the vehicle position is known, the driving lane is not known since there are generally no maps with detailed lane information. Therefore, this paper also presents a self-learning method, using this Precise Point Positioning information, to create maps which include the position of lanes. This method is tested using an artificially created dataset, using the accuracies from the real-world test. This shows that the method can get the position of a lane at an accuracy of 20 cm. The combination of accurate information of the position of a vehicle and information about the position of the lane, can be used to give lane-specific advice for drivers, and can even be a step towards automated driving.

14:54-15:12
TB3.4
Model Based Vehicle Localization for Urban Traffic Surveillance Using Image Gradient Based Matching, pp. 945-950

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Chinese Acad. of Sciences
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The matching between 3D model projection and 2D image data is a key technique for model based localization, recognition and tracking problems. Firstly, we propose a fitness function to evaluate the matching degree that uses image gradient information in the neighborhood of model projection. The weighting adjustment and the normalization for visible model projection are involved, which improves the correctness and robustness of fitness function. The fitness function is used for vehicle localization and the 3D pose is reduced to location and orientation. Then, we present a direct search optimization method with 3X3 search kernel for location estimation. The “disturbed particles” is used to avoid falling into local optimum and the coarse-to-fine optimization strategy is adopted to greatly reduce computational cost. Finally, we propose a 3D pose estimator to find location and orientation by optimizing the fitness function within orientation range. Experiments on real traffic surveillance videos reveal that the proposed optimization algorithm is effective and both fitness function and 3D pose estimator are correct and robust against clutter and occlusion.
Unattended camera devices are increasingly being used in various intelligent transportation systems (ITS) for applications such as surveillance, toll collection, and traffic enforcement. In these fielded systems, a variety of factors can cause camera obstructions and persistent view changes that may adversely affect their performance. Examples include camera misalignment, intentional blockage resulting from vandalism, and natural elements causing obstruction, such as foliage growing into the scene and ice forming on the pavement. In addition, other persistent view changes resulting from new scene elements of interest being captured, such as stalled cars, suspicious packages, etc., might warrant alarms.

Since these systems are often unattended, it is often important to automatically detect such incidents early. In this paper, we describe innovative algorithms to address these problems. A novel approach that uses the image edge map to detect near-field obstructions without a reference image is presented. For the unobstructed scene is presented. A second algorithm that can be used to detect more generic obstructions and persistent view changes using a learned scene element cluster map is then discussed. Lastly, an approach to detect and distinguish persistent view changes from changes in the orientation of the fixed camera system is explained. Together, these algorithms can be useful in a variety of camera-based ITS applications.

Automated, unattended camera systems used for various transportation applications such as toll collection and photo enforcement need to capture high quality images in a variety of outdoor scenarios. In particular, they need to remain functional in low ambient illumination conditions (nighttime and cloudy day situations) to enable identification of objects or persons involved in incidents being monitored or extracting relevant information. Over time, for installed camera systems in the field, several problems can develop, such as external flash unit failures, focus drifts, and exposure issues. Thus, it is important to periodically monitor the nighttime images/videos taken by the camera system to ensure nominal functionality. However, due to constantly changing scene elements, it is not practical to compare a historical reference image with an identical scene against current camera output to detect problems. To address this, we present image quality metrics that can be extracted without a nominal reference image and can be used to characterize these problems. These can be incorporated into algorithms that can enable automated camera diagnostics for intelligent transportation systems.

A novel system for detection and tracking of vehicles from a single camera is presented. The core of the system is high-performance vision algorithms: the WaldBoost detector and the TLD tracker that are scheduled so that a real-time performance is achieved.

The vehicle monitoring system is evaluated on a new dataset collected on Italian motorways which is provided with approximate ground truth obtained from laser scans. For a wide range of distances, the recall and precision of detection for cars are excellent. Statistics for trucks are also reported. The dataset with the ground truth is made public.

### Attachment

Persistent vehicle detection and tracking from a single camera in motorway scenario, in different traffic and varying lighting conditions. Results are compared with a “Ground Truth” automatically generated from lasercan scanner data. See Readme file for full explanation.
A System for Storing and Retrieving Huge Amount of Trajectory Data, Allowing Spatio-Temporal Dynamic Queries, pp. 989-994

d'Acicerno, Antonio
Leone, Marco
Saggese, Alessia
Vento, Mario

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In the framework of intelligent traffic surveillance, we propose a system for efficiently storing and retrieving moving objects' trajectories extracted from surveillance cameras. We index spatio-temporal data by using a method based on off-the-shelf (widely available) bi-dimensional indexes and enhanced by a segmentation stage. The proposed system does not restrict the choice of the parameters of range queries at query time, unlike clustering and similarity-based methods do. The experimental results, obtained on a standard PC-based system both on a well known real-world trajectory dataset and on synthetic data, confirm the efficiency of the proposed approach.

Multi-Objective Traffic Light Control System Based on Bayesian Probability Interpretation, pp. 995-1000
Khamis, Mohamed A.
Gomaa, Walid
El-Shishiny, Hisham

Egypt-Japan Univ. of Science and Tech. (E-JUST)
Egypt-Japan Univ. of Science and Tech. (E-JUST)
IBM Center for Advanced Studies

In this paper, we present an approach for evaluating traffic performance along corridors and its variation based on floating car data (FCD). In contrast to existing work, our approach can cope with long and irregular FCD reporting intervals. Resampling of sparse FCD in time and interpolation increases spatial resolution of FCD positions along the corridors. FCD position density is computed with a uniform kernel, which leads to traffic performance expressed as average travel time per meter and average speed. Experimental results based on real-world FCD for a freeway section and arterial roads in Vienna illustrate the plausibility of the approach, and an example illustrating our approach before and after a traffic influencing measure shows its advantage over using dedicated probe vehicle runs, temporary sensor installations or human observers. A sensitivity analysis provides guidelines for the important parameters.

Route Guidance and Demand Analysis Using Taxi Data (Regular Session)

Aslam, Javed
Lim, Sejoon
Rus, Daniela

Northeastern Univ.
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In this paper, we present a congestion-aware route planning system. First we learn the congestion model based on real data from a fleet of taxis and loop detectors. Using the learned street-level congestion model, we develop a congestion-aware traffic planning system that operates in one of two modes: (1) to achieve the social optimum with respect to travel time over all the drivers in the system or (2) to optimize individual travel times. We evaluate the performance of this system using 10,000+ taxis trips and show that on average our approach improves the total travel time by 15%.
In the last decade, the real-time vehicle location systems attracted everyone attention for the new kind of rich spatio-temporal information. The fast processing of this large amount of information is a growing and explosive challenge. Taxi companies are already exploring such information in efficient taxi dispatching and time-saving route finding. In this paper, we propose a novel methodology to produce online short term predictions on the passenger demand spatial distribution over 63 taxi stands in the city of Porto, Portugal. We did so using time series forecasting techniques to the processed events constantly communicated for 441 taxi vehicles. Our tests - using 4 months of real data - demonstrated that this model is a true major contribution to the driver mobility intelligence: 76% of the 86411 demanded taxi services were accurately forecasted in a 30 minutes time horizon.

As urbanization increases rapidly, there is a need for better understanding of the city and how it functions. Increasing digital data produced by the city's inhabitants holds great potential for doing so. In this work, an analysis of mobile phone call intensity and taxi volume in Lisbon, Portugal was carried out. With one source of data describes how city operates socially over mobile phone network and the other characterizes urban dynamic in traffic network, we discovered the inter-predictability between them. Based on one month of observation, we found that the variation in the amount of mobile phone calls was strongly correlated with the taxi volume of the previous two hours. Hence taxi volume can be used to predict mobile phone call intensity of the next two hours. In addition, we found that the level of inter-predictability varied across different time of the day; taxi was a predictor during PM hours while mobile phone call intensity became a predictor for taxi volume in AM hours. Strong correlations between these two urban signals were observed during active hours of the day and active days of the week.

Route planning is a core part of the traffic information system. Conventional route planning models rely heavily on an improved weighted shortest path algorithm, while this paper proposes a route planning methodology based on taxis' experienced travels. Taking advantage of the data from floating cars, the framework explores drivers' experience in route choices, extracts taxis' operating behaviors to establish the database of experienced routes, and repairs incomplete and abnormal routes to update the database. Given the starting and ending segments, alternative experienced route choice set can be obtained by traversing the database. Taking the road network and taxis' GPS data of Guangzhou city for instance, we make comparisons of the shortest paths and experienced ones, and focus on their differences in factors like length, turning frequency, frequency of signalized intersections, travel time, etc. Various numerical results are documented to show that experienced routes appear better considering all the factors than shortest-distance or shortest-time routes.

### TB7

**Lane Level Traffic Management (Regular Session)**

14:00-14:18 TB7.1

**Dynamic Lane Separation to Prevent Blocking Back - a Comparison of Two Dynamic Lane Separation Controllers**, pp. 1032-1037

Soekroella, Aroen

TU Delft

Hegyi, Andreas

Delft Univ. of Tech.

Hoogendoorn, Serge

Delft Univ. of Tech.

van Kooten, Jaap

Arane

Blowning back is one of the major causes of degradation of freeway network performance. When a freeway diverge one of the outgoing links is jammed, the traffic heading to the other outgoing link will often also be delayed due to the back-propagation of the jam tail into the common area upstream of the diverge. Most approaches consider this as a secondary effect of the real bottleneck on the congested link, and use this as a motivation to try to resolve the bottleneck. While this is a valid approach, in some cases this is not possible, and the traffic heading to the non-congested outgoing link will suffer from a bottleneck that is not even on their route. Here we solve the blocking back problem by separating the traffic toward the two outgoing links by dynamic lane allocation. We analyze the jam propagation and traffic state evolution for the cases with and without dynamic lane separation. Next we develop two control approaches, one based on the queue tail location and the other based on the shock wave theoretical considerations. The two controllers are evaluated by microscopic simulations for their resulting performance in terms of total travel time. The simulation results indicate that the queue tail location based controller is superior to the shock wave theory based controller.

14:18-14:36 TB7.2

**Simulation-Based Benefit Evaluation of Dynamic Lane Grouping Strategies at Isolated Intersections**, pp. 1038-1043

Wu, Guoyuan

Univ. of California-Riverside

Boriboonsomsin, Kanok

Univ. of California-Riverside

Zhang, Liping

Univ. of California, Berkeley

Barth, Matthew

Univ. of California-Riverside

Unlike conventional traffic signal control strategies, which assume that an intersection's geometric configuration is given as an exogenous input, dynamic lane grouping (DLG) strategies aim to further improve roadway capacity utilization under significant traffic demand variation. This is accomplished by dynamically adjusting the turning movement assignments for each lane. Previous numerical analyses have demonstrated that such a DLG strategy is effective in balancing lane flow ratios and reducing intersection delays.
This paper presents an evaluation of a DLG strategy's benefits at an isolated intersection using microscopic traffic simulation. It is demonstrated that such a DLG strategy can provide significant mobility and sustainability benefits over conventional strategies.

14:36-14:54 TB8.3
A Genetic Fuzzy System for Modeling Mandatory Lane Changing, pp. 1044-1048
Hou, Yi
Univ. of Missouri-Columbia
Edara, Praveen
Univ. of Missouri-Columbia
Sun, Carlos
Univ. of Missouri-Columbia

A Fuzzy Logic-based lane changing model was developed for mandatory lane changes at lane drops. Genetic Algorithm was used for optimizing the widths of membership functions. The Next Generation Simulation (NGSIM) dataset of vehicle trajectories was used for model development and validation. The model performed better than a comparable binary Logit model in terms of predicting the merge and non-merge events. The model has applications in traffic simulation and driver assistance systems.

14:54-15:12 TB8.4
Using a Centralized Controller to Optimize the Traffic of Intelligent Vehicles in a Single Lane Highway Provided with a Suicide Lane, pp. 1049-1054
Reghelein, Ricardo
Univ. Tecnológica Federal do Paraná
Arruda, Lúcia Valéria Ramos
Univ. Tecnológica Federal do Paraná (UTFPR)

This paper presents a mathematical solution to optimize the microscopic centralized traffic management of intelligent vehicles in a single lane highway provided with a suicide lane. Therefore an optimization model that uses the travel time as criteria is proposed. The model considers important elements of a highway system such as capacity of acceleration of each vehicle, traffic rules and topography of the lane. It deals with traffic situations such as overtaking, slopes, obstacles, and speed reducers. As the model takes time to run, a simulation algorithm is also proposed. The results of the algorithm provide also references to solve the problem of overtaking priority. Moreover, new indexes for microscopic traffic assessment are proposed. Experimental results are presented to evaluate both the model and the algorithm.

14:18-14:36 TB8.2
Analysis of Impact Factors for Plug-In Hybrid Electric Vehicles Energy Management, pp. 1061-1066
Khayyer, Pardis
The Ohio State Univ.
Wollaeger, James
The Ohio State Univ.
Onori, Simona
The Ohio State Univ.
Marano, Vincenzo
The Ohio State Univ.
Ozugner, Umit
The Ohio State Univ.
Rizzoni, Giorgio
The Ohio State Univ.

Energy management strategies play a critical role in the fuel consumption of hybrid and Plug-in Hybrid Electric Vehicles (PHEV). Most advanced energy management techniques may be further optimized by help of information obtained from Intelligent Transportation Systems (ITS). Following the previously studied impact factors on PHEV energy consumption, in this paper new impact factors are studied. Energy consumption associated with these factors is investigated for subsequent development of energy management strategies in optimizing fuel economy.

14:36-14:54 TB8.3
Research on Shift Schedule of Hybrid Bus Based on Dynamic Programming Algorithm, pp. 1067-1071
Yu, Hui-long
Beijing Institute of Tech.
Xi, Junqiang
Beijing Institute of Tech.
Chen, Yongdan
Beijing Institute of Tech.

In this paper, shift schedule of a hybrid bus equipped with Automated Mechanical Transmission (AMT) is researched. Although the one-parameter or two-parameter shift schedule is usually used for hybrid buses, this approach cannot make full use of the advantage of hybrid driving. A new shift schedule, which is based on Dynamic Programming algorithm, is proposed for hybrid buses, a solving algorithm is also presented. The best shifting points for the hybrid buses are obtained via the proposed shift schedule when they work in the typical urban driving-cycle conditions in China. After comparing with the traditional two-parameter shift schedule and the best fuel economy shift schedule, the best shifting points are proved to significantly improve the fuel economy of the hybrid buses and the frequent shifting situation is obviously reduced.

14:54-15:12 TB8.4
Deviations in Markov Chain Modeled Electric Vehicle Charging Patterns from Real World Data, pp. 1072-1077

IEEE ITSC 2012 PROGRAM
Within this paper a Markov chain is used to simulate the charging and driving behavior of a cohort of electric vehicles. The probability transition matrix is constructed by analyzing the real world data from an ongoing Electric Vehicle (EV) trial, Switch EV. The vehicles are split into a combination of drive, park and charge states as well as low, mid and high state of charge. The Markov chain is formed from the probability of transitioning between each state for a specified time period. The Markov chain produced results from both work and home based charging regimes that correlate well with the real world results with modeled results showing the features present in real world data. From comparisons of fresh sample runs to the ideal modeled charging distribution it can be seen that the Markov chain has little systematic difference between the ideal distribution and the newly generated distribution within a short period of time. The Markov chain was used to investigate the effect on the charging pattern from a large perturbation of the vehicle state population. It is found that despite initial fluctuations to the charging pattern, which qualitatively correspond with expectations, the population distribution settles down into the typical pattern within 1-2 days.

Estimating the energy consumption of electric vehicles accurately along a given route is an important prerequisite for increasing their acceptance. In this paper, an algorithmic framework for interpolating a track described by a set of waypoints using sub-splines is presented. Furthermore, the velocity and acceleration a driver would choose is simulated along the course. The results are evaluated by comparing them to real consumption measurements of an electric vehicle during a test drive.

Speeding is one of the most prevalent contributing factors in traffic crashes. The prediction of speeding is important for reducing excessive speeds and preventing speeding-related traffic accidents and injuries. Speeding (either intentional or unintentional) is a consequence of inappropriate speed control. This work extends a previous mathematical model of driver speed control to provide quantitative predictions of intentional and unintentional speeding. These predictions consist of the time at which the driver exceeds the speed limit and the magnitude of speeding. Based on these modeling predictions, this work develops an intelligent speeding prediction system (ISPS) to prevent the occurrence of speeding. An experimental study using a driving simulator is conducted to evaluate ISPS. We find no significant difference between modeled predictions and experimental results in terms of the time and magnitude of intentional speeding. Also, ISPS can successfully predict the majority of unintentional speeding instances, with only a small portion of unnecessary speeding warnings (false alarms). Applications of the ISPS to reducing driving speed, and preventing the real-time occurrence of speeding and speeding-related traffic accidents are discussed.

Speed is one of the main contributors to the occurrence and to the impact of road accidents. Intelligent Transport Systems can play a significant role in the improvement of traffic safety as well as the reduction of greenhouse gas emissions. Combining Intelligent Speed Assistance with limitation of the number of engine revolutions was expected to have positive effects. It was however unclear to what extent such a Context Aware Intelligent Speed Adaptation system influences acceleration and speed in relation with the prevailing maximum speed limit, fuel consumption as well as to what extent users accept the system. Furthermore, it was not clear what the subjective estimate of the impact of this system on driving behavior and safety is. Therefore, an extensive Field Operational Test in the Dutch city of Leiden and neighboring cities was performed with a repeated measures design. Eighteen taxis participated in this FOT, consisting of a control condition (no device) and two experimental conditions. We show that the system has a substantial influence on acceleration and speeding behavior. However some unanticipated results with regard to fuel consumption were established. Furthermore, acceptance of the system is generally low. A substantial influence on the subjective estimates of the impact of the system on driving behavior and safety was found. Finally in this contribution a discussion section and recommendations for future research are provided.

Speeding Prediction with a Mathematical Model and Its Validation, pp. 1085-1090
Zhao, Guozhen
Inst. of Psychology, Chinese Acad. of Sciences

The paper develops a heuristic optimization algorithm for automated vehicles (equipped with cooperative adaptive cruise control CACC systems) at uncontrolled intersections using a game theory framework. The proposed system models the automated vehicles as reactive agents interacting and collaborating with the intersection controller (manager agent) to minimize the total delay. The system is evaluated using a case study considering two different intersection control scenarios: a four-way stop control and the proposed intersection controller framework. In both scenarios, four automated vehicles (a single vehicle per approach) was simulated using a Monte Carlo simulation that was repeated 1000 times. The results show that the proposed system reduces the total delay relative to a traditional stop control by 35 seconds on average, which corresponds to an approximately 70 percent reduction in the total delay.
Vehicle forward collision imminent braking (CIB) systems have been equipped in high-end passenger vehicles by many auto manufacturers. Due to the complex nature of the CIB technology, the features and performance of various CIB systems differ significantly. As to date, there are no standards to evaluate and compare different CIB systems. This paper describes a systematic methodology for the evaluation of CIB systems which include both braking and warning. The percentage kinetic energy reduction is used as a common unit to allow the evaluation of the performance of both CIB braking and CIB warning. The information collected from some ongoing vehicle active safety testing projects will be used to validate the proposed methodology.

Recently several artificial intelligence labs have suggested the use of fully equipped vehicles with the capability of sensing the surrounding environment to enhance roadway safety. As a result, it is anticipated in the future that many vehicles will be autonomous and thus there is a need to optimize the movement of these vehicles. This paper presents a new tool for optimizing the movements of autonomous vehicles through intersections: iCACC. The main concept of the proposed tool is to control vehicle trajectories using Cooperative Adaptive Cruise Control (CACC) systems to avoid collisions and minimize intersection delay. Simulations were executed to compare conventional signal control with iCACC considering two measures of effectiveness - delay and fuel consumption. Savings in delay and fuel consumption in the range of 91 and 82 percent relative to conventional signal control were demonstrated, respectively.

This paper compares vehicle speeds before and at 12-months after DSFS installation. Overall the signs were effective in reducing mean and 85th percentile speeds. The evaluation also showed that the signs produced a significant reduction in the percent of vehicles traveling over the posted or advisory speed.

The utility of this particular ITS application is that these systems specifically target drivers who are speeding rather than all drivers. In this way, the system “interacts” with an individual driver and may lead to better compliance since the message appears more personalized.

**Computation of Driver Safety Rating Using In-Vehicle Data Recorders: Case Study of Bangkok Public Transportation, pp. 1121-1126**
Saiprasert, Chalermpol National Electronics and Computer Tech. Center
Pattara-atikom, Wasan National Electronics and Computer Tech. Center

This paper proposes a novel algorithm for the computation of Driver Safety Rating. The Driver Safety Rating is evaluated by detecting dangerous driving patterns based on vehicles data collected via in-vehicle data recorder. Dangerous driving patterns include rapid acceleration, harsh braking and driving over the speed limit and four triggering events are used in the proposed algorithm. A case study using real world data from public mini vans operating throughout Bangkok is deployed in this work. In addition to the proposed algorithm, a fine tuning technique to adjust the calculation process is introduced. An online survey is used to collect passengers feedback in the form of a score to reflect how they actually feel about the safety aspect of the journey. The proposed algorithm is then finely tuned in order to optimise for the scores derived from passengers feedback. Experimental results reveal that only two of the four triggering events have a significant impact on the overall computation of the Driver Safety Rating for this given set of data.

**GIS-Based Road Safety Evaluation Model for Cyclist in Campus of Higher Education Mega Center, pp. 1127-1131**
Hu, Jihua Sun Yat-sen Univ.
Zhong, Guangpeng Sun Yat-sen Univ.
Cheng, Zhifeng Sun Yat-sen Univ.
Wang, Dalei Beijing Jiaotong Univ.

In China, many cities construct Higher Education Mega Centers (HEMC) in large-scale, but HEMC's construction is finished in a short period, many problems have no time to discuss and be left unsolved, especially in road traffic. For example, in these years, there are many road accidental injuries to the students in HEMC; most of them are cyclists, for bicycle is the main traffic vehicle of campus students. This paper summarizes four main factors that influence the cyclist safety in campus: slope gradient, road curvature, the distance approaches to the intersections and other special factors (like rainy day) that contribute to the road risk. By using of S-type function in Fuzzy Mathematics, the forward three main risk factors are quantified and normalized, and a comprehensive safety evaluation model for cyclist is established. The east campus of Sun Yat-sen University in GZ HEMC has been used as an application of the road risk distribution model. With the help of GIS software, all risk values of points in road are interpolated through sample points by DTM function, and the risk DTM is overlaid on the remote sensing image of the same.
area. Finally a risk distribution map along road for cyclists of campus in sunny days is created, so does in rainy days. Through field based interviews, we can prove that risk distribution map is in accord with realistic bicycle crash locations, it can serve as a basis reference for improving cyclist safety in campus of HEMC, as well as a safety infr

16:54-17:12 TC2.4
Rail Extraction Technique Using Gradient Information and a Priori Shape Model, pp. 1132-1136
Corsino Espino, Jorge
Mines Paris-Tech.
Stanciulescu, Bogdan
Ec. des Mines de Paris (ParisTech)

This paper presents a comparative study of different rail detection techniques as well as a new method based on an efficient algorithm without any empirical thresholds. The main problem with rail detection is that both the track-bed and the exterior conditions (weather/light conditions) vary along the path. On the other hand, there are properties that can be exploited to improve the conventional lane detection. We present an edge detection based on the estimated position of the rails that follows the rail edges upwards in the image, determining a free-from-obstacles space. The existing techniques are also analyzed and compared.

17:12-17:30 TC2.5
Investigating Pedal Errors and Multi-Modal Effects: Driving Testbed Development and Experimental Analysis, pp. 1137-1142
Tran, Cuong
Univ. of California, San Diego
Doshi, Anup
Univ. of California, San Diego
Trivedi, Mohan M.
Univ. of California at San Diego

These days, Intelligent Driver Assistance Systems (IDAS) for driving safety enhancement have an increasingly important role. Although there have been a large amount of related research studies in this area, developing an efficient assistance system, which can perceive and assist the driver in a non-intrusive and naturalistic manner, is still an open question. Due to the diverse characteristics and safety issue of driving, one initial and major difficulty in studying and developing such systems is to have adequate infrastructure testbeds with multi-modal sensing and displays. In this paper, we introduce two multi-modal driving testbeds (including both a real-world vehicle and a driving simulator) that we have been developing for years in our laboratory. Based on these testbeds, we describe two novel joint audio visual driving experiments and databases that we have built for investigating driver pedal misapplication error phenomenon in traffic accident prevention. We will then discuss our analysis towards understanding some factors influencing driver pedal errors including driver workload, sequential effect, and cue modality (i.e. audio visual stimuli) as well as a possibility to predict and mitigate pedal errors to some extent using our approach for modeling and prediction of driver foot behavior.

1143-1148
Li, Zhixia
Univ. of Wisconsin-Madison
Yang, Qingyan
Iteris Inc.
Wei, Heng
Univ. of Cincinnati

Considering the fact that more than 40 percent of US vehicle traveled miles are on the arterial roads, how to cost-effectively monitor and estimate the arterial congestion levels using data from existing ITS facilities is highly demanded by government agencies. This paper aims at evaluating the effectiveness in traffic status estimation of an alternative approach which uses a combination of volume and occupancy data obtained from existing system detectors placed on the arterial corridor. In doing so, the concept of V-Plus-O (%V plus Occupancy) is used in the paper. This concept combines the volume data and the occupancy data collected from the system detector into a single measure of effectiveness (MOE) for arterial traffic status estimation. To evaluate the effectiveness of this alternative approach, a case study has been conducted at a major corridor in downtown Detroit, Michigan. A simulation model has been developed and calibrated as a test bed to compare the traffic status estimated using the proposed alternative approach to the traffic status computed based on speed threshold specified in the Highway Capacity Manual 2010. It has been finally concluded that the V-Plus-O approach can effectively estimate the arterial traffic status, and is promising to serve as a cost-effective alternative to expensive radar and video based methods for real-time arterial traffic status monitoring without any necessities for new equipment installation.

16:18-16:36 TC3.2
Simplified, Data-Driven, Errorable Car-Following Model to Predict the Safety Effects of Distracted Driving (I), pp. 1149-1154
Przybyla, Jay
Univ. of Utah
Taylor, Jeff
Univ. of Utah
Jupe, Jason
Armstrong Forensic Engineers
Zhou, Xuesong
Univ. of Utah

An errorable car-following model is presented in this paper. The model was developed to predict the situational risk associated with distracted driving. To obtain longitudinal driving patterns, this paper analyzed and utilized NGSIM naturalistic driver and traffic database to identify essential driver behavior and characteristics. NGSIM data was modified according to data from cognitive psychology concepts to examine the probabilistic nature of distracted driving due to internal vehicle distractions. The errorable microscopic car-following model was developed and validated, which can be fully integrated with the naturalistic data and incorporate the probabilities of driver distraction. The proposed model predicts that distracted driving in congested conditions can result in crash rates 3.25 times that of normal driving conditions.

16:36-16:54 TC3.3
Parts-Based Object Recognition Seedeed by Frequency-Tuned Salieny for Child Detection in Active Safety, pp. 1155-1160
Cheng, Shinko
Hrl Lab. LLC
Molineros, Jose
HRL Lab. LLC
Owachko, Yuri
HRL Lab. LLC
Levi, Dan
General Motors, Advanced Tech. Center, Israel
Zhang, Wende
General Motors, Res. and Development

IEEE ITSC 2012 PROGRAM
This paper proposes a novel system for automatically detecting children from a color monocular back-up camera, as part of a back-up warning device in passenger vehicles. We presented the use of an attentional mechanism that focuses compute-intensive bounding-box classifiers on a subset of all possible bounding-box solutions to enable real-time performance of 248ms per frame with negligible reduction in performance. The attentional mechanism called Attention to Children which consists of a window generation and verification cascade of based on Frequency-Tuned Saliency, Variational-Optical-Flow Obstacle Detection and finally a parts-based classifier. We also presented a method of reducing much of the cascade classifier evaluations by judicious sampling of the bounding-box solution space. The result is a reduction in the number of windows evaluated down to 439 from more than 12K windows in traditional sliding window techniques, a 97% reduction in the number of windows. The verification stages leading up to the parts-based classifier further reduces the number of windows to half. Together with a parallel processing and pipelining, the final processing time was 248ms per frame.

**Driving Motion Capture Based Driver Behavior Analysis (I)**, pp. 1161-1165
Shi, Jianjun  
Wei, Heng  
Shi, Shengqing  
Beijing Univ. of Tech.

In this paper a study is presented to use a driving motion capture system to capture and interpret driving motion for a better understanding of driver behaviors which is crucial to highway traffic safety. The impetus to do this research is triggered by the prevalent success of a motion capture system in other areas such as computer 3D animation, bio-mechanics and athletic sports analysis. Driving motion capturing is a process to record and track drivers' body movements and obtains their motion parameters in a three-dimensional space. The established driving motion database through the capturing system can be used to analyze the impacts of human fatigue and alcohol on their driving performance under varying traffic conditions.

**Intersection Detection and Safety (Regular Session)**

16:00-16:18  
**Multi-Object Tracking at Intersections Using the Cardinalized Probability Hypothesis Density Filter**, pp. 1172-1177
Reuter, Stephan  
Meissner, Daniel  
Dietmayer, Klaus  
Univ. of Ulm  
Univ. of Ulm  
Univ. of Ulm

A high fraction of accidents with body injuries in urban areas occur at intersections. Thus, improving safety at intersections using infrastructure based perception systems is desirable. In order to recognize and track the moving objects, a network of laserscanners is used to observe the intersection. In this contribution, a robust object recognition algorithm for vehicles and pedestrians is proposed. Further, the Cardinalized Probability Hypothesis Density with integrated estimation of the clutter density is applied to tracking vehicles and pedestrians at an intersection. The performance of the system is evaluated using real world sensor data of an intersection.

16:18-16:36  
**Cooperative Multi Sensor Network for Traffic Safety Applications at Intersections**, pp. 1178-1183
Goldhammer, Michael  
Strigel, Elias  
Meissner, Daniel  
Brunsmann, Ulrich  
Doll, Konrad  
Dieltmayer, Klaus  
Univ. of Applied Sciences Aschaffenburg  
Univ. of Ulm  
Univ. of Ulm  
Univ. of Applied Sciences Aschaffenburg  
Univ. of Applied Sciences Aschaffenburg  
Univ. of Ulm

To significantly reduce injury and fatal accidents, smart intersections equipped with sensors and communication infrastructures have been proposed. In this publication a novel multi sensor network to perceive the intersection environment is presented. Based on an intensive analysis of accident scenarios in Germany the system was designed to address 75% of all severe and lethal accidents. 14 laserscanners, 10 cameras, signal phase tapping and an 12V communication unit have been installed at a public intersection in Aschaffenburg, Germany. By using computer based field of view modelling the sensor positions are carefully selected to avoid occlusions. Thus, the infrastructure perception system provides a bird's eye view. Our experiments show that spatial and temporal alignment of sensor data is achieved. We also demonstrate that a part of the sensor network, a calibrated stereo system, allows 3D coordinates in the field of view region of the cameras to be determined with an accuracy of 30 mm.

16:36-16:54  
**Iicas: Intelligent Intersection Collision Avoidance System**, pp. 1184-1190
Kaadan, Asaad  
Refai, Hazem  
Univ. of Oklahoma  
Univ. of Oklahoma

The number of vehicle collisions, especially at intersections, continues to rise despite recent advancements in vehicular technologies. Innovative design solutions for collision avoidance systems and transportation infrastructure are needed. In this paper we introduce Iicas, a novel Intelligent Intersection Collision Avoidance System that utilizes various
components and advanced features to detect and identify vehicles, predict collisions, and issue appropriate warning signals. Inherent intelligent features such as self-calibration, power management, auto mesh forming, and Over-The-Air (OTA) upgrade increase system reliability and functionality at a price point much less than comparable systems.

16:54-17:12 TC4.4

VeloRegistration Based Intersection Detection for Autonomous Driving in Challenging Urban Scenarios, pp. 1191-1196

Zhu, Guanwen, Wuhan Univ.
Mao, Qingzhou, Wuhan Univ.
Chen, Long, Wuhan Univ.
Li, Ying, Wuhan Univ.
Li, Qingquan, Wuhan Univ.

In this paper, an improved intersection detection method is proposed by applying the VCS-based algorithm on the registered scans instead of the single scan. Both the registration and intersection detection approach are independent on Global Positioning System (GPS), Geographic Information System (GIS), Inertial Navigation System (INS) or other auxiliaries which have been extensively used in autonomous navigation. The novel registration method named VeloRegistration addresses the data registration problem and moving object detection simultaneously by introducing a tracking-classification operator into iterative matching process. The accurate and massive information generated by VeloRegistration enables us to cope with much more complicated intersection scenarios, especially there are dead zones caused by severe occlusion. Experimental validation, including three real world data sets acquired in Wuhan, China substantiate the effectiveness and robustness of our approach in challenging urban scenarios.

17:12-17:30 TC4.5

A Feasibility Study on a Cooperative Safety Application for Cyclists Crossing Intersections, pp. 1197-1204

Thielen, Daniel, German Aerospace Center (DLR)
Lorenz, Tobias, German Aerospace Center (DLR)
Hannibal, Marco, German Aerospace Center (DLR)
Köster, Frank, German Aerospace Center (DLR)
Plättner, Jens, German Aerospace Center (DLR)

Introduction of wireless vehicular communications enables a variety of new ITS use-cases, allowing for cooperation between vehicles and infrastructure services. However, the cooperation between vehicles and vulnerable road users (VRU) is not considered in these use cases. Currently there are already efforts to investigate the feasibility and the impact of systems to protect VRU. Due to the continuously increasing number of traffic participants in urban environments this paper focuses on protecting cyclists in intersection scenarios. Therefore this paper provides a feasibility study on a cooperative safety application for vehicles and bicycles using a vehicle equipped with Vehicle-to-X communication (ETSI ITS G5) technology and a commercial mobile device using consumer WLAN (IEEE 802.11g) at the bicycle. Within a demonstration it is proven that the set up and the deployment of such a system is feasible. Thus it could help to decrease the number of accidents between vehicles and bicycles or at least mitigate the impact of an accident.

16:54-17:54 TC5

Simulation and Modeling 5 (Regular Session)

16:00-16:18 TC5.1

Determinants of Powered Two-Wheelers Virtual Lane Width in Urban Arterials, pp. 1205-1210

Nikias, Vasileios, National Tech. Univ. of Athens
Vlahogianni, Eleni, School of Civil Engineering, National Tech. Athens
Lee, Tzu-Chang, National Cheng Kung Univ.
Gollas, John, National Tech. Univ. of Athens

The present paper aims at modeling the dynamic width of the virtual lane of the Powered Two-Wheelers (PTWs) and revealing the critical factors that may influence it, such as the speed of the motorcycles, the existence of a heavy vehicle and so on. All possible manners of PTW maneuvering in an urban arterial (2 lanes per direction of travel) were identified and then data were collected from real measurements using advanced video analysis techniques. Further, statistical models were developed in order to reveal the relation between the virtual lane's width and several determinants such as PTW speeds, lane headways, traffic mix and so on. Results showed that the virtual lane width depended on the speed of the PTW, the existence of a plateau, the existence of a heavy vehicle and the headways in both lanes. Moreover, results revealed the need to address the human behavior and the cognitive aspects of driving during the modeling.

16:18-16:36 TC5.2

Investigation on Traffic Flow Competition between Main Road and On-Ramp on Urban Freeway, pp. 1211-1214

He, Shuyan, Beijing Jiaotong Univ.
Guan, Wei, Beijing Jiaotong Univ.

Bottlenecks at highway or urban freeway are one of origins of traffic congestion. Based on empirical investigation on traffic data collected from Beijing urban freeway, we find that when traffic is dense, upstream flow and ramp flow are correlated significantly. Competitions between the two flows at vicinities of several on-ramps during a morning peak are studied. Based on these empirical observations, a flow competition model as an extension of CTRM (cell transmission model) is developed. The proposed model focuses on reproducing correlated upstream flow and ramp flow in dense traffic. Both empirical data and simulation results point out that several traffic phenomena, such as capacity drop and spontaneous traffic breakdown, can be explained as results of such a competition.

16:36-16:54 TC5.3

Estimating Flexible Route Choice Models Using Sparse Data, pp. 1215-1220

Fadaei Oshyani, Masoud, KTH Royal Inst. of Tech.
Sundberg, Marcus, KTH Royal Inst. of Tech.
Karlstrom, Anders, KTH Royal Inst. of Tech.

GPS and nomad devices are increasingly used to provide data from individuals in urban traffic networks. In many different applications, it is important to predict the continuation of an observed path, and also, given sparse data, predict where the individual (or vehicle) has been. Estimating the perceived cost functions is a difficult statistical estimation problem, for different reasons. First, the choice set is typically very large. Second, it may be important to take into account the correlation between the (generalized) costs of different
routes, and thus allow for realistic substitution patterns. Third, due to technical or privacy considerations, the data may be temporally and spatially sparse, with only partially observed paths. Finally, the position of vehicles may have measurement errors. We address all these problems using an indirect inference approach. We demonstrate the feasibility of the proposed estimator in a model with random link costs, allowing for a natural correlation structure across paths, where the full choice set is considered.

16:54-17:12 TC5.4

Analysis and Prediction of Deceleration During Car Following Using Stochastic Driver-Behavior Model, pp. 1221-1226

Angkititrakul, Pongtep Nagoya Univ.
Miyajima, Chiyomi Nagoya Univ.
Takeda, Kazuya Nagoya Univ.

Driver deceleration behavior contains large amount of information regarding individual driving characteristics, driving environment, and situations perceived as potentially hazardous by a driver. This paper focuses on deceleration behavior involving both release of the gas pedal and depression of the brake pedal during on-the-road car following. A Bayesian framework was employed to calculate the probability of a driver decelerating at a given point in time, using only low-level driving signals. A stochastic driver-behavior model based on a Dirichlet process mixture model was employed to capture distinct characteristics of different driver's driving behavior. In addition, this framework exploits estimated time-to-collision (TTC) information, using both negative and positive values as a criticality indicator of driving situations perceived by the driver. Experimental validation was conducted using the on-the-road car-following behavior of sixty-four drivers. The results showed the promise of this framework for estimating deceleration probability during car following.

17:12-17:30 TC5.5

Predicting Arrival Times of Buses Using Real-Time GPS Measurements, pp. 1227-1232

Sinn, Mathieu IBM Res.
Yoon, Ji Won IBM Res.
Calabrese, Francesco IBM Res.
Bouillet, Eric IBM Res.

Predicting arrival times of buses is a key challenge in the context of building intelligent public transportation systems. In this paper, we describe an efficient non-parametric algorithm which provides highly accurate predictions based on real-time GPS measurements. The key idea is to use a Kernel Regression model to represent the dependencies between position updates and the arrival times at bus stops. The performance of the proposed algorithm is evaluated on real data from the public bus transportation system in Dublin, Ireland. For a time horizon of 50 minutes, the prediction error of the algorithm is less than 10 percent on average. It clearly outperforms parametric methods which use a Linear Regression model, predictions based on the K-Nearest Neighbor algorithm, and a system which computes predictions of arrival times based on the current delay of buses. A study investigating the selection of interpolation points to reduce the size of the training set concludes the paper.

16:00-16:18 TC6.1

Modeling Monetary Costs of Multi-Class Traffic Flow – Application to the Dynamic Management of Truck Lanes, pp. 1233-1238

Schreiter, Thomas Delft Univ. of Tech.
Pel, Adam Delft Univ. of Tech.
van Lint, Hans Delft Univ. of Tech.
Hoogendoorn, Serge Delft Univ. of Tech.

Traffic is composed of different vehicle classes, each characterized by the vehicle length, the value of time (VOT) and other class-specific properties. Multi-class traffic flow models aim to capture these class-specific differences. In this paper, a multi-class model is appended with a monetary cost framework accounting for the value of time of each vehicle class, thereby enabling the computation of the total network costs. Subsequently, the framework is analytically applied to show the conditions under which it is justified to prioritize certain traffic classes in order to maximize the monetary flow (which is equivalent to minimizing the total monetary network costs). An illustrative example is given in which the framework is used to find the conditions (bottleneck capacity, traffic demand, pce, VOT) under which activating a dedicated lane for trucks is beneficial.

16:18-16:36 TC6.2

Freight Origin-Destination Estimation Based on Multiple Data Sources, pp. 1239-1244

Ma, Yinyi Erasmus Univ.
Van Zuylen, H.J. Delft Univ. of Tech.
Kuik, Roelof Erasmus Univ. Rotterdam

Freight origin-destination (OD) information is increasingly important for understanding the influence of transportation on network congestion. Traditional OD estimation methods based on a single data source, usually loop detectors, are not easily transferred to freight OD estimation. However, alternative data capture technologies are nowadays available to gather traffic information. Examples are automatic number plate recognition (ANPR), Bluetooth scanners, and Weigh-in-Motion systems. This paper aims to develop feasible approaches based on Entropy Maximization and Bayesian Networks to estimate freight OD matrix using multiple sources of captured data. In the case of the A15 motorway in the Netherlands, we illustrate how the captured data is informative about transport behavior in the area and how the proposed methods lead to an estimation of the freight OD matrix.

16:36-16:54 TC6.3

GPS Tracking of Freight Vehicles to Identify and Classify Bottlenecks, pp. 1245-1249

Dailey, Daniel J. Univ. of Washington
McCormack, Ed Univ. of Washington
Zhao, Wenjuan Washington State Department of Transportation

This paper presents a systematic methodology for identifying and ranking bottlenecks using probe data collected by commercial GPS fleet management devices. This methodology is based on the hypotheses that truck speed distributions can be represented by either a unimodal or bimodal probability density function, and it proposes a new reliability measure for evaluating roadway performance.

16:54-17:12 TC6.4
Evacuating large metropolitan areas during emergencies in an efficient manner is one of the critical concerns of most responsible agencies. Previous studies focused mainly on strategic evacuation plans or controls for passenger cars, giving inadequate attention to those pedestrians relying on transit systems or other modes. This study has developed a multimodal evacuation system for Baltimore city. The proposed system can generate evacuation plans to guide people to the parking lots or pick-up points, dispatch shuttles to pick up evacuees, and provide route guidance to vehicles. The system uses a hybrid method to simulate traffic conditions, allowing users to evaluate the effectiveness of the proposed plan. An evacuation planning for Baltimore downtown is used as an illustration case in this study.

It is important to evacuate pedestrians properly in large public buildings under emergency conditions. A multi-objective optimization model based on Heuristic ant colony algorithm for emergency evacuation is proposed in this paper. The two objectives of this model are to minimize the evacuation clearance time and to minimize the total path crowding degree. The Heuristic ant colony algorithm takes into account the distances between the evacuees and the dangerous or safe targets. In addition, this model is applied to a large stadium to simulate the whole evacuation process. In order to make the results realistic, experiments that consider the evacuees' real responses to the instructions are conducted. By simulating the process of pedestrian evacuation with this model, the results show the feasibility of the algorithm, so as to provide a scientific basis for guiding the real evacuation process.

Under emergency situations, citizens are often forced to evacuate an inhabited area for their own safety. During this process, drivers' behavior becomes a very important factor determining vehicle movements in the affected area. In this research, the impact of driver aggressiveness on traffic flow properties related to evacuation, such as travel time to the safe zones, is modeled through microscopic simulation and the use of detailed driver behavior models. A sensitivity analysis examining the impact of each individual model on the network is first performed, followed by an analysis of the interaction of the most influential models. The findings of this research can be useful in developing realistic evacuation strategies and plans, in which the expected impact of the drivers' behavior due to their stress is explicitly taken into consideration.
This paper addresses the problem of reliably detecting parking spots in semi-filled parking lots using on-board laser line scanners. In order to identify parking spots, one needs to detect parked vehicles and interpret the parking environment. Our approach uses a supervised learning technique to achieve vehicle detection by identifying vehicle bumpers from laser range scans. In particular, we use AdaBoost to train a classifier based on relevant geometric features of data segments that correspond to car bumpers. Using the detected bumpers as landmarks of vehicle hypotheses, our algorithm constructs a topological graph representing the structure of the parking space. Spatial analysis is then performed on the topological graph to identify potential parking spots. Algorithm performance is evaluated through a series of experimental tests.

This paper proposes a novel fully-automatic method for recognizing various parking slot markings in image sequences acquired by an Around View Monitor (AVM) system which is gaining popularity as a parking-aid product. The proposed method utilizes an approach which finds parking slots in AVM image sequences using a simple detector and combines sequentially acquired slots rather than using a sophisticated heavy detector in order to achieve the robustness against diverse practical situations. Parking slots are first detected in the current image using the hierarchical tree structure based approach presented in our previous paper [1]. Then, the current positions of previously detected parking slots are predicted using a transformation between consecutive images, and the parking slots detected in the current image and predicted from previous images are combined. The resulting parking slots are clustered according to their types and orientations, and the clusters which contain more than a predetermined number of slots are selected as final parking slots. The proposed method was evaluated using 10 AVM image sequences that include 134 parking slots, and demonstrated a detection rate of 95% with only three false detections.

Parallel parking, in general, is a moderate difficulty maneuver. Moreover, for inexperienced drivers, it can be a stressful situation that can lead to mistakes such as being far from the sidewalk or damage another vehicle resulting in traffic tickets that range from simple parking violation to crash-related violations.

In this paper we propose a computationally effective approach to perform a collision-free parallel parking. The method will calculate the minimum parking space needed and then the minimum possible path for the parallel parking. This method is computationally inexpensive in comparison with the state of art. Moreover, it could be used by any car because the parameters needed to perform all computations are taken from published datasheets.

Technical Program for Wednesday September 19, 2012
vehicle and/or a driver before reaching an intersection. This system is also expected to suppress the unnecessary fuel consumption and reduce CO2 emissions. The purpose of this paper is to evaluate the impact of the SRES which will be installed at signalized intersections. To estimate the impact, we develop the micro traffic simulation model which includes the behavior of a driver with/without SRES. We employed the time integral of difference of space distance and stopping distance or TIDSS as the indicator for measurement of safety, while we employed the equations to calculate fuel consumption and CO2 based on an average velocity. As the result of simulations, it was confirmed that SRES might help to reduce collision, fuel consumption and CO2 emissions at signalized intersections.

09:18-09:36 WA1.2
Traffic Sign Detection and Analysis: Recent Studies and Emerging Trends, pp. 1310-1314
Megelmose, Andreas Aalborg Univ.
Trivedi, Mohan M. Univ. of California at San Diego
Moelslund, Thomas Aalborg Univ.

Traffic sign recognition (TSR) is a research field that has seen much activity in the recent decade. This paper introduces the problem and presents 4 recent papers on traffic sign detection and 4 recent papers on traffic sign classification. It attempts to extract recent trends in the field and touch upon unexplored areas, especially the lack of research into integrating TSR with a driver-in-the-loop system and some of the problems that presents. TSR is an exciting field with great promises for integration in driver assistance systems and that particular area deserves to be explored further.

09:36-09:54 WA1.3
Suspended Traffic Lights Detection and Distance Estimation Using Color Features, pp. 1315-1320
Diaz-Cabrera, Moises Univ. of Las Palmas de Gran Canaria
Cerri, Pietro Univ. of Parma
Sanchez-Medina, Javier J. Univ. of Las Palmas de Gran Canaria

Traffic Light Detection is a problem differently approached by many research groups around the world. The present work exhibits a novel technique to detect suspended traffic lights, based on colors and features such as black area of traffic lights or area of lighting lamps. Additionally, the traffic light distance is estimated aiming at slowing down and stopping in the correct position, in case of red light. Some preliminary test results are presented to assess both the detection rate and the distance estimation.

09:54-10:12 WA1.4
Visibility Estimation of Traffic Signals under Rainy Weather Conditions for Smart Driving Support, pp. 1321-1326
Sato, Ryuei Nagoya Univ.
Doman, Keisuke Nagoya Univ.
Deguchi, Daisuke Nagoya Univ.
Mekada, Yoshito Chukyo Univ.
Ide, Ichiro Nagoya Univ.
Murasu, Hiroshi Nagoya Univ.
Tamatsu, Yukimasa DENSO Corp.

The aim of this work is to support a driver by notifying the information of traffic signals in accordance with their visibility. To avoid traffic accidents, the driver should detect and recognize surrounding objects, especially traffic signals. However, when driving a vehicle under rainy weather conditions, it is difficult for drivers to detect or to recognize objects existing in the road environment in comparison with fine weather conditions. Therefore, this paper proposes a method for estimating the visibility of traffic signals for drivers by image processing under rainy weather conditions. The proposed method is based on the concept of visual noise known in the field of cognitive science, and extracts two types of visual noise features which affect the visibility of traffic signals. We expect to improve the accuracy of visibility estimation by combining the visual noise features with the texture feature introduced in the previous work. Experimental results showed that the proposed method could estimate the visibility of traffic signals accurately under rainy weather conditions.

09:00-09:18 WA2.1
Vehicle Control Based on a LPV Control and a Nonlinear Control to Detect Critical Driving Situation Due to High Dynamic Loads, pp. 1327-1332
Menhour, Lghani Mathématiques et Systèmes CAOR
Charara, Ali HEUDIASYCY UMR UTC/CNRS 6599
Lechner, Daniel INRETS-MA

This paper presents two control laws dedicated to the vehicle control and gives a comparison between them. The first control law is designed to control the vehicle from steering angle and is based on the LPV control strategy, the solution for this problem is achieved using the LMI framework and the interpolation gains method. The second strategy controls the longitudinal and lateral motion of the vehicle via wheel torque traction and steering torque respectively. It is based on a second order sliding mode control. These control laws are used to perform closed-loop simulations with a non linear vehicle model, under high dynamic loads to detect critical driving situations such as physical limitation of the vehicle in a bend. These laws are tested using the experimental data acquired by four wheeled vehicle Peugeot 307 from IFSTTAR.

09:18-09:36 WA2.2
Nonlinear Observers of Tire Forces and Sideslip Angle Estimation Applied to Road Safety: Simulation and Experimental Validation, pp. 1333-1338
Wang, Bin HEUDIASYCY UMR UTC/CNRS 7253
Cheng, Qi Heudiasyc
Victorino, Alessandro Univ. de Tech. de Compiegne, Departement deGenieInfor
Charara, Ali HEUDIASYCY UMR UTC/CNRS 6599

Extensive research is focus on the stability control in the modern industrial auto-mobile society. Some active safety systems, such as Electronic Stability Program (ESP) and Traction Control System (TCS) have been widely used as safety option in our quotidain cars. These systems are based on the information which contains the motion characteristic of vehicle. Nevertheless, some complex safety system needs more information which can preferable describe the precise motion features, such as sideslip angle and tire forces. This article will principally present two non-linear observers: EKF (Extended Kalman filter) and PF (Particle filter) to estimate
these variables, respectively. These observers are designed based on the non-linear double track model. The Dugoff model is used to elaborate the relation between tire forces and sideslip angle. Performances of these observers are tested by using the experimental data in real driving test, using our laboratory vehicle equipped with a real-time sampling and processing system. Particularly, the estimation process with EKF has been developed as a real-time application for the onboard test. Furthermore, a simulator is involved in the critical driving test which is hazardous in real driving condition.

09:36-09:54 WA2.3
Traffic Situation Assessment by Recognizing Interrelated Road Users, pp. 1339-1344
Platho, Matthias
Univ. of Ilmenau
Gross, Horst-Michael
Ilmenau Univ. of Tech.
Eggert, Julian
Honda Res. Inst. Europe GmbH

With the trend to highly automated driving, future driver assistance systems are required to correctly assess even complex traffic situations and to predict their progress. As soon as other road users are present the number of possible situations becomes infinite, rendering their assessment based on learned situation types impossible. In this paper we propose to break the situation down into sets of interrelated entities by estimating for each road user the entities that affect its behavior most. The decomposition offers numerous advantages: Attention can be focused on relevant entities only and predictions can be performed with a smaller set of considered entities. As the high variability among situations requires a large amount of data for learning and testing, we implemented a simulation environment, that gives access to the causes for the behavior of each road user. In a simulated intersection scenario we show that we can reliably infer the affecting entities for each road user only utilizing features that can be obtained by common sensors.

09:54-10:12 WA2.4
Genesis of Booster Curves in Electric Power Assistance Steering Systems, pp. 1345-1350
Ciarla, Valentina
GipsaLab
Cahouet, Violaine
Univ. Joseph Fourier GipsaLab
Canudas de Wit, Carlos
Grenoble
Quaine, Franck
Univ. Joseph Fourier GipsaLab

The typical architecture of an Electric Power Assistance Steering (EPAS) system includes a static map to provide the correct amplification to the driver's exerted torque. In literature, it is generally known as booster curve. This paper concerns the study of the amplification criteria, that are commonly used to these booster curves. The basic concepts of the Electric Power Steering (EPS) systems with a realistic model for the friction contact, that acts on the wheels are discussed. A relation between the assistance and the driver's torque is provided, under the hypothesis of a position-oriented control of the movement and the Stevens' power law. Finally, the simulation results proposed at the end of this paper validate the shape of the booster curves and are in accord with the initial hypotheses.

10:12-10:30 WA2.5
Temporal Association Rule Mining for the Preventive Diagnosis of Onboard Subsystems within Floating Train Data Framework, pp. 1351-1356
Sammouri, Wissam
UPE, IFSTTAR, GRETTIA
Come, Etienne
UPE, IFSTTAR, GRETTIA

The increasing interest in preventive maintenance strategies for railway transportation systems as well as the emergence of telecommunication technologies have both led to the development of floating train data (FTD) systems. Commercial trains are being equipped with both positioning and communications systems as well as onboard intelligent sensors monitoring various subsystems all over the train. The collected sizable amounts of real-time spatio-temporal data can be used to leverage the development of innovative diagnosis methodologies based on temporal and sequential data mining. This paper presents a temporal association rule mining approach named T-patterns, applied on highly challenging floating train data. The aim is to discover temporal associations between pairs of timestamped alarms, called events, that can predict the occurrence of severe failures within a complex bursty environment. Experiments carried out on Alstom's TrainTracerTM data show promising results.

09:00-09:18 WA3.1
Vehicle Localization and Autonomous Navigation 1 (Regular Session)

09:09-09:18
Real Time Localization, Path Planning and Motion Control for Autonomous Parking in Cluttered Environment with Narrow Passages, pp. 1357-1364
Tehrani Nik Nejad, Hossein
DENGOS Corp.
Do, Quoc Huy
Toyota Tech. Inst.
Sakai, Ryohei
Toyota Tech. Inst.
Han, Long
Toyota Tech. Inst.
Mita, Seiichi
Toyota Tech. Inst.

This paper propose a novel practical method for autonomous parking in cluttered environment with narrow passages. We present a modified FastSLAM algorithm for environment mapping to reduce the map entropy and increase the localization accuracy for autonomous parking. The proposed path planning method is based on predefined arc paths for real time generation of smooth paths to avoid obstacles. The corresponding control commands are generated to minimize the steering angle control error which executed by the vehicle actuators. The proposed parking method is implemented on an autonomous vehicle platform and evaluated in the different environments with narrow passages.

Attachment. This video shows an autonomous parking experiment inside the building. As shown in the movie, the experiment place has narrow passages and makes it difficult for parking. The steering, acceleration and brake are controlled by the computer and the student in the car is just for safety issue. The research can be extended for developing practical application of autonomous parking in multi level parking area at supermarket.

09:18-09:36 WA3.2
Multi-Sensor Localization – Visual Odometry As a Low Cost Proprioceptive Sensor, pp. 1365-1370
Bak, Adrien
DxO Lab.
Gruyer, Dominique
IFSTTAR
Bouchafa, Samia
Univ. Paris Sud XI
Driver assistance systems in today's cars assist drivers when the car is in motion. However, there is relatively less, to almost no work on assistance systems when the car is stationary. This paper focuses on such a system, and describes the design and realization of a collision avoidance system for a novel car door assistance system, the smart car door. An omnidirectional camera is attached to each side-view mirror of a car, and the fold-in fold-out movement of the mirror is used to generate 3D information about static obstacles next to the car based on a motion stereo approach. The car door controller uses the sensor data to compute collision-free door opening paths, and the two-hinge kinematic system of the smart car door enables to move the door around static obstacles. The latter increases the door entrance area in tight parking lots, which drastically improves the ingress/egress to/from a vehicle. These are enhancements to currently available systems that only indicate the presence of obstacles next to the car. Experiments on a fully realized prototype demonstrated a robust generation of 3D information about obstacles next to the car. A study with 20 test users showed that our system strongly supports the users to avoid collisions when operating the door.

The ubiquitous nature of present wireless networks makes the real-time and accurate location-tracking of mobile assets a realizable possibility. However, the existing solutions with their high infrastructure and operational costs, and technical implementation difficulties are not attractive for practical event-activated asset tracking, control, and diagnostics. In this paper, we provide complete system architecture and a description of fully-functional prototype implementation of a mobile based and event-activated solution for low-cost and real-time asset-tracking in urban environments. The accuracy and stability of the proposed solution is established via rigorous field-trials.

Vehicle logo detection is of great importance in intelligent transportation system (ITS) applications since it augments the traditional license plate recognition (LPR) based vehicle identification solutions. An algorithm based on the combinational consideration of appearance and symmetrical
information is proposed to locate the vehicle logo in a digital image. Air-intake grille, as the most evident visual aspect in the front view of the vehicle, can be efficiently detected and recognized thereby providing information about related position of vehicle logos. Symmetry as another widely used feature for analyzing vehicle's front-view image has also been taken into consideration along with grille detection in this paper. This hybridization facilitates more accurate vehicle logo detection rate comparing using isolated symmetry (faces challenge on complex background) or edge statistic (can not handle non-small-grille vehicle). Experimental results on a large number of images validate the robustness and efficiency of the proposed algorithm.

09:54-10:12 WA4.4
Research on Compressed EKF Based SLAM Algorithm for Unmanned Underwater Vehicle, pp. 1402-1406
Wang, Hongjian Automation Coll. Harbin Engineering Univ. Harbin,HeiLon
Li, Cun 409 Department, automation Coll.
Lv, Hongli 409 Department, automation Coll.
Chen, Xinghua automation Coll. engineering university

The Extend Kalman Filter based algorithm for simultaneous localization and mapping cannot satisfy the requirement of real time map updating because of the increasing number of landmarks and the heavy calculating cost while AUV working for long time endurance. The Compressed EKF based SLAM is introduced in this paper. And the method of map management and the local map switch strategy are addressed, which divide the AUV navigating area into several local sub-maps. The navigation error calculating based on landmarks in sub-map is completed in local area by using Extend Kalman filter, and the global map updating is done only when the condition satisfied the switch rule of the sub-map. Finally the CEKF-SLAM based navigating method is tested with the trial data, and by comparing with the dead reckoning navigating result, the test results show that the navigation error of CEKF-SLAM algorithm is less than that of dead reckoning algorithm, and on the same time, the former reduces the calculation cost for AUV navigation.

WA5 Simulation and Modeling 1 (Regular Session) Iliamna
09:00-09:18 WA5.1
Link Observability without Path Enumeration: A Revisit, pp. 1407-1410
Ng, ManWo Old Dominion Univ.

In this paper we revisit the following link observability problem: Determine the smallest subset of links in a traffic network for counting sensor installation, in such a way that it becomes possible to infer the flows on all remaining links. While a solution methodology has already been proposed in the literature, unfortunately, path enumeration was required which is infeasible for large-scale networks. In this work, we present a reformulation of the link observability problem, requiring only node enumeration. Using this node-based approach, we prove a conjecture made in the literature by deriving an explicit relationship between the number of nodes and links in a transportation network, and the minimum number of sensors to install in order to be able to infer all link flows. Numerical results are reported and discussed.

09:18-09:36 WA5.2
Measurement of Heavy Traffic Using Temporal Template, pp. 1411-1416
Tsukanome, Takuma Hirosaki Univ.
Onoguchi, Kazunori Hirosaki Univ.

This paper presents the method which can measure traffic situation in heavy congestion. The proposed method calculates average speed of passing vehicles from Temporal Template well used in the field of gesture recognition. It is created by accumulating motion areas detected in an image sequence by the frame differential method, changing intensity of them for every frame. The proposed method is robust to overlap of vehicles because it estimates speed of vehicles without detecting and tracking vehicles individually. At first, Temporal Template is created from accumulating frame differential results. Next, median intensity is calculated on each horizontal scan line of Temporal Template. And then, the relation between the vertical axis of Temporal Template and median intensity is approximated as straight lines. Average speed of passing vehicles is obtained from the inclination of these straight lines. Temporal Template contains no motion area if there is no passing vehicle or all vehicles almost stops on the road. Therefore, if Temporal Template has no motion area and the background subtraction image has no foreground area, our method judges that no passing vehicle exists on the road. On the other hand, if Temporal Template has no motion area and the background subtraction image has some foreground areas, it judges that all vehicles almost stops on the road. Experimental results including the scene of heavy congestion show the effectiveness of the proposed method.

09:36-09:54 WA5.3
Calibration of CORSIM Models Considering All Model Parameters Simultaneously, pp. 1417-1422
Paz, Alexander Univ. of Nevada, Las Vegas
Molano, Victor Univ. of Nevada, Las Vegas
Gaviria, Carlos Univ. of Cauca

This study proposes a calibration methodology for microscopic traffic flow simulation models that has the capability to simultaneously consider all model parameters and also to calibrate time-dependent aspects of the model, such as link counts. The Simultaneous Perturbation Stochastic Approximation algorithm provides the optimization engine that determines the calibrated set of model parameters. In this study, experiments were conducted using two different CORSIM models; the results illustrate the effectiveness of the proposed calibration methodology. Current research focuses on expanding the proposed methodology to enable the simultaneous calibration of link counts, speeds, and associated bottlenecks.

09:54-10:12 WA5.4
Traffic Jam Modeling and Simulation (I), pp. 1423-1428
Yin, Derek Univ. of Alberta
Qiu, Tony Univ. of Alberta

In this paper various theories on traffic jams and stop-and-go wave modeling were reviewed and discussed. These include traditional microscopic car-following model, asymmetric traffic theory, first-order and second-order macroscopic models, traffic disturbance model, phase transition model as well as macroscopic simulation. The mechanism of stop-and-go waves, causes, generation, propagation, and absorption was discussed. A macroscopic simulation model was developed which suits for both free flow and stop-and-go traffic conditions. Ten hours of macroscopic simulation was performed on a section of freeway in California. The model
predicted traffic speed and density were compared with field measured data. It was concluded that by applying proper boundary conditions for each roadway segment and incorporating capacity drop in the model, the macroscopic simulation model can reasonably predict the stop-and-go traffic states.


Maheshwari, Pankaj
Univ. of Nevada, Las Vegas

Khaddar, Romesh
Univ. of Nevada, Las Vegas

Kachroo, Pushkin
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Paz, Alexander
Univ. of Nevada, Las Vegas

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Sustainability has recently become a very important research area in transportation because of the dependencies between transportation, economic and environmental system. A lot of research is taking place in various aspects that try to understand the interdependencies. However, there is a need to capture the behavior of such systems over time. The research presented in this paper is the first attempt to build dynamic models that try to capture the interdependent behavior of these systems. The research is influenced and motivated by the predator-prey models developed by renowned researchers Lotka and Volterra. The current study is performed to capture the interaction between interdependent systems, i.e., transportation system, activity system, and environmental system. To study the interactions from a macro-scale, this research emphasizes non-linear modeling techniques to capture the nominal behavior of all the three systems. The results indicate that the performance of transportation system and the activity system follow a periodic behavior with phase lag, while the performance of environment system decreases with time. The modeling approach proposed in this research will be helpful to other researchers so that they can modify and enhance such models for proper analysis of sustainable systems.

WA6
Katmai Intelligent Solutions for Air Transportation and Air Space – (ISATAS) (Special Session)

Organizer: Castro, António
LIACC, Univ. of Porto

Towards an Autonomous and Intelligent Airline Operations Control (I), pp. 1429-1434

Castro, António J. M.
LIACC, Univ. of Porto

Rocha, Ana Paula
Faculty of Engineering of Porto (Portugal)

Oliveira, Eugénio
Faculty of Engineering, Univ. of Porto

Studies have estimated that irregular operations (flights affected by a disruption) can cost between 2% and 3% of the airline annual revenue and that a better recovery process could result in cost reductions of at least 20%. Even for small airlines this can represent millions of Euros. In this paper we propose a multi-agent system (MAS) whose members represent the roles, functionalities and competences existing in a typical Airline Operations Control Centre (AOCC), the airline entity responsible for managing the impact of irregular events on planned operations. This multiagent based system produces intelligent solutions in the sense that its outcomes are the result of an autonomous reaction and adaption to changes in the environment, solving partial problems simultaneously. We tested our MAS using real data from TAP Portuguese airline company and experimentally compared our system with solutions found by the human operators on TAP Portugal AOCC. A comparison was also made with a more traditional sequential approach that is the typical method followed by AOCCs when solving disruptions. Results from those comparisons show that it is possible to reduce costs and have a better integrated solution with the proposed system.

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Forster, Carlos H. Q.
Inst. Tecnologico de Aeronautica

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Inst. Tecnologico de Aeronautica

Handing the large amount of information from aircraft trajectories that are produced daily from air traffic control radar systems requires models for representing trajectories in a compact, easy to calculate, representative and distinctive form. These models should permit to perform clustering and classification operations efficiently and effectively. The Fourier descriptors have these characteristics and this article presents the results obtained on actual aircraft trajectories including approach and takeoff operations over a terminal area. Clustering and classification techniques in the feature space of Fourier descriptors were able to correctly separate the various types of operations. Additionally, based on the results of the clusters obtained, a method is presented for the classification of trajectories in progress based on kernel density estimation. An interesting result from the point of view of air traffic control for the detection of anomalous traffic is demonstrated.

Huang, Shimeng
Univ. of Pittsburgh
This paper studies the configuration for intersecting flows of aircraft. Intersections of aircraft flows can be considered as basic building blocks for air traffic networks, and traffic networks can be designed through finding optimal arrangements of intersections whose conflict zones do not overlap. A conflict zone is defined as a minimal circular area centered at the intersection of two flows which allows aircraft approaching the intersections to resolve conflict completely within the conflict zone. This paper derives the relationship between the size of a conflict zone and the intersection angle of the two flows. Such a relationship guides to find an optimal configuration for intersecting aircraft flows. An example involving n converging flows of aircraft demonstrates the efficiency of the proposed configuration of intersections: the result of conflict resolution shows a greatly reduced traffic complexity compared with the solution derived from our previous study, the complexity metric is reduced from $O(n^4)$ to $O(n^2)$.

We present a novel approach to tracking heavy machinery used as snowplows for the improvement of commuter safety. We have developed hardware designed for universal installation in snowplows that relay location and plow position data without human interaction over a cellular network to the real-time traffic simulator FreeSim [1-3]. FreeSim analyzes the data and overlays it onto Google Maps [4] by color-coded lines displaying the time elapsed since the roadway was last plowed. The plow position is determined utilizing magnetic fields between the plow blade and a stationary mount on the snowplow. By publicly displaying this information we aim to educate the end user with the current reported road conditions.

Climate change and severe weather impacts on transportation and infrastructure have become global and environmental issues in the whole world. All human and transportation infrastructure systems are affected by climate change. Taiwan was hit by Typhoon Morakot and it caused a flood disaster in August 2009. This research focuses on the network reliability assessment with route information under severe weather. Two indexes are proposed to examine network reliability under route information, including: connectivity reliability and travel time reliability. Numerical experiments are conducted based on a real traffic network, the Jiaxian network, to illustrate the impact assessment of network reliability.

To make the longitudinal ventilation systems more efficient and energy saving in road tunnels, it is being combined with typical model predictive control (MPC) strategies. Good application of such method is based on a comprehensive understanding of the system characteristics. Using CFD (Computational Fluid Dynamics) simulation, step response model is chosen to describe the dynamic behaviors of the system in a road tunnel with comprehensive health-related indexes which is difficult to obtain by field measurement. The results show that the “Fan Model”, which characterizes the effect of jet speed on CO (carbon monoxide) concentration, is approximately bilinear within fan's economical working range and system settling time is longer when jet speed decreases than it increases. The “Tunnel tube model”, which characterizes the effect of traffic intensity on CO concentration, links to traffic flow features, and has a similar settling time in normal operation and a traffic-speed-related delay time when maximum CO concentration is considered. This can provide guidance or index to control the tunnel ventilation system economically and useful data to implement MPC strategy in the system.
The capability to detect and/or forecast traffic condition is of utmost importance. Recent advances in technology have made available numerous new monitoring systems, such as probe vehicles. Together with traditional volume and time mean speed measurements relative to a local section monitored continuously in time, probe vehicles provide additional type of data, such as space mean speed and travel time, relative to road segments monitored in specific time intervals. Therefore, the aim of this paper is to study how to exploit available information detected by new monitoring devices in the estimation of traffic flow conditions. Different data fusion techniques have been analyzed, such as measurement data fusion and state vector fusion. Several simulations have been carried out in a test network, traveled by probe vehicles and constituted of 9 cells with an on ramp and an off ramp and with two fixed traffic sensors located in two different cells. More promising results have been obtained in the case of measurement data fusion rather than state vector fusion.

09:18-09:36  WA8.2

Current State and Future Outlook of Traffic Data Fusion in London, pp. 1483-1488

Hu, Jun  Imperial Coll. London
Kaparias, Ioannis  City Univ. London
Bell, Michael Geoffrey  Imperial Coll. London
Harrison

Metropolitan areas today have become more than ever saturated with various types and sources of real-time data. Yet, the unsolved practical challenge how to most effectively combine data sources currently prevents the wide use of this data as a powerful tool to both improve the quality of the transport supply and to influence travel demand. Focusing on London, this paper investigates the current state and attempts to give an outlook into the future of traffic data fusion in dense urban network environments. Successes and gaps in the current state are identified, and extensions are proposed, along with respective deployment scenarios and impacts assessment.

09:36-09:54  WA8.3

First Order Velocity Based Travel Time Model, pp. 1489-1494

Farokhi Sadabadi, Kaveh  Univ. of Maryland
Haghani, Ali  Univ. of Maryland

A general first-order model relating directional derivatives of travel time with speed at each point in the time-space domain is used in speed based travel time estimation. Due to its partial differential equation (PDE) form, this model makes it possible to estimate travel times without the need for trajectory construction based on speeds which is a cumbersome integration operation. A forward time backward space (FTBS) finite difference scheme is presented to approximate the general model. While the general model and its corresponding FTBS solution scheme are designed for smooth situations, the traffic stream is replete with discontinuities especially as congestion increases. For these situations an equivalent conservative model based on the first order continuum traffic flow model with Greenshields flux is proposed. A Godunov scheme is proposed to approximate the conservative model. US-101 dataset from NGSIM project is used to illustrate the performance of the proposed models. Three factors impacting the performance of the proposed schemes that is underlying speed estimate accuracy, traffic congestion level and discretization level are considered.

09:54-10:12  WA8.4

Road Intersection Intelligent Traffic Management Supported by Inter-Vehicle Sensor Fusion, pp. 1495-1502

Conde Bento, Luis Manuel  Inst. de Sistemas e Robotica
Nunes, Urbano  Inst. de Sistemas e Robotica
Parafita, Ricardo Jorge  Inst. de Sistemas e Robotica
Pedrosa - Univ. de Coimbra

This paper describes a traffic management system applied to road intersections, namely roundabout and crossroads. A microscopic traffic simulator was developed to study traffic management techniques and evaluate their performance. The intelligent management techniques are aimed to minimize accidents, traffic congestion and consequently the environmental costs of road traffic. Each vehicle is modeled by an agent and each agent provides information depending on its vehicle sensors. The envisioned traffic management algorithm is supported by V2V and V2I communication, allowing the exchange of information, such as vehicle’s pose, between vehicles and the intersection traffic management system. An accurate vehicle’s pose is of extreme importance for the traffic management system, to achieve this accuracy various sensors are simulated and fusion algorithms presented, namely satellite navigation systems, wheel and steering wheel encoders. The sensorial fusion uses as well other auxiliary sources of information such as laser range finders and magnetic markers.

Attachment. This video shows the simulation of an Intelligent Traffic Management System (ITSM) in two types of intersections, roundabout and crossroads. In this video the proposed ITSM performance is compared to not using a Traffic Management System in three traffic fluxes density (low, medium and high). Additionally lengthy vehicle platoons arriving from one direction at either the roundabout and crossroads is also show in this video. Author contact information: L.C. Bento, R. Parafita and U. Nunes are with the ISR-Institute of Systems and Robotics, University of Coimbra, Portugal. L.C. Bento is also with the Electrical Department, Polytechnic Institute of Leiria, Portugal. email: conde, parafita, urbano@isr.uc.pt.

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The control performance of two methods are compared under various road conditions and driving inputs. Model referenced control method needs control input to satisfies linear reference model, and then generates unnecessary tire lateral forces, it may lead to worse performance than uncontrolled vehicle with step steer input in low friction road. As the results of simulation, map based controller seems to be better than model referenced in the viewpoint of stability.

Using Grid Maps to Reduce the Number of False Positive Measurements in Advanced Driver Assistance Systems, pp. 1509-1514

Nuss, Dominik
Univ. of Ulm

Reuter, Stephan
Univ. of Ulm

Konrad, Marcus
EvoBus GmbH - Daimler Buses

Munz, Michael
- 

Dietmayer, Klaus
Univ. of Ulm

In Advanced Driver Assistance Systems (ADAS), object tracking is a crucial method to foresee dangerous situations. The Joint Integrated Probabilistic Data Association (JIPDA) offers the advantage, that existence and association uncertainties are considered in multi-target tracking. Recently, real-time capable implementations have been presented. However, the real-time capability is only given, if a certain number of tracked objects is not exceeded. Thus, so called false positive object detections yield a problem. To mitigate this issue, additional information about the vehicle's environment is used to identify measurements that are not relevant. The idea is to focus on moving objects for tracking. As an example, an Occupancy Grid Map is used to distinguish between stationary and non-stationary objects. The approach is evaluated using real-world data of a research vehicle.

Are Drivers Aware of Their Behavior Changes When Using In-Vehicle Systems, pp. 1515-1518

Yang, Yan
Univ. of Southampton

McDonald, Mike
Univ. of Southampton

Bryan, Reimer
Massachusetts Inst. of Tech.

Bruce, Mehler
Massachusetts Inst. of Tech.

The growing use of In-Vehicle Information Systems (IVISs) has become a safety concern due to the higher workload caused to drivers, which in turn affects their driving performance and visual behavior. This paper studied both drivers’ self-perception of their behavior and the associated direct measurements while performing a set of In-Vehicle tasks in addition to driving. An experiment was conducted to compare these self-perceptions with their actual performance and visual behavior in real traffic conditions to improve the understanding of the associations and any gaps. The results suggest drivers are largely aware of the negative impacts of performing additional mental tasks whilst driving, although these tend to be over-estimated. More importantly, they under-estimate the effects of performing In-Vehicle tasks on their visual searching range, which reduced significantly. This has important safety implications, as driving requires intensive visual information processing, although the effects of different In-Vehicles tasks on various driver characteristics groups can be investigated using this objective and subjective comparison method.

Real-Time Vehicle Detection by Parts for Urban Driver Assistance, pp. 1519-1524

Sivaraman, Sayanan
Univ. of California at San Diego

Trivedi, Mohan M.
Univ. of California at San Diego

In this study, we propose a novel, lightweight approach to real-time detection of vehicles using parts at intersections. Intersections feature oncoming, preceding, and cross traffic, which presents challenges for vision-based vehicle detection. Ubiquitous partial occlusions further complicate the vehicle detection task, and occur when vehicles enter and leave the camera’s field of view. To confront these issues, we independently detect vehicle parts using strong classifiers trained with active learning. We match part responses using a learned matching classification. The learning process for part configurations leverages user input regarding full vehicle configurations. Part configurations are evaluated using Support Vector Machine classification. We present a comparison of detection results using geometric image features and appearance-based features. The full vehicle detection by parts has been evaluated on real-world data, runs in real time, and shows promise for future work in urban driver assistance.

Driver Assistance Systems 2 (Regular Session)

An Analysis on Users’ Evaluation for Self-Balancing Two-Wheeled Personal Mobility Vehicles, pp. 1525-1530

Ando, Ryosuke
TTRI (Toyota Transportation Res. Inst.

Li, Ang
Urban Transport Center, Ministry of Housing and Urban-RuralDevel

In order to promote the personal mobility vehicles including the self-balancing two-wheeled one and the three wheeled one in Japan, the authors organized an event for experiencing them. This paper focuses on the self-balancing two-wheeled personal mobility vehicles. We aim to discuss about the operability, acceptability and effectiveness in terms of an analysis on the users’ evaluation obtained by a questionnaire which were conducted after their experiencing.

Fault-Tolerant Controller Design for Automated Guided Vehicle Systems Based on Petri Nets, pp. 1531-1536

Yan, Jiaxiang
Indiana Univ. Univ. Indianapolis (IUPUI)

Li, Lingxi
Indiana Univ. Univ. Indianapolis (IUPUI)

In this paper, we propose an approach for the design of fault-tolerant controllers for automated guided vehicle systems (AGVs) that are modeled by Petri nets. In particular, we consider multiple faults detection and identification in Petri nets that have state machine structures (i.e., every transition in the net has only one input place and one output place). We develop an approximation algorithm to design the fault-tolerant Petri net controller so as to minimize the sum of the arc weights in the (input and output) incident matrices of the redundant controller. A design example for an AGV system is also provided to illustrate our approach.

Reachability Analysis of Cooperative Adaptive Cruise Controller, pp. 1537-1542

Kianfar, Roozbeh
Chalmers Univ. of Tech.

Falcone, Paolo
Chalmers Univ. of Tech.

Fredriksson, Jonas
Chalmers Univ. of Tech.
In this paper, a set based approach to safety analysis of Adaptive Cruise Control (ACC) and Cooperative Adaptive Cruise Control (CACC) is presented. Reachability analysis techniques are used to compare the minimum safe inter-vehicle distances which can be achieved with ACC and CACC controllers. Not surprisingly, the results indicate that a shorter inter-vehicle distance can be achieved with a CACC controller. The presented method can also be used to design the required inter-vehicle distance for a given controller. Furthermore, we show how backward reachability analysis and invariant set theory can be used to find the Maximal Asymptotic Safe Set. This is defined as a set of position error, relative speeds and acceleration, which a given controller is guaranteed to control to the desired speed and inter-vehicle distance. The calculation of the Maximal Asymptotic Safe Set is demonstrated for ACC and CACC controller designed based on mixed $H^2/\infty$ state feedback. Finally, the calculation of the Maximal Asymptotic Safe Set is extended to the case of vehicle model uncertainties.

11:54-12:12 WB2.4

Driver Assistance Systems Modeling by Model Predictive Control, pp. 1543-1548

Wang, Meng Delft Univ. of Tech.
Daamen, Winnie Delft Univ. of Tech.
Hoogendoorn, Serge Delft Univ. of Tech.
van Arem, Bart Delft Univ. of Tech.

Recently, an optimal control framework has been put forward to model human driver behavior and Advanced Driver Assistance Systems (ADAS). Although the models are shown to be face valid, applications are limited to the open-loop optimal control problem, which are based on the assumption that a driver expects a certain dynamic speed profile and this predecessor. While human drivers are assumed to be good in anticipating traffic, ADAS are poor at predicting the dynamics of other vehicles, due to a limited looking-ahead range and errors of sensors and actuators. This contribution furthers the optimal control framework to model automatic ADAS vehicles by relaxing the assumption that ADAS vehicles can predict the dynamics of other vehicle and solving the optimal control problem in a receding horizon way. This work assumes that within a prediction horizon, other vehicles are driving at stationary conditions (zero accelerations). An ADAS vehicle predicts system dynamics based on this assumption and makes control decisions to optimize its cost. The modeling framework is applied to design ACC systems and EcoACC systems, where multiple control objectives including safety, efficiency and sustainability are taken into account. The prediction horizon is tuned by face validating the behavior of a controlled vehicle. Simulation comparisons show that EcoACC systems result in higher fuel efficiency and a smoother vehicular behavior compared to ACC systems.

The development of cooperative vehicle safety (CVS) applications, such as collision warnings, turning assistants, and speed advisories, etc., has received great attention in the past few years. Accurate vehicular localization is essential to enable these applications. In this study, motivated by the proliferation of the Global Positioning System (GPS) devices, and the increasing sophistication of wireless communication technologies in vehicular networks, we propose a distributed location estimate algorithm to improve the positioning accuracy via cooperative inter-vehicle distance measurement. In particular, we compute the inter-vehicle distance based on raw GPS pseudorange measurements, instead of depending on traditional radio-based ranging techniques, which usually either suffer from high hardware cost or have inadequate positioning accuracy. In addition, we improve the estimation of the vehicles’ locations only based on the inaccurate GPS fixes, without using any anchors with known exact locations. The algorithm is decentralized, which enhances its practicability in highly dynamic vehicular networks. We have developed a simulation model to evaluate the performance of the proposed algorithm, and the results demonstrate that the algorithm can significantly improve the positioning accuracy.

11:18-11:36 WB3.2

Communicationless Navigation through Robust Visual Odometry, pp. 1555-1560

Van Hamme, David Univ. Coll. Ghent
Veelaert, Peter Ghent Univ. - Univ. Coll. Ghent
Philips, Wilfried Ghent Univ. IBBT

GPS navigation is often found undependable in urban situations where tall structures occlude large parts of the sky. To keep accurate position in these situations, we need an alternative method. We propose a novel visual odometry method that is shown to provide reliable relative motion estimation in typical urban road driving using a single camera. While the short-term accuracy is good, relative motion estimation by itself is susceptible to drift and therefore insufficient to provide good long-term absolute position estimates. To overcome this drift, we propose to warp the visual odometry output to a stored map. This warping must be able to cope with temporary discrepancies between visual odometry and map data. The proposed mapping does not make a hard decision about road position, but instead entertains all plausible hypotheses about the followed trajectory and their associated warping costs. Evaluation on real test sequences proves that the method successfully eliminates drift, and on average stays within 7 metres of simultaneously recorded GPS data. This proves that the combined visual odometry and mapping are sufficient to provide positioning with comparable accuracy to GPS in those situations when GPS is unavailable.

11:36-11:54 WB3.3

Lightweight Lane Positioning of Vehicles Using a Smartphone GPS by Monitoring the Distance from the Center Line, pp. 1561-1565

Sekimoto, Yoshihide Univ. of Tokyo
Matsubayashi, Yutaka Kokusai Kogyo Co., Ltd.
Yamada, Harutoshi Center for Spatial Information Science, Univ. of Tokyo
Imai, Ryuichi National Inst. of Land and Infrastructure Management, MLIT
Usui, Tomotaka Center for Spatial Information Science, Univ. of Tokyo
Kanasugi, Hiroshi Inst. of Industrial Science, Univ. of Tokyo
This paper presents a simple method for using the separation distance (offset) between a smartphone GPS and the center line on a digital road map to determine the lane position of a car. The method was verified.

**11:54-12:12** WB3.4

**Illumination Robust Road Detection Using Geometric Information**, pp. 1566-1571

Oh, Changbeom\(^1\) Yonsei Univ.
Son, Jongin\(^2\) Yonsei Univ.
Sohn, Kwanghoon\(^3\) Yonsei Univ.

Road detection is an important task in intelligent transportation system (ITS). Over the past few decades, several vision-based approaches for road detection have been proposed and most of them are based on color information. However, color information may result in false road detection under variation of illumination conditions. To deal with illumination problems, we propose an illumination invariant road detection method using geometric information. By incorporating geometric information with a color-based road probability map, the proposed method robustly detects road regions on real scene containing variation of illumination such as shadow and mixed artificial lights. Experimental results show that the proposed method outperforms the conventional methods.

**WB4** ITS Implementations 1 (Regular Session)

**11:00-11:18** WB4.1

**A Distributed Algorithm for Adaptive Traffic Lights Control**, pp. 1572-1577

Faye, Sébastien\(^4\) Telecom ParisTech
Chaudet, Claude Telecom ParisTech
Demeure, Isabelle Télécom ParisTech

In this paper, we address the problem of controlling traffic lights at an intersection with a spatially distributed sensor network. We propose a sensor network architecture that does not depend on a centralized coordinator and we separate logically it into 4 levels of hierarchy. On this architecture, we define and evaluate through simulations an adaptive traffic light control algorithm. Based on two main objectives, this algorithm decides dynamically of the green lights sequences by selecting the movements composing each phase and its duration. Simulation results show that this algorithm, if properly tuned, has the capacity to reduce average waiting time at an intersection, while avoiding starvation.

**11:18-11:36** WB4.2

**DVS: A Distributed Virtual Signboard for Information Dissemination and Preservation in Vehicular Networks**, pp. 1578-1583

Hu, Zhengqing Nanyang Pol.
Motani, Mehrul National Univ. of Singapore

With increasing affluence and growing urban populations, traffic congestion is a world-wide problem and affects almost everybody. One way to mitigate this problem is to provide real-time traffic information to drivers. This will allow them to make better travel and navigation decisions, such as avoiding congested areas or getting out of blocked lanes. In this paper, we consider a fully distributed information access, dissemination and preservation protocol for road traffic conditions called the Distributed Virtual Signboard (DVS). The DVS disseminates real time local traffic information to drivers to alert them of possible disruptions, and keeps the information alive in the relevant area, in a fully distributed fashion. It provides a low cost and widely applicable solution because it does not require any dedicated roadside infrastructure. The DVS uses traffic in both directions on the road, to form a virtual information loop. Specifically, a double token ring is implemented to increase the information delivery ratio and to increase the robustness of the whole scheme. Analysis shows that, when congestion happens, which is normally associated with a situation of high car density, the probability of token handover failure is close to zero. We have also shown that, almost all cars passing through the virtual loop can get the traffic alert under DVS.

**11:36-11:54** WB4.3


Rhode, Stephan Karlsruhe Inst. of Tech.
Gauterin, Frank Karlsruhe Inst. of Tech.

We introduce an incremental total-least-squares vehicle mass estimation algorithm, based on a vehicle longitudinal dynamics model. Available control area network signals are used as model inputs and output. In contrast to common vehicle mass estimation schemes, where noise is only considered at the model output, our algorithm uses an errors-in-variables formulation and considers noise at the model inputs as well. A robust outlier treatment is realized as batch total-least-squares routine and hence, the proposed algorithm works in a superior way on a broad range of vehicle acceleration. The results of six test runs on various vehicle masses show highly accurate mass estimation results on high and low dynamics of vehicular operation.

**11:54-12:12** WB4.4

**Application of Reinforcement Learning with Continuous State Space to Ramp Metering in Real-World Conditions**, pp. 1590-1595

Rezaee, Kasra Univ. of Toronto
Abdulhai, Baher Univ. of Toronto
Abdelgawad, Hossam Univ. of Toronto

In this paper we introduce a new approach to Freeway Ramp Metering (RM) based on Reinforcement Learning (RL) with focus on real-life experiments in a case study in the City of Toronto. Typical RL methods consider discrete state representation that lead to slow convergence in complex problems. Continuous representation of state space has the potential to significantly improve the learning speed and therefore enables tackling large-scale complex problems. A robust approach based on local regression, named k nearest neighbors temporal difference (kNN-TD), is employed to represent state space continuously in the RL environment. The performance of the new algorithm is compared against the ALINEA controller and typical RL methods using a micro-simulation testbed in Paramics. The results show that RM using the kNN-TD method can reduce total network travel time by 44% compared to the do-nothing case (without RM) and by 17% compared to ALINEA.

**WB5** Simulation and Modeling 3 (Regular Session)

**Simulation and Modeling 3 (Regular Session)**
In this paper, a k-nearest neighbor locally weighted regression method (k-LWR) is proposed to forecast the short-term traffic flow. Inspired by k-nearest neighbor (k-NN) method, the traffic flows which have the same clock time with the current traffic flow are viewed as neighbors. The traffic flows which have the same clock time with the predicted traffic flow are viewed as the outputs of the neighbors. The neighbors most similar to the current traffic flow are viewed as nearest neighbors. It is observed that each nearest neighbor has different similarity with the current traffic flow, and the similarity is relevant to the contribution of the nearest neighbor’s output to predicted traffic flow. The greater the similarity is, the greater the contribution is. These contributions of the nearest neighbors’ outputs are obtained by the locally weighted regression (LWR) method. In this way, k-LWR uses less data, but uses it more effectively. We use the root mean square error (RMSE) between the actual traffic flow and the predicted traffic flow as the measurement. The proposed method is tested on the actual data from Xingye intersection and Feihu intersection in Jiangsu Province in China. The experimental results show that k-LWR has 20% and 24% improvement over the pattern recognition algorithm (PRA), 26% and 30% improvement over k-NN, for the two intersections, respectively.

11:00-11:18 WB5.1
A K-Nearest Neighbor Locally Weighted Regression Method for Short-Term Traffic Flow Forecasting, pp. 1596-1601
Li, Shuanghuang Inst. of Automation, Chinese Acad. of Sciences
Shen, Zhen Inst. of Automation, Chinese Acad. of Sciences
Zhu, Fenghua Inst. of Automation, Chinese Acad. of Sciences
Xiong, Gang Inst. of Automation, Chinese Acad. of Sciences

In this paper, a k-nearest neighbor locally weighted regression method (k-LWR) is proposed to forecast the short-term traffic flow. Inspired by k-nearest neighbor (k-NN) method, the traffic flows which have the same clock time with the current traffic flow are viewed as neighbors. The traffic flows which have the same clock time with the predicted traffic flow are viewed as the outputs of the neighbors. The neighbors most similar to the current traffic flow are viewed as nearest neighbors. It is observed that each nearest neighbor has different similarity with the current traffic flow, and the similarity is relevant to the contribution of the nearest neighbor’s output to predicted traffic flow. The greater the similarity is, the greater the contribution is. These contributions of the nearest neighbors’ outputs are obtained by the locally weighted regression (LWR) method. In this way, k-LWR uses less data, but uses it more effectively. We use the root mean square error (RMSE) between the actual traffic flow and the predicted traffic flow as the measurement. The proposed method is tested on the actual data from Xingye intersection and Feihu intersection in Jiangsu Province in China. The experimental results show that k-LWR has 20% and 24% improvement over the pattern recognition algorithm (PRA), 26% and 30% improvement over k-NN, for the two intersections, respectively.

11:18-11:36 WB5.2
Scalability in Urban Autonomy through Overlapping Decompositions of Hybrid-State Systems, pp. 1602-1607
Kurt, Arda The Ohio State Univ.
Ozguner, Umit The Ohio State Univ.

This study investigates the issue of scalability for autonomous vehicles and systems in urban environments. As the number of agents such as infrastructure elements and communication-capable vehicles increases, the systems that are designed to sense/track/control these agents get burdened under the increased number of tracks/measurements. By employing the concept of overlapping decompositions, it is possible to divide and parallelize the workload, with limited degradation of overall system performance. The paper demonstrates this methodology on simple urban scenarios, involving autonomy of infrastructure elements and autonomous vehicle interactions.

11:36-11:54 WB5.3
Networked Driving Simulator Based on SIGVerse and Lane-Change Analysis According to Frequency of Driving, pp. 1608-1613
Bando, Takashi DENSO Corp.
Shibata, Tomohiro Nara Inst. of Science and Tech.

Driving includes many social factors, such as interaction with other vehicles. In this study, we attempted to examine the social interactions in driving through developing a novel driver assistance system; this system is intended to aid nonexpert drivers in assessing such interactions. We first present a novel networked driving simulator based on SIGVerse which is a software platform for research that adopts a constructive or computational approach. We investigated the differences in driving behaviors when changing lanes, which is a basic type of driving behavior that includes traffic interaction. We employed 30 subjects and each subject took part in tests under four different conditions to examine driving behavior in terms of driving experience. Our results show that frequent drivers achieved smoother lane changes by appropriately controlling the timing of lane changing than drivers who rarely drive or who lack a driving license.

11:54-12:12 WB5.4
Parameter Sensitivity Analysis of a Cooperative System by Means of Microscopic Traffic Simulation, pp. 1614-1619
Riemann, Raffaela TUM CREATE - Centre for Electromobility
Baur, Mathias Tech. Univ. München
Fullerton, Matthew Tech. Univ. München

The scope of the research study is to evaluate the parameter sensitivity of certain cooperative systems' parameters within microsimulation scenarios. A methodology and testing framework for the evaluation of the parameter sensitivity is developed. The parameter sensitivity of cooperative of a Broken Down Vehicle Warning function is tested and analyzed. Within this research, it was shown that certain parameter variations have significant effects on the overall traffic, showing that the effects of parameter variations shall be taken into consideration when performing microsimulation of cooperative systems. The sensitivity analysis showed that the proportion of C2X vehicles and the communication range are generally sensitive to variations. These results are especially interesting for electric vehicles as cooperative system can be enablers for the electric vehicles. Furthermore electric vehicles will benefit from an increased driving efficiency.

WB5.3 Networked Driving Simulator Based on SIGVerse and Lane-Change Analysis According to Frequency of Driving, pp. 1608-1613
Bando, Takashi DENSO Corp.
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11:00-11:18 WB6.1
Towards an Uncertainty Aware Short-Term Travel Time Prediction Using GPS Bus Data: Case Study in Dublin, pp. 1620-1625
Trigueiro Baptista, Arthur Royal Inst. of Tech. KTH, Sweden
Bouillet, Eric IBM Res.
Pompey, Pascal IBM Res.

In this paper we propose and study the performances of a bus travel times prediction model using real bus location data from the city of Dublin. The proposed prediction model uses a modified version of the K-Nearest Neighbors algorithm, KNN, algorithm and exhibits a significant improvement over the baseline KNN. We also investigate the benefits of decomposing travel times in three components: running time, dwell time at bus stops and time stopped at traffic lights. We discuss that most of the uncertainty on the travel times comes from time spent at bus stops and traffic lights, and prediction of running time only is much improved due to the reduced uncertainty at bus stops and traffic lights. Finally we show the need of a prediction algorithm for time spent at bus stops and
traffic lights that added to the prediction of running time would allow for an uncertainty aware time travel predictor.

11:18-11:36  WB6.2

Reliability in Stochastic Time-Dependent Traffic Networks with Correlated Link Travel Times, pp. 1626-1631

Dong, Wei  Swinburne Univ. of Tech.
Li, Minyi  Swinburne Univ. of Tech.
Vo, Quoc Bao  Swinburne Univ. of Tech.
Vu, Hai L.  Swinburne Univ. of Tech.

Optimal route selection with reliable expected travel time has been a focus of research in transportation networks where the reliability is subject to many uncertainty factors such as traffic incidents or recurring traffic congestions. In this paper we develop an approximation method to obtain the reliability of a route travel time in a stochastic time-dependent traffic network. The proposed method takes into consideration the probabilistic nature of the travel time on individual links and their spatial correlation between adjacent links of a selected route. Reliability calculations and the accuracy of our approximation are discussed via a simple illustrative example and a larger network.

11:36-11:54  WB6.3

Unscented Kalman Filter for Urban Link Travel Time Estimation with Mid-Link Sinks and Sources, pp. 1632-1637

Hage, Rémi  IFSTTAR
Bétaillé, David  IFSTTAR
Peyret, François  IFSTTAR
Mezel, Dominique  ENSIL
Smal, Jean-christophe  IFSTTAR

To estimate the link travel time, the classical analytical procedure uses cumulative plots at upstream and downstream locations. This procedure is vulnerable in urban networks mainly due to significant flow to and from mid-link sinks and sources. One of the important developments recently done on this topic has yielded to the CUPRITE methodology. This method is derived from the classical analytical procedure. It integrates probe vehicle data to correct deterministically the upstream cumulative plot to match the information of probe vehicles travel times, whilst the downstream cumulative plot is kept unchanged. The algorithm proposed and validated in this research estimates urban links travel times based on an unscented Kalman filter (UKF). This algorithm integrates stochastically the vehicle count data from underground loop detectors at the end of every link and the experienced travel time from probe vehicles. The proposed methodology, which can be used for travel time estimation in real-time, is compared to the classical analytical procedure and to the CUPRITE method in case of mid-link perturbation. Along to its lower sensitivity than CUPRITE, the UKF algorithm makes it possible detection and exclusion of outliers from both data sources.

11:54-12:12  WB6.4

Practical Time-Dependent and Stochastic Routing with Historical Measurements of Travel Times, pp. 1638-1643

Demeyer, Sofie  Ghent Univ.
Audenaert, Pieter  Ghent Univ.
Logghë, Steven  Be-Mobile
Pickavet, Mario  Ghent Univ.
Demeester, Piet  Ghent Univ.

We present a case study of an industrial-strength time-dependent and stochastic routing system, which makes use of predicted travel times for road networks. Next to a short theoretical consideration, the major focus of this research was on the practical implementation of the system, which aims at efficiently routing in a road network making use of stochastic travel time information. Using historical measurements collected by cell phone and GPS tracking techniques, we derive time-dependent travel time probability distributions for all links in our network. Making use of these distributions, one can accurately determine the travel time distributions for whole routes. In this way, the chance of arriving in time at the destination can be optimized. Moreover, a number of suggestions, not yet implemented due to various causes, for extending and improving the platform are presented. The results of this work are deployed by the industrial partners involved in this research.

12:12-12:30  WB6.5

Evaluation of Travel Time Estimation Based on LWR-V and CTM-V: A Case Study in Stockholm, pp. 1644-1649

Allström, Andreas  Linköping Univ.
Gundlegård, David  Linköping Univ.
Rydgren, Clas  Linköping Univ.

Real-time estimations of current and future traffic states are an essential part of traffic management and traffic information systems. Within the Mobile Millennium project considerable effort has been invested in the research and development of a real-time estimation system that can fuse several sources of data collected in California. During the past year this system has been adapted to also handle traffic data collected in Stockholm. This paper provides an overview of the model used for highways and presents results from an initial evaluation of the system. As part of the evaluation process, GPS data collected in an earlier field-test and estimations generated by the existing system used by the TMC in Stockholm, are compared with the estimations generated by the Mobile Millennium system. Given that the Mobile Millennium Stockholm system has not undergone any calibration, the results from the evaluation are considered promising. The estimated travel times correspond well to those measured in the field test. Furthermore, the estimations generated by the Mobile Millennium system can be regarded as superior to those of existing traffic management system in Stockholm. The highway model was found to perform well even with a reduction in the number of sensors providing data. The findings of this study indicate the robustness of the Mobile Millennium system and demonstrate how the system can be migrated to other geographical areas with similar sources of available data.

WB7  Traffic Flow Management (Regular Session)  King Salmon

11:00-11:18  WB7.1

Compare Linear Interpolation and Adaptive Smoothing Methods on Traffic Flow Information Reconstruction, pp. 1650-1655

Guo, Wei  Tsinghua Univ.
Wang, Qi  Tsinghua Univ.
Li, Zhiheng  Tsinghua Univ.
Zhang, Yi  Tsinghua Univ.
Li, Li  Tsinghua Univ.
Zhang, Zuo  Tsinghua Univ.
With rapid development of transportation system, traffic information collection, which provides accurate and reliable traffic data, receives more and more attentions. However, under practical conditions, most roads and freeways are equipped with limited amount of loop detectors. Thus, researchers are delving into traffic information reconstruction by utilizing limited information. In this paper, we compare the classical linear interpolation method and a special nonlinear interpolation method, the adaptive smoothing method, on reconstructing the spatial-temporal dynamics of traffic flow rate, density and velocity. Tests on NGSIM dataset show that both methods are effective.

11:18-11:36
The Optimal Discretized Timing Plan for Individual Oversaturated Intersections, pp. 1656-1660
Zou, Bin Tsinghua Univ.
Hu, Jianming Tsinghua Univ.
Zhang, Yi Tsinghua Univ.

The topic of traffic control for individual intersections has been studied for many years. A lot of work has been devoted to designing signal timing plans able to make things better under oversaturated situations. In this paper, we discuss how to discretize Gazis two-stage control strategy that had been introduced in [1] for a single oversaturated intersection. We give an optimal discrete timing plan and prove that it gives the least delay.

11:36-11:54
Towards a Realistic Optimization of Urban Traffic Flows, pp. 1661-1668
Angius, Fabio Univ. of California
Reineri, Massimo Pol. di Torino
Chiasserini, Carla Fabiana Pol. di Torino
Gerla, Mario Univ. of California
Pau, Giovanni Univ. of California

In spite of recent advances in Intelligent Transport, vehicular traffic dynamics are still hard to represent and analyze. Most of the previous work on traffic regards highways or single lanes where vehicles interact in one dimension. Models for multi-dimensional vehicle-to-vehicle interactions and models for urban intersections are quite complicated and hardly applicable on a large scale. Nonetheless, urban traffic jams are an actual problem that requires a solution. This paper proposes a method to optimize urban traffic layout using basic heuristics and computationally efficient simulations. Instead of modeling an entire urban map with hundreds of intersections, each typology of intersection is simulated in order to understand how it responds to different traffic patterns and intensities. This knowledge is leveraged to allow the computation of minimal delay route on the complete road map. In order to validate our model, we use the solution obtained with our heuristic to derive the average travel delay through simulation on realistic Manhattan topologies with different intersection types.

11:54-12:12
Traffic Incident Detection by Multiple Kernel Support Vector Machine Ensemble, pp. 1669-1673
Xiao, Jianli Shanghai Jiao Tong Univ.
Liu, Yuncai Shanghai Jiao Tong Univ.

In order to further improve the performances and stabilization of multiple kernel support machine (MKL-SVM) in traffic incident detection, this paper presents a new algorithm called MKL-SVM ensemble. The proposed algorithm uses the bagging technique to train different individual MKL-SVM classifiers, then takes the weighted voting way to combine the output of the individual MKL-SVM classifiers. Some experiments have been performed to evaluate the performances of the four algorithms: standard SVM, SVM ensemble, MKL-SVM and the proposed algorithm (MKL-SVM ensemble). The experimental results show that the proposed algorithm has the best comprehensive performances in traffic incident detection. More important, the performances of the proposed algorithm are very stable. Meanwhile, in order to achieve relatively better performances, the proposed algorithm need less individual classifiers to construct the ensemble than SVM ensemble algorithm. Thus, compared to SVM ensemble algorithm, the complexity of the ensemble classifier of the proposed algorithm is reduced greatly. Conveniently, the proposed algorithm also avoids the burden of selecting the appropriate kernel function and parameters.

WB7.2
11:18-11:36
The Optimal Discretized Timing Plan for Individual Oversaturated Intersections, pp. 1656-1660
Zou, Bin Tsinghua Univ.
Hu, Jianming Tsinghua Univ.
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WB8
11:00-11:18
Queue Length Estimation Using Conventional Vehicle Detector and Probe Vehicle Data, pp. 1674-1681
Badillo, Brian E. Harmonia Holdings Group, LLC
Rakha, Hesham A. Virginia Tech.
Rioux, Thomas W. Rioux Engineering & Harmonia Holdings Group
Abrams, Marc Harmonia Holdings Group, LLC

The paper presents IntelliFusion, an algorithm that fuses inductive loop detector data with real-time vehicle probe data obtained from Connected Vehicles to enhance back of the queue estimates. The work also presents an evaluation of the data fusion algorithm using datasets produced by eTExAS, a microscopic traffic simulation model for signalized intersections. Results of the evaluation show queue length estimates produced by the IntelliFusion algorithm are accurate to within the length of a single vehicle even at low levels of market penetration (e.g., LMP = 20%).

WB8.1
11:18-11:36
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WB8.2
11:18-11:36
Wide-Area, Web-Based Mobility Analysis Using Probe Data, pp. 1682-1686
Pack, Michael Univ. of Maryland Center for Advanced Transportation Technology

This paper describes a web-based visual analytics monitoring system for identifying major bottlenecks, reporting on travel time reliability, and displaying other congestion measures using private sector vehicle probe data fused with agency incident/event data where available. This system represents an exponential leap forward in capabilities to report on system performance in terms of speed and ease of access, usability, and overall data availability. This paper demonstrates how states are using the system to justify construction projects, demonstrate the benefits of transportation projects, identify areas for improvement, and analyze travel times using a variety of data sources, with an emphasis on vehicle probe data. The underlying system includes probe data from as early as 2008 through today that is being used to analyze trends from year-to-year, month-to-month, and day-to-day. The resulting suite of tools provide significant new capabilities to researchers and analysts that will likely fuel additional research.
The development and update of reliable Geographic Information Systems (GIS) greatly benefits Intelligent Transportation Systems developments including real-time traffic management platforms and assisted driving technologies. The collection and processing of the data required for the development and update of GIS is a long and expensive process which is prone to errors and inaccuracies, making its automation promising. The article introduces a method which leverages the emergence of sparsely sampled probe vehicle data to update and improve existing GIS. We present an unsupervised classification algorithm which discriminates between signalized road segments (as having a signal at the downstream intersection) and non-signalized road segments. This algorithm uses a statistical model of the probability distribution of vehicle location within a link, derived from hydrodynamic traffic flow theory. The decision of whether the link has a traffic signal or not is taken according to model selection criteria. Numerical results performed with sparsely sampled probe data collected by the Mobile Millennium system in the Bay Area of San Francisco, CA underline the importance of the problem addressed by the article to improve the accuracy and update signal information of GIS. We showcase the ability of the method to detect the presence of traffic signals automatically.

Probe vehicles equipped with GPS can be used to permanently collect traffic speed information for an entire road network, and the statistical mean value of link speeds collected over time is often used as an estimator for mid-term predictions. For road links with sparse probe vehicle data, the estimated mean may be too inaccurate due to the low sample size, and speeds for road links with missing probe vehicle data must be imputed from other data. This paper proposes to apply a Gaussian-mixture based technique to increase the robustness of speed estimates. Typical shapes of the diurnal speed curve are learnt from historical data of all links in the road network. The model is able to provide robust estimates of mean speed curves based on only a few available observations and drastically reduces the amount of data needed to store them by 95%. Experimental results on a comprehensive set of 857,527 day speed curves show that the predictions are superior to traditional approaches based on aggregated or disaggregated historical mean values.
This paper presents the design of an active safety system for prevention of unintended roadway departures. In normal driving conditions, the driver fully commands the vehicle while the safety system corrects the driver's steering and braking action in case there's a risk that the vehicle unintentionally departs the road. A model of the driver's nominal behavior is first estimated based on his observed behavior. A nonlinear model of the vehicle in closed loop with the driver is then used to reformulate the threat assessment and control problems as a combined optimization problem. The resulting predictive controller is always active and mode switching is not necessary. Experimental data collected using human drivers in a driver simulator, demonstrate the capability of the suggested controller to detect and avoid roadway departures while avoiding unnecessary interventions.

Model of Collision Avoidance with Lane Departure Warning in Real-World Departure Collisions with Fixed Roadside Objects, pp. 1720-1725
Kusano, Kristofer Virginia Tech.
Gabler, Hampton Clay Virginia Tech.

This study developed and presented a computational model of road departure collisions which used data collected from real-world crashes as the basis for simulations of collision avoidance for vehicles equipped with Lane Departure Warning (LDW) systems. Real-world collisions were extracted from a database of 890 serious road departure crashes with detailed reconstructions of the vehicle trajectory and impact locations. The model was developed using the simulation software PreScan (TASS Americas) and simulated driver steering maneuvers following a road departure and LDW. We used the model to simulate a subset of road departure collisions with objects close to the road and with little driver steering after the road departure. In our dataset, these crashes corresponded to approximately 25% of departures with available data and lane markings (47 cases). Between 3% and 5% of hazards were avoided with a LDW delivered at lane crossing. If the LDW was delivered 1 s prior to departure, between 19% and 34% of crashes were avoided. This model is a first step in a larger LDW benefits estimates study. Future models should include simulations of drivers who were steering prior to the crash without LDW, which were excluded from the current study.

Self-Defensive Coordinated Maneuvering of an Intelligent Vehicle Platoon in Mixed Traffic, pp. 1726-1733
Guo, Chunzhao Toyota Tech. Inst.
Wan, Nianfeng Clemson Univ.
Mita, Seiichi Toyota Tech. Inst.
Yang, Ming Shanghai Jiao Tong Univ.

Cooperative driving is a promising technology for reducing traffic jams, limiting CO2 emissions and reducing traffic accidents. With the future mixed traffic, the current platooning concept comes to its limitations when human-driven vehicles interfere with the platoon between the autonomous vehicles without negotiation. In this interfering situation, most of them have to break down into two platoons, which may ensure the safety while lose the efficiency. In this paper, we introduce a self-defensive coordinated maneuvering strategy to generalize platooning to situations with non-automated interfering vehicles in mixed traffic. It allows the vehicles in the platoon to observe the interfering vehicles' behaviors, predict their intentions, and then react by changing their platoon formations so as to keep such vehicles always out of the platoon. In the proposed framework, the platoon can not only "talk" and "listen" for cooperative driving based on the communication system, but also "guessing" and "reacting" to actively defend the completeness based on the on-board sensors. Therefore, higher safety and efficiency can be expected. Simulation results in various typical but challenging interfering situations with mixed traffic show the effectiveness of the proposed approach.

Attachment. This video shows the examples of the proposed self-defensive coordinated maneuvering of an intelligent vehicle platoon in mixed traffic, which provides a better understanding of the dynamic level of the platoon formation change. It also let the reader better understand how the interfering vehicle engage the maneuver with the platoon.

Optimal Braking and Steering Control for Active Safety, pp. 1741-1746
Moshchuk, Nikolai General Motors Company
Chen, Shih-Ken
Zagorski, Chad
Chatterjee, Aamarapali
General Motors Company
General Motors Company
General Motors Company

The paper summarizes the development of an optimal braking and steering control for collision avoidance maneuver. The goal is to minimize the distance to the target vehicle ahead of the host vehicle subject to vehicle and environment constraints. Comparative study of standalone steering versus braking in a collision avoidance maneuver is given and results are discussed. The collision avoidance steering maneuver is effective only when the forward velocity is above a certain limit dictated by the surface friction coefficient and vehicle/tire characteristics. The algorithms were implemented in Simulink and verified in CarSim. The results indicate that there is an optimal braking and steering control resulting in minimal distance needed for collision avoidance maneuvers.

14:36-14:54 WC2.3

Shared Control System to Safeguard Mobility of Wheeled, Actively Articulated Truck-Trailer Vehicles on Structured and Rough Terrain, pp. 1747-1752
Labenda, Patrick
Ruhr-Univ. Bochum

For transportation tasks predominantly wheeled vehicles are used. This is due to a wheel's easy construction, its simple actuation and control implementation as well as the fact that no energy is wasted to overcome gravitational effects. But wheeled vehicles are best suited for a use on prepared terrain and surfaces. Their mobility on unstructured and rough terrain is significantly limited. These limits can be overcome by the integration of active articulations which enable a vehicle system's reconfiguration and accommodation to various environmental conditions. The paper at hand describes a wheeled, actively articulated transportation system in form of a mobile robot and experimental small-scale model, respectively. The system is equipped with a shared control system to safeguard its efficient mobility with respect to performance indices maneuverability, terrainability and trafficability, both, on structured and rough terrain. The developed shared control system is introduced and first experimental results are presented.

14:54-15:12 WC2.4

In-Vehicle Speaker Recognition Using Independent Vector Analysis, pp. 1753-1758
Yamada, Toshiro
Tawari, Ashish
Trivedi, Mohan M.
Univ. of California, San Diego
Univ. of California, San Diego
Univ. of California at San Diego

As part of human-centered driver assist framework for holistic multimodal sensing, we present an evaluation of independent vector analysis for speaker recognition task inside an automotive vehicle. Independent component analysis-based blind source separation algorithms have attracted attentions in recent years in the application of speech separation and enhancement. Compared to the traditional beamforming technique, the blind source separation method may typically require less number of microphones and perform better under reverberant environment. We recorded two speakers in the driver and front-passenger seats talking simultaneously inside a car and used independent vector analysis to separate the two speech signals. In the speaker recognition task, we show that by training the model with the speech signals from the IVA process, our system is able to achieve 95 % accuracy from a 1-second speech segment.

### WC3

<table>
<thead>
<tr>
<th>Pedestrian Detection (Regular Session)</th>
<th>Dillingham</th>
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<td>14:00-14:18 WC3.1</td>
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Early Detection of the Pedestrian's Intention to Cross the Street, pp. 1759-1764
Köhler, Sebastian
Goldhammer, Michael
Bauer, Sebastian
Doll, Konrad
Brunsmann, Ulrich
Univ. of Applied Sciences Aschaffenburg
Univ. of Applied Sciences Aschaffenburg
Friedrich-Alexander-Univ. Erlangen-Nuremberg
Univ. of Applied Sciences Aschaffenburg
Univ. of Applied Sciences Aschaffenburg

Dietmayer, Klaus
Univ. of Ulm

This paper focuses on monocular-video-based stationary detection of the pedestrian's intention to enter the traffic lane. We propose a motion contour image based HOG-like descriptor, MCHOG, and a machine learning algorithm that reaches the decision at an accuracy of 99 % within the initial step at the curb of smart infrastructure. MCHOG implicitly comprises the body language of gait initiation, especially the body bending and the spread of legs. In a case study at laboratory conditions we present ROC performance data and an evaluation of the span of time necessary for recognition. While MCHOG in special cases indicates detection of the intention before the whole body moves, on average it allows for detection of the movement within 6 frames at a frame rate of 50 Hz and an accuracy of 80 %. Feasibility of the method in a real world intersection scenario is demonstrated.

Attachment. The following video illustrates results of our work on detecting pedestrian's intention to cross the street. It consists of four sequences where the test persons start walking from the standstill. Two sequences were captured in the laboratory and two sequences at a real world intersection. Furthermore two of the sequences correspond to images sequences in the paper to get a more detailed view.

14:18-14:36 WC3.2

Nighttime Pedestrian Detection by Selecting Strong Near-Infrared Parts and Enhanced Spatially Local Model, pp. 1765-1770
Lee, Yi-shu
Chen, Yi-Ming
Fu, Li-Chen
Hsiao, Pei-Yung
Chuang, Li-An
Chen, Yi-Hsiang
Luo, Ming-Fang
National Taiwan Univ.
National Taiwan Univ.
National Taiwan Univ.
National Univ. of Kaohsiung
National Taiwan Univ.
National Taiwan Univ.
Chung-Shan Inst. of Science and Tech.

We propose a nighttime pedestrian detection method for a moving vehicle equipped with a camera and the near-infrared lighting. The objects in the nighttime environment will reflect the infrared projected. In some cases, however, the clothes absorb most of the infrared and make the pedestrian partially invisible in that part. To deal with this, a part-based pedestrian detection method according to the feature points marked on parts is used. Due to high computation load, selection of effective parts becomes imperative. In this research work, we analyze the relations between the detection rate/processing time and different numbers/types of parts. Besides, traditional training of the part detector normally requires a large number of training samples. Therefore, we propose a method using the ignorance of the parts of the pedestrian for detection and achieve a good performance.
Pedestrian detection and action recognition is a demanding field in video-based driver assistance systems. Future systems not only try to detect pedestrians but also aim to predict the pedestrian's intention in order to guarantee the best safety for him/her and other traffic participants. Our contribution to that tendency consists of a method to reliably estimate the pedestrians' head pose in low resolution video sequences taken from an on-board camera. Assuming a pre-determined pedestrian, the head pose is initialized using normalized confidence values from a set of head pose detectors. Integrating the head pose predictions over time using particle-filtering will further result in a higher robustness and efficiency. Experiments on public available datasets (CHIL/CLEAR2007, CAVIAR) and real world scenarios show a performance improvement compared to single image based approaches. The developed method can be integrated easily into an overall system and will serve for a better pedestrian path prediction and intensity estimation within risk assessment.

Pedestrian detection is an important part of intelligent transportation systems. In the literature, Histogram of Oriented Gradients (HOG) detector for pedestrian detection is known for its good performance, but there are still some false detections appearing in the cases with flat area or clustered background. To deal with these problems, in this research work we develop a new feature which is based on pairing comparison computations, called Comparison of Granules (CoG). The idea of CoG is to encode the textural information of local area describing how different the pixel intensities are distributed within a region. It is shown that the special characteristics of CoG feature are "small" and "efficiency" relative to HOG. By incorporating this new feature, we propose a HOG-CoG detector which through our validation experiment achieves 38% log-average miss rate in full image evaluation and 90% detection rate at 10^-4 false positives per window on INRIA Person Dataset. Another contribution of this work is that, we also present a training scheme that can be applied on huge database for training a detector. Such training scheme can reduce the number of hard samples during bootstrap training.

Pedestrian recognition is one of the key technologies for advanced driver assistance systems and autonomous driving systems. This paper proposes a fusion system for reliable pedestrian recognition using a high-definition LIDAR and a vision sensor to achieve high performance in various conditions. Pedestrian candidates are extracted from two sensors in parallel by support vector machine based classifiers. In particular, the region of interest in the image processing is set by information about objects derived from the LIDAR processing to reduce false positives as well as computational burden. All candidates are integrated by their likelihood calculated from their classification scores, using multiple thresholds according to the detection condition of the target in two sensors. A quantitative evaluation in a road environment confirms the effectiveness of the proposed system.

We present a data-driven method for predicting driver behavior of sufficiently low complexity to be implemented in an automotive context. We develop a method to predict the driver's intended cruising speed as they launch from a stopped position. Our goal is to make this prediction in spite of highly modal driving by the driver (i.e., they drive in either an aggressive or relaxed manner). To reduce complexity and improve prediction, we do not try to calculate the hidden variables causing the modal driving or try to predict the vehicle's entire trajectory through filtering. We instead formulate a supervised learning problem to estimate the cruise speed directly. First we segment the trajectories into launch, cruise, and deceleration behavioral segments based on vehicle state and environment. Within each segment, we extract a low dimensional feature set which can be used to learn a model for predicting cruise speed under modal driving. In particular, a dynamical model is fit to the launch sequence data and its coefficients are used as regressors for a Nadaraya-Watson estimator. Results from a real-time implementation show that for a single road type, prediction error is significantly lower than other standard prediction methods. A key point is that our simpler prediction technique can yield good prediction results over long time scales with low complexity by predicting goal states directly rather than predicting the evolution of the vehicle state in time.
Knowledge of the gaze point of the driver can improve comfort and safety whilst driving in manifold ways. Head movements, combined with the line of gaze, play a fundamental role in predicting the driver’s actions and in inferring his intention. However, a gaze tracking system for automotive applications needs to satisfy high demands: It must not disturb the driver in his freedom of movements, it must cover large and fast head turns in yaw and pitch, be resistant to changing illumination conditions, be fast enough to recognize fast mirror checks, which are performed almost exclusively through eye rather than head movements, and be accurate and reliable enough to derive high quality information for driver assistance systems relying on their output.

In this work a multi-template, ICP-based gaze tracking system is introduced. The system determines the head pose and subsequently estimates the driver’s line of gaze by analysing the angles of the eyes. Due to a fast search of correspondences, and switching between point to point and point to plane alignment, real-time performance and high accuracy can be achieved. The system is compared with other state of the art head pose estimation systems based on a publicly available benchmark database, where a classification rate of 92% at a tolerance of 10 degrees in yaw could be achieved. We further show in the experiments section, that head rotations up to 4 radians per second can be handled.

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. Thus, in this paper we introduce these concepts already in the development phase of a product that will be used in an in-vehicle environment. We present the IC-DEEP (In-Car Ergonomics Evaluation Platform), which is an implementation approach in form of a Serious Game (SG) to autonomously assess, under low-time and low-cost conditions, the factors that can jeopardize the driving performance when manipulating or receiving information from in-vehicle information systems (IVISs). We evaluate the feasibility of the proposed approach and draw conclusions on its effects on behavioral changes and IVIS assessment.
further mitigate the influence of noise and improve the accuracy of prediction, an empirical model decomposition (EMD) method is derived to decompose the original short-term traffic flow data into several intrinsic mode functions (IMFs) and adopt them as the inputs for the RHNNs. Therefore, an ERHNN prediction model, which comprises good predictive ability for the nonlinear and non-stationary signals through the combination of the merits of OHPBFs, EMD and ERHNN, is proposed to predict short-term traffic flow more effectively. The validity of the ERHNN prediction model is verified using all day short-term traffic flow data at high way I-80W in California. Simulation results demonstrate that the proposed ERHNN prediction model is with superior performance compared with the pure recurrent neural network (RNN) and RHNN prediction models.

14:18-14:36

A Micro-Simulation Model of Pedestrian-Vehicle Interaction Behavior at Unsignalized Mid-Block Locations, pp. 1827-1833

Wang, Tianjiao
Univ. of Southampton
Wu, Jianping
Tsinghua Univ.
McDonald, Mike
Univ. of Southampton

The frequent interaction between vehicles and jaywalking pedestrians at unsignalized locations is one of the main characteristics of traffic systems in some developing countries such as China, due to less disciplined behavior on urban streets. The inadequate understanding and improper management of the mixed traffic contribute much to traffic congestion and accidents. Existing micro-simulation tools are of limit use for evaluating system performances at unsignalized locations, or comparing operations between unsignalized and signalized scenarios. A project was proposed to study the pedestrian-vehicle interaction behavior in urban street environment by micro-simulation modeling. This paper presents partial results of this project, focusing on the development and validation of the simulation model of the interaction behavior of the two modes at unsignalized mid-block locations. The result can be used as a tool to supplement current guidelines for pedestrian related problems, and also contributes to the knowledge base to incorporate pedestrians into existing micro-simulation models in a more realistic way.

14:36-14:54

Modelling Traffic Dynamics in Motorway Networks, pp. 1834-1839

Fitzgerald, Aidan
Queen’s Univ. Belfast
Marshall, Adele H.
Queen’s Univ. Belfast
Moutari, Salissou
Queen’s Univ. Belfast

Due to the rapid growth of traffic density, the necessity to increase the operational efficiency and capabilities of intelligent transportation systems (ITSs) has led to the development of various traffic modelling theories. The Lighthill-Whitham and Richards (LWR) model [12, 13], uses fluid based partial differential equations to capture traffic dynamics along continuous stretches of road. In contrast to the LWR model, the artificial neural network model [4, 14] utilizes historical observations of traffic flow rates to forecast flow-rate locally. This paper aims to introduce a new hybrid macroscopic model which combines the complementary features of the LWR and artificial neural network models, to effectively simulate traffic flow in road networks. The model developed in this paper demonstrates the ability to, within a certain degree of accuracy, forecast traffic flow in a road network that includes junctions and continuous stretches of road. Furthermore, the proposed model offers an appropriate trade-off between accuracy and computational complexity, therefore it is suitable for real time applications.

14:54-15:12

Micro-Simulation Study on the Effect of On-Street Parking on Vehicular Flow, pp. 1840-1845

Guo, Hongwei
Department of Transportation Engineering, Beijing Institute of Tech.
Wang, Wuhong
Department of Transportation Engineering, Beijing Institute of Tech.
Guo, Weiwei
Department of Transportation Engineering, Beijing Institute of Tech.

Abstract—On-street parking is an important component of urban parking system. It is an efficient means for providing more parking spaces and balancing the parking demand and supply. However, it is easy to decrease traffic performance and increase the risk of traffic accident. Aimed at evaluate the influence of on-street parking on characteristics of vehicular flow, a cellular automata model is developed for describing the interaction between the on-street parking maneuvers and vehicular flow in the one-way street with on-street parking spaces. The model takes different driving manuvers into account according to the dynamic features of different vehicles. Numerical simulation is performed using an extensive Monte Carlo procedure. The results show that the driving maneuvers of on-street parking can antedate traffic state transition from free flow to congested flow at low density. The maximum volume and travel speed are also influenced significantly. The finding in this paper has important ramifications for policy in the area of parking management and planning.

14:00-14:18

A Sequential Testing Approach for Change-Point Detection on Bus Door Systems, pp. 1846-1851

Cheilletz, Nicolas
Univ. Paris-Est, IFSTTAR/GRETTIA
Samé, Allou
Univ. Paris-Est, IFSTTAR/GRETTIA
Aknin, Patrice
Univ. Paris-Est, IFSTTAR/GRETTIA

Detecting change-points and anomalies on sequential data is common in various domains such as fraud detection for credit cards, intrusion detection for cyber-security or military surveillance. This study is motivated by the predictive maintenance of pneumatic doors in transit buses. For this purpose, buses are instrumented and data are collected through embedded sensors. Inspired by the CUSUM and GLR approaches, this paper deals with on-line change-point detection on sequential data where each observation consists in a bivariate curve. The system is considered out of control when a change occurs in the curves probability distribution. A specific regression model is used to describe the curves. The unknown parameters of this model are estimated using the maximum likelihood principle. Experimental studies performed on realistic data demonstrate the promising behavior of the proposed method.

14:18-14:36


Millonig, Alexandra
Austrian Inst. of Tech.
Sleszynski, Marek
Austrian Inst. of Tech.

Abstract—In the current context of high traffic densities and rapid urbanization, the time spent in public transport waiting for a train or bus is a factor which significantly influences the overall experience of passengers. Waiting time is one of the most important criteria for comparing the quality of different modes of transport. The quality of experience (QoE) is a subjective judgment of the performance of a system by the user. The closer the QoE is to the ideal QoE of 100%, the more satisfied the user is. Waiting time can be defined as the travel time that is observed by the user, i.e., the perceived waiting time is the time that the user perceives to be waiting. The perception of waiting time is a subjective experience and its value differs from user to user. It is strongly influenced by factors such as the environment, the type of mode and the service itself. Furthermore, the perception of waiting time is influenced by the awareness of the time and the perceived uncertainty of the time. The aim of this paper is to contribute to a better understanding of how passengers perceive waiting time in public transport. The study is based on an empirical investigation of the waiting times perceived by passengers in different modes of transport, using a questionnaire-based approach. The results show that the perceived waiting time is significantly influenced by the mode of transport and the awareness of the waiting time. The findings of this study can be used by transport operators to improve passengers’ satisfaction and increase the attractiveness of public transport.
Waiting for public transport services is one of the most important factors deteriorating public transport customer satisfaction. Although there are several approaches for enhancing the waiting experience for passengers, little consolidated knowledge exists concerning the effects of particular offers under different circumstances such as site characteristics or group preferences. This contribution introduces an approach for measuring the influence of different waiting activities on the perception of waiting times. We analyzed the activities and waiting time perception of 1215 public transport passengers in three types of stations in order to explore the effect of particular entertainment offers on the ability to estimate the duration of waiting times. The results indicate strong influences of station characteristics as well as user characteristics on waiting activities and time perception.

14:36-14:54 WC6.3

**A Portable Pedometer Based on Inductive Proximity**, pp. 1858-1861

Shajahan, Sheik [Indian Inst. of Tech. Madras]
Mohammed Ali [Indian Inst. of Tech. Madras]
George, Bobby [Indian Inst. of Tech. Madras]

This paper presents a new pedometer which requires, practically, no user dependent calibration. This new scheme is based on an inductive proximity sensing principle. The proposed pedometer consists of two modules, to be installed one in each shoe. These modules can be easily integrated, by the user, into commercially available shoes. A prototype unit has been developed and tested. Results are matching well with reference measurements. New sensor is less expensive and does not require frequent calibrations.

14:54-15:12 WC6.4

**Making Public Transportation Schedule Information Consumable for Improved Decision Making**, pp. 1862-1867

Gupta, Raj [IBM Res.]
Srivastava, Biplav [IBM Res.]
TamilSelvam, Srikant [IBM Res.]

Traffic chaos is increasing by the day in cities around the world, and especially in developing countries, due to rapid increase in the use of private vehicles. One reason for this trend is the lack of information about commuting choices possible with the existing public transportation network. Although schedules of individual modes may be available, they are not amenable to direct analysis and furthermore, give an integrated view of the services possible in the city. In this paper, we describe an efficient approach to transform readily available schedules into a more consumable standard form, and demonstrate its usage in a decision support tool for commuting choice selection. We have fine-tuned the process to remove common schedule errors and can easily incorporate new cities into the system within days for improved decision support. The approach is complementary to other alternatives that work with real-time data, e.g., GPS on buses, but need longer time, investment and extensive instrumentation to implement.

14:36-14:54 WC7.1

**BSM Emulator – Advanced Vehicle Safety Application**

**Experimental Investigations** (Regular Session)

14:00-14:18 WC7.1

**Testbed, pp. 1868-1873**

Gupta, Somak Datta [PATH, UC Berkeley]
Lin, Chih-Che [Information and Communications Research Lab., Ind ustrial Technology]
Chan, Ching-Yao [ITS, Univ. of California at Berkeley]

The emerging IEEE 1609/802.11p network protocol suite [1][2][3][4][5][6][7] enables a variety of vehicular applications [8]. For example, Applications based on SAE J2735 Basic Safety Messages (BSMs) [9] have been developed to avoid vehicle collisions and enhance driving safety. Evaluation of applications to be deployed is usually conducted with field trials, which are costly and labor intensive.

In this paper, we develop and implement a network emulation platform (called the BSM Emulator) for the new IEEE 802.11p/1609 network. The BSM Emulator can generate SAE J2735 BSMs with different MAC addresses, emulating the existence and the behaviors of multiple OBU and vehicles. By using this tool, one IEEE 802.11p/1609 device can imitate the BSM broadcast behaviors of multiple vehicles around an intersection, greatly facilitating field trials of vehicular networks/applications and reducing the cost of conducting field trials. To the best of the authors’ knowledge, this paper is the first work that develops and implements an integrated environment for the evaluation of IEEE 802.11p/1609 network and SAE J2735 related vehicular applications.

14:18-14:36 WC7.2

**A Robotic Platform to Evaluate Autonomous Driving Systems**, pp. 1874-1879

Belbachir, Assia [IFSTTAR]
Smal, Jean-christophe [IFSTTAR : French Inst. of Science and Tech. for Transport]
Blosseville, Jean-marc [IFSTTAR]

The paper proposes an assessment framework in which two platforms are used, one is simulation based, the other, Robert, is a robot that carries out the basic control of actuators. Robert platform can be installed on any cars. Authors have completed those basic capabilities in one case with upper level control (path planning, upper control) to assess perception capabilities. Robert basic controllers have also been completed to evaluate full autonomous control capabilities, without the difficulty to maintain low level controllers.

14:36-14:54 WC7.3

**A System for Coupled Road Traffic Utility Maximisation and Risk Management Using VANET**, pp. 1880-1887

Fitzgerald, Emma [Univ. of Sydney]
Landfeldt, Bjorn [Lund Univ.]

We propose a system for dynamic, real-time management of traffic accident risk in which vehicles exchange information via a vehicular ad-hoc network and use received information in calculating an estimate of current risk levels. We test the system's effectiveness in increasing the utility of the road network while maintaining the accident rate. We further prove the convergence of our proposed algorithm and investigate the information propagation, convergence rate and bandwidth requirements of the system and find that the system is able to increase the utility at maintained accident rate while operating within the confines of the IEEE 802.11p radio standard.

14:54-15:12 WC7.4
An Experimental Study on Changes of Muscle Fatigue among Utilizing Standing-Type Mobile Vehicles and Walking, pp. 1888-1893

Hashimoto, Naohisa  National Inst. of AIST
Sakurai, Yoshisaka  Japan Inst. of Sports Sciences
Suzuki, Yusuake  AIST
Tomita, Kohji  AIST
Horiiuchi, Eichi  AIST
Matsumoto, Osamu  AIST
Yokozuka, Masashi  AIST

Many robotics technologies are being developed. One of the technologies is utilized in a personal vehicle. A personal vehicle, which is high energy efficiency, has been expected as new personal mobility. It is well-known that a personal vehicle is higher energy efficiency, and needs less space than a normal vehicle. On the other hand, with respect to the fatigue, there are less enough experimental data using a personal vehicle, especially a standing-type personal vehicle. Thus, it will be necessary to evaluate the fatigue using standing-type personal vehicle. Two types of standing-type personal vehicles and normal walking were utilized in this study. The changes of muscle hardness on foot were employed in order to measure the amount of fatigue. The amount of fatigue was measured before and after moving about 3 [km] distance in real world on using each vehicle. The experiments and questionnaires after doing experiments were done with 6 subjects. Experimental result shows that there is a difference between two kinds of standing-type personal vehicles. The amount of muscle fatigue by using one small vehicle changes larger than two methods. It assumed that muscle fatigue can be affected by stability, power and space around feet from the results of experiments and questionnaires.

WC8
Network Level Traffic Analysis (Regular Session)
14:00-14:18  WC8.1

Network Zoning Based on Community Detection for Urban Traffic Control, pp. 1894-1899

Chen, Cheng  Inst. of Automation, Chinese Acad. of Sciences
Ai, Yunteng  Inst. of Automation, Chinese Acad. of Sciences
Zhu, Fenghua  Inst. of Automation, Chinese Acad. of Sciences

Network Zoning is a key problem for the coordination in hierarchical control system. In traffic control area, considering the characteristics of road network, like directed and spatial property, we give one appropriate method for network zoning. Inheriting the advantages of several community detection methods, this method takes the distance between intersections and the scale of intersection into account simultaneously. And we also applied it to the parallel transportation management systems (PtMS) in Tianhe area of Guangzhou for network zoning. The results of experiments illustrate its effectiveness.

Efficient representation of traffic networks, including congestion states, plays an important role in the effectiveness of routing algorithms incorporating Intelligent Transportation Systems (ITS) data. We employ an emerging concept in analyzing complex networks called “community structure detection” to capture traffic network dynamics in the form of hierarchical community-based representations of road networks. A key strength of these community (structure) detection methods is their computational efficiency. We investigate the impact of traffic dynamics on the hierarchical community-based representations of large road networks. The resulting hierarchical community representations and their evolution over varying traffic conditions with time can aid the computational performance of real-time routing algorithms. We analyze the performance of hierarchical community detection methods on the metropolitan road networks of New York City, Detroit, and San Francisco Bay area.

14:36-14:54  WC8.3
Markov-Based Redistribution Policy Model for Future Urban Mobility Networks, pp. 1906-1911

Volkov, Mikhail  Massachusetts Inst. of Tech.
Rus, Daniela  MIT
Aslam, Javed Alexander  NEU

In this paper we present a Markov-based urban transportation model that captures the operation of a fleet of taxis in response to incident customer arrivals throughout the city. We consider three different evaluation criteria: (1) minimizing the number of transportation resources for urban planning; (2) minimizing fuel consumption for the drivers; and (3) minimizing customer waiting time increase the overall quality of service. We present a practical policy and evaluate it by comparing against the actual observed redistribution of taxi drivers in Singapore. We show through simulation that our proposed policy is stable and improves substantially upon the default unmanaged redistribution of taxi drivers in Singapore with respect to the three evaluation criteria.

14:54-15:12  WC8.4
Modeling ITS Data Sources for Generating Realistic Traffic Operating Parameters for Project-Level Conformity Analysis, pp. 1912-1917

Liu, Hao  Univ. of Cincinnati
Wei, Heng  Univ. of Cincinnati
Yao, Zhuo  Univ. of Cincinnati

The challenge in characterizing on-road traffic source emissions affected by traffic management or control countermeasures is often the lack of the realistic traffic flow data at the microscopic level for the project-level transportation conformity analysis. With the advancement of Intelligent Transportation Systems (ITS) technologies, more and more ITS devices are deployed for monitoring traffic. Those ITS devices provide promising data sources for inputs to the emission models for the project level analysis. Taking advantage of those data sources, this paper presents an integrated framework to facilitate the on-road transportation emission estimation under various traffic operations which are influenced by the traffic management and control measures. The implementation of the framework is demonstrated by applying the three components of the framework, i.e., traffic flow phase identification module, vehicle classification module and MOVES (Motor Vehicle Emission Simulator) analysis module, in a case study where inductive loop data are utilized. The information provided by the framework can help traffic
operation agency improve or develop efficient traffic management or control measures for energy saving and environment protection.

15:12-15:30 WC8.5


Diab, Hilal RWTH Aachen Univ.
Ben Makhlouf, Ibtissem RWTH Aachen Univ.
Kowalewski, Stefan RWTH Aachen Univ.

Intersections are one of the most complex driving scenarios for an autonomous vehicle. When a platoon of autonomous vehicles following a leader approaches the intersection, the platoon should change its highway mode to other modes in order to cross the intersection safely. Therefore, the position, velocity and acceleration of the vehicles inside the platoon should be available. Furthermore, information about the position and velocity of other vehicles in the intersection area should be known too. The platoon controller should use all these information to decide which mode will be adopted. In fact, the platoon has to decide whether to stop, to pass or to split the platoon while crossing the intersection. This paper proposes a scaled testing platform of four electronically coupled vehicles equipped with a positioning system and an intersection management system. We tested different scenarios related to different crossing modes of the platoon. The experiments showed that we can change the platoon mode from a highway mode to an intersection drive efficiently.
Surnames, Given_names

Abbas-Turki, Abdeljalil
Abdel-Rahim, Ahmed
Abdelatah, Akmal
Abdelghany, Khaleed
Abellard, Alexandre
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Conference Announcement

16th International IEEE Conference on Intelligent Transportation Systems

October 6-9, 2013, The Hague, The Netherlands

Intelligent Transportation Systems for All Transport Modes

The IEEE Conference on Intelligent Transportation Systems is the annual flagship conference of the IEEE Intelligent Transportation Systems Society. IEEE-ITSC2013 welcomes articles in the field of Intelligent Transportation Systems, conveying new developments in theory, analytical and numerical simulation and modeling, experimentation, advanced deployment and case studies, results of laboratory or field operational test.

The theme of the IEEE-ITSC2013 conference is Intelligent Transportation Systems for All Transportation Modes. Major advances in information and communication technology are enabling a vast array of new possibilities in transportation.

ITS are emerging worldwide to make transportation more efficient, reliable, cleaner and safer. ITS are used in road, water, rail and air transportation to collect information about transportation flows from a multitude of sources and manage them effectively, shifting collective traffic and transportation management paradigms towards end user orientation.

Program Topics

The technical areas include but are not limited to the following:

- Multi-modal ITS
- Advanced Public Transportation Management
- Ports, Waterways, Inland navigation, and Vessel Traffic Management
- Modeling, Simulation, and Control of Pedestrians and Cyclists
- Air, Road, and Rail Traffic Management
- ITS User services
- Emergency Management
- Transportation Networks
- Emissions, Noise, Environment
- Management of Exceptional Events: Incidents, Evacuation, Emergency Management
- Security Systems
- Safety Systems
- Driver and Traveler Support Systems
- Commercial Vehicle Operations
- Intelligent logistics
- Sensing and Intervening, Detectors and Actuators
- Data Management Systems
- Communication in ITS
- Cooperative Techniques and Systems
- Intelligent Vehicles
- Vision, and Environment Perception
- Electric Vehicle Transportation Systems
- Electronic Payment Systems
- Intelligent Techniques in ITS
- Traffic Theory for ITS
- Modeling, Control and Simulation
- Human Factors, Travel Behavior
- ITS Field Tests and Implementation
Paper submission
Complete manuscripts in PDF format must be electronically submitted for peer-review in IEEE standard format. Detailed submission instructions can be found through the conference website.

Special Sessions, Tutorials, and Workshops
Special session organization is encouraged. Proposals for workshops, tutorials, and special sessions should be submitted via the conference submission website.

Best Paper Award and Best Student Paper Award
A "Best Paper Award" and a "Best Student Paper Award" will be conferred to the author(s) of a full paper presented at the conference, selected by the Awards Committee. The "Best Student Paper Award" will be given to a paper of which the first author is a student.

Journal and Magazine Publication of Selected Papers
Selected papers of exceptional quality will be invited for submission to a special issue of the IEEE Transactions on Intelligent Transportation Systems or the IEEE Intelligent Transportation Systems Magazine. Authors will be asked to revise their papers according to the standards of the Transactions or the Magazine. The papers will be subject to the Transactions’ and Magazine’s review process.

Important Dates
Special session proposal submission deadline: February 25, 2013
Full paper submission deadline: March 15, 2013
Workshop/tutorial proposal submission deadline: May 1, 2013
Notification of acceptance: June 1, 2013
Final paper submission deadline: July 1, 2013

Organizing committee
General Chair - Bart van Arem
General Co-Chair - Hans van Lint
Program Chair - Andreas Hegyi
Program Co-Chair - Bart De Schutter
Special Sessions Chair - Alfredo Núñez
Special Sessions Co-Chair - Hans van Lint
Finance Chair - Felicita Viglietti
Publications, Publicity, and Sponsoring Chair - Vincent Marchau
Local Arrangements and Registration Chair - Nicole Fontein

Conference website: http://ieee-itsc13.org/
IEEE Intelligent Vehicles Symposium – IV’13
23-26 June 2013, Gold Coast, Australia
http://www.iv2013.org

Call for Papers

THE INTELLIGENT VEHICLES SYMPOSIUM (IV’13) is the premier annual forum sponsored by the IEEE INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY (ITSS). Researchers, academics, practitioners, and students from universities, industry, and government agencies are invited to discuss research and applications for Intelligent Vehicles and Cooperative Vehicle Systems. The technical presentations are characterized by a single session format so that all attendees remain in a single room for multilateral communications in an informal atmosphere. Tutorials will be offered on the first day followed by three days of presentations. An exhibition area will be available for the presentation of products and projects.

The IFAC – INTELLIGENT AUTONOMOUS VEHICLES CONFERENCE IAV’13 will also be held at Gold Coast, from 26 June to 28 June 2013. It is the very first time, since their inception, that these two premier conferences will be held back-to-back. A special reduced conference fee will thus be on offer to intelligent autonomous vehicles researchers and practitioners towards encouraging them to attend both events and explore underpinning synergies. For details please visit www.iav2013.org

The IV’13 Program topics include but are not limited to:
Advanced Driver Assistance Systems
Automated Vehicles
Vehicular Safety, Active and Passive
Vehicle Environment Perception
Driver State and Intent Recognition
Eco-driving and Energy-Efficient Vehicles
Impact on Traffic Flows
Cooperative Vehicle – Infrastructure Systems
Collision Avoidance
Pedestrian Protection
V2I/V2V Communication
Proximity Detection Technology
Assistive Mobility Systems
Proximity Awareness Technology
Intelligent Ground, Air and Space Vehicles
Autonomous/Driverless Vehicles
Image, Radar and Lidar Signal Processing
Information Fusion
Vehicle Control
Telematics
Human Factors and HMI
Electric and Hybrid Vehicle Technologies
Novel Interfaces and Displays
Intelligent Vehicle Software Architecture

For detailed submission instructions visit the conference website at www.iv2013.org

Important Dates
Workshop, Special Session and Tutorial Proposals 01 November 2012
Paper Submission 01 November 2012
Notification of Acceptance 15 January 2013
Early Registration 15 February 2013
Final paper Submission 28 February 2013

Proposals
For special sessions, demonstrations, and exhibition proposals please contact respective chair.

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Notes