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SOCIETY NEWS

From the Editor
Miguel Ángel Sotelo

As the year comes to its end, we have had the opportunity to enjoy another successful ITS Conference in The Hague, The Netherlands, 6-9 October. Several ITS Awards were presented to outstanding researchers and students in the ITS community during the conference. In this issue, we offer our readers an interesting featured article on TRAMAN21, an ERC Advanced Investigator Grant on Traffic Management for the 21st century, by Prof. Markos Papageorgiou from the Technical University of Crete, Greece.

As usual, we start this issue with the “Message from the President” by Dr. Christoph Stiller. This will be his last message in the Newsletter as President of the ITSS, given that his term will end in December 2013. We want to express our utmost gratitude to Dr. Stiller for his seamless and generous service to the ITS Society in the latest years.
Message from President:

Challenges in ITS

By Dr. Christoph Stiller, President

This time I am writing my message from my vacations right at the Lago Garda, a beautiful lake with many small villages in Italy. Many renowned individuals have travelled here including Goethe. Among many conquerors, the Venetians have moved huge ships across the mountains surrounding the lake. Even though my own work on ITS is quite far, ITS is ubiquitous at the same time. Coming here led my way through the St. Gotthard tunnel, which is impressive 16.942 kilometers (10.527 mi) in length below the St. Gotthard Pass in the Alps. It is the third-longest road tunnel in the world after Norway's Lærdal Tunnel (24.5 km), and China's Zhongnanshan Tunnel (18 km). Looking at such great milestones in engineering skills forces me to philosophize about ITS in our daily life.

Individual mobility is precious to humans. It is a basis of our prosperity and directly contributes to our quality of life. On the flip side transportation is intertwined with damages like few other accepted technologies. These include environmental damages due to noise and exhaust, consumption of resources and space as well as loss of productive time in traffic congestions. Between the age of 15 and 29 the most likely cause of death is a traffic accident. Just in the European Union the economical damage caused by traffic accidents is estimated to the vast amount of 210 Billion US$ every year.

In this situation innovations in ITS are more important than ever. We are currently witnessing strong advances of research in autonomous driving vehicles. Even though many experts consider it still takes several decades until unsupervised autonomous driving can cope with arbitrary situations of everyday traffic, systems are progressively introduced into the market that can cope with restricted situations, such as automated yet supervised low speed following on a congested highway. Extensions to theses systems are expected in next-generation automobiles.

Personally, I am convinced that emerging car-2-x communication systems provide important contributions to solve ITS challenges. The Grand Cooperative Driving Challenge in 2011 in the Netherlands has shown that communication among inhomogeneous vehicles enables cooperative and safe traffic and leads to homogenized flow.

Excellent ITS engineers that work in an interconnected community are a prerequisite to approach these challenges. In this context I am very pleased with the growing number of student members in the ITS society. More and more young researchers willing to network on an international level in ITS make me confident that we will stay able to provide innovations in ITS that fulfill the needs of the people.

You read this message most likely just after the ITS conference that has taken place in the Hague, the Netherlands and I hope you have enjoyed meeting old friends and creating new contacts in an inspiring atmosphere.
Message from President:

Challenges in ITS

By Dr. Christoph Stiller, President

Do not forget to listen to the latest ITS Podcast at http://itsp.cicei.com/ which also reports on latest advancements in ITS. Last not least, this is the time to renew your IEEE ITSS membership to stay connected with the world largest professional community in engineering for the sake of humanity.

Sincerely,

Christoph Stiller
President IEEE ITSS
Report of BOG Meeting October 2013

By Daniel J. Dailey, VP for Administrative Activities

The BOG meeting was held October 6, 2013 in the Kurhaus Hotel, The Hague, Netherlands in conjunction with the ITSC2013 meeting. The President and each of the Vice Presidents made presentations on activities in their areas and the 2014 Officers Election was held. The material below is an overview of what was a long meeting….

Highlights on activities:
- ITS Podcast
- ITS Now
- New Format for Newsletter
- Impact Factor for Magazine expected in Mid-2014
- ITSS is the fastest growing Society in IEEE
- Possible Distinguished Lecture Series

Business is carried on using Robert’s Rules and the motions acted on are summarized below:
- ITSS becomes 7th co-sponsor of the IEEE Transportation Technology Award; Financial impact $2500 per year (Motion:Stiller, Second:Eskidarian) Approved Unanimously
- Motion to terminate sponsorship of IEEE Biometrics Council; Financial Impact $2000/year; Approved Unanimously
- ITSS become a member of IEEE Technical Committee on RFID in 2014; Financial Impact $5000/year for three years; (Motion:Stiller, Second:Wang) Approved (Two Abstentions)
- The decision on conferences will be made between the fourth year out and the third year out but no later than the first face to face BOG meeting three years out. (Motion:Barth, Second:Zhang) Approved.
- Approve ICVES 2014 to be in Hyderabad India, VP of conference will work on budget to guarantee 20% surplus and other IEEE Requirements (Motion:Zhang, Second:Stiller) Approved.
- Approve 2014 ISI in the Hague, (Motion:Zhang, Second:Barth) Approved
- Collocate SOLI 2014 in conjunction with ITSC 2014 (Motion:Zhang, Second:Trivedi), Approved
- Vice president of Conferences form an adhoc committee to create conference policy (Motion:Sopensky, Second:Wang) Approved: Member Volunteers: Emily, Zeng, Morris, Sotelo, Zhang
- Categorize the motions relative to each VP and publish it on the web for the past five years. (Motion:Eskandarian, Second:Trivedi) Daniel Zeng volunteers
- Approve technical co-sponsorship of ICALT 2014 in Tunis, Tunisia; Financial Impact $500, (Motion:Stiller,Seconded Zhang) Approved
- BOG Approval for VP conferences, VP Technical Activities, VP Finance to work with president to approve co-sponsored conferences without financial liabilities for previously co-sponsored conferences. (Motion:Barth, Second:Sopensky) Approved.
Report of BOG Meeting October 2013

By  Daniel J. Dailey, VP for Administrative Activities

- Increase the page budget for 2014 from 2256 to 2656 and Increase transactions from 4 to 6 issues (Motion:Wang, Second:Sopensky) Approved Unanimously
- Increase editorial assistant salary by $6000 for extra efforts on transactions and magazine. (Motion:Wang, Second:Zeng) Approved Unanimously
- To approve Transactions AE’s presented conditioned on completing 3 reviews acceptably. (Motion:Wang, Second:Stiller) Approved Unanimously
- Recommend BOG Approve the 2014 associate editors for the Magazine. (Motion:Miller, Second:Stiller) Approved Unanimously

Elections:

Vice President for Publication Activities: Jason Geng - Elected
Vice President for Conference Activities: Wei-Bin Zhang – Elected
Vice President for Member Activities: Daniel Zeng - Elected
Editor-in-Chief of Transactions: FeiYue Wang - Elected
Editor-in-Chief of Magazine: Jeff Miller - Elected
IEEE 2013 ITS Award Announcement

IEEE ITS Institutional Lead Award
IEEE ITS Outstanding Research Award
IEEE ITS Outstanding Application Award

Purpose and Selection Criteria of Awards

The IEEE ITS Outstanding Research Award, IEEE ITS Outstanding Application Award, and IEEE ITS Lead Award are given annually for ITS researchers, practitioners, and research/development teams who have made significant contributions to research in ITS related fields (ITS Research Award), developed and deployed successful ITS systems or implementations (ITS Application Award), and demonstrated leadership in promoting ITS technologies (ITS Institutional Lead Award). These awards are established to recognize, promote, and publicize major research contribution, application innovations with real-world impact, and ITS institutional leadership.

Winners of 2013 IEEE ITS Awards

2013 IEEE ITS INSTITUTIONAL LEAD AWARD:
Chris Urmson
Google Self-Driving Car Team
Google, USA
For institutional leadership in research, development, and applications of advanced self-driving vehicle technologies.

2013 IEEE ITS OUTSTANDING RESEARCH AWARD:
Mohan Trivedi
University of California at San Diego, USA
For contributions to machine vision and learning for intelligent vehicles, and driver assistance and transportation systems.

2013 IEEE ITS OUTSTANDING APPLICATION AWARD:
Miguel Ángel Sotelo
VISUALISE
University of Alcalá, SPAIN
For contributions in applications of traffic signs automatic inspection technologies for safer road Transportation.

Congratulations!

For further information, please contact Dr. Jason Geng, VP for Membership Activities, IEEE ITSS.
Purpose and Selection Criteria of Awards

The prestigious IEEE ITSS Best Ph.D. Dissertation Award is given annually for the best dissertation in any ITS area that is innovative and relevant to practice. This award is established to encourage doctoral research that combines theory and practice, makes in-depth technical contributions, or is interdisciplinary in nature, having the potential to contribute to the ITSS and broaden the ITS topic areas from either the methodological or application perspectives.

Winners of 2013 IEEE ITSS Best Ph.D. Dissertation Awards

First Place:

Samah El-Tantawy
Advisor: Prof. Baher Abdulhai
University of Toronto, Canada
Title: Multi-Agent Reinforcement Learning for Integrated Network of Adaptive Traffic Signal Controllers

Tied second place winner (listed in alphabetic order of last names):

Xiquen Chen
Advisor: Prof. Qixin Shi/Li Li
Tsinghua University, China
Title: Stochastic Evolutions of Dynamic Traffic Flow: Modeling and Application

Manuel Fogue
Advisor: Prof. Francisco J. Martinez/Piedad Garrido,
University of Zaragoza, Spain
Title: Design and Evaluation of a Traffic Safety System based on Vehicular Networks for the Next Generation of Intelligent Vehicles

Congratulations!

For further information, please contact Dr. Jason Geng, VP for Membership Activities, IEEE ITSS.
ITSPodcast: 6 episodes off, and counting!

At the ITS Podcast Editorial Board, we are working real hard to have, month after month, our ITS Podcast published with new interesting interviews. We’ve talked about autonomous driving, environmentally aware ITS, navigation systems, traffic jam fighting, human factors and ITS, and more.

Now we are so glad to announce that our episode number 6 is already available. You can listen it on-line or download here: http://itsp.cicei.com

Here is some news regarding this new publication:

• We have refurbished our website to make it more user-friendly to our mobile and tablet listeners.
• Remember that we allow moderated comments in our website. So please, feel free to enrich our show with your ideas, suggestions, etc. This bi-directionality is something we are really proud of. Therefore, we are eager to read your feedback.
• Do you use linked-in? Do you know we have created a group for this publication? Please join us here: http://www.linkedin.com/groups/ITS-Podcast-5156368/about
• There is another easy option that many people like: You can simply subscribe to these periodic publications by introducing your email address at the "Follow" button in the right lower corner of our website.

Finally, we really need your help to make this new publication known. You can help us to make it know as follows:

• If you do have a Facebook account: Please like us (http://www.facebook.com/itsp.itss)
• If you do have a Twitter account: Please follow and Re-Tweet us (@ITSPodcast)
• If you do have a Google+ account: Please like us (ITSPodcast)
• You can also visit our website (itsp.cicei.com) and click on the social sharing icons of your preference at the top or the bottom of each page/post.
• Please, distribute this information to the email distribution lists you think is appropriate.

Thank you very much for all your help!

Javier Sanchez-Medina
Editor in Chief for ITS Podcast
javier.sanchez.medina@ieee.org
itsspodcast@gmail.com
Women in Engineering (WIE) has over 425 affinity groups, 15,000 members and 35 society representatives serving on the WIE committee. Thank you for representing your society to help increase recruitment, retention and recognition of women in engineering.

Unfortunately, representation of women in IEEE is low when compared to industry averages. Women represent 11% of electrical engineering and 17% of computer science graduates in the United States (according to the US Bureau of Labor Statistics). Yet, when looking at all IEEE societies, women comprise only 6% of the society membership. The IEEE Professional Communication Society leads society representation of women with a 21% participation rate.

On behalf of the IEEE Women in Engineering Committee (WIEC), I encourage you to collaborate with us to increase the recruitment and retention of women within the IEEE fields of interest.

IEEE WIE has developed a focused plan to recruit and retain women. Although we have had several recent successes with the “I Change the World. I am an Engineer.” campaign, we still have much work to do. I hope that your society will consider collaborating with us on two key initiatives this year, the online chats and a WIE International Leadership Conference (WIE-ILC) planned for 2014. I look forward to any other ideas you might have on how to recruit and engage more women within our profession. Thank you for your volunteer leadership!

Sincerely,

Nita Patel
2013 IEEE Women in Engineering Chair

24 June 2013
IEEE Women in Engineering facilitates the global recruitment, retention and recognition of women in technical disciplines creating a vibrant community of IEEE women and men collectively using their diverse talents to innovate for the benefit of humanity.

**RECRUIT**

Collaborate with IEEE WIE to reach professional, technical women in different technical and engineering disciplines. Maximize your society’s brand recognition with technical women at different stages of their career through partnership opportunities tailored for all budgets.

**INSPIRE**

Your sponsorship demonstrates your society’s commitment to diversity and development for professional women in industry and academia. Sponsor society’s have the opportunity to expand professional networks and provide engagement opportunities.

Help expand the WIE community to fuel innovation, facilitate knowledge sharing and provide support. WIE focuses on providing a community working together to inspire the next generation through our STAR mentoring program, to recruit IEEE members through special project funding, to retain women within the profession through conference partnerships and to recognize exemplary WIE members through WIE awards and IEEE award nomination support.

Contact us today to discuss a mutually beneficial partnership customized for your society!

**Nita Patel**

2013 WIE Chair
IEEE WIE INTERNATIONAL LEADERSHIP CONFERENCE

PARTNERSHIP OPPORTUNITIES

**WIE Magazine**  
(various levels starting at $1,500)  
Highlight women within your society through professional interviews and/or articles highlighting achievements and/or professional careers.

**PARTNERSHIP ELEMENTS:**  
- Society to provide contact information for interview candidates  
- Society to provide full page, color society advertisement  
- Deadlines are July 1st and December 1st of each year for the December and June issues, respectively

**WIE-ILC Conference**  
(various levels, starting at $1,000)  
Support the WIE International Leadership Conference with a focus to elevate, educate and inspire women engineers and to provide technical professionals in industry and academia the leadership development opportunities necessary for advancement in their careers.  
http://sites.ieee.org/wie-ilc/sponsor/

**PARTNERSHIP ELEMENTS:**  
- Inquire for separate conference level support opportunities ranging from a booth at the conference career fair to providing leadership speakers

**WIE ieee.tv channel**  
If your society has a video highlighting women within that discipline, WIE will be happy to host the video on its ieee.tv channel. The video will be used to encourage young girls to pursue engineering and recognize achievements of women within the profession.  
https://ieee.tv.ieee.org/chanels/wie

**PARTNERSHIP ELEMENTS:**  
- Sponsoring society to provide video  
- WIE to coordinate and host on WIE ieee.tv channel

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Expand the IEEE community by reaching women engineers! Contact Keyana Tennant.

call: 732.981.3423  
e-mail: women@ieee.org  
info: http://www.ieee.org/women
PARTNERSHIP OPPORTUNITIES

**WIE on-line chat ($500)**

Present technology trends within the society and/or professional development topics. Allow women to network with others through the IEEE WIE Facebook page. The online chats provide a casual environment for women to network and share ideas.

PARTNERSHIP ELEMENTS:
- Sponsoring society to identify potential women for online chat
- WIE to coordinate and host webinar

**WIE newsletter (various levels)**

Advertise your society in the newsletter and/or highlight society events. The newsletter is distributed monthly to all WIE members.

[www.ieee.org/membership_services/membership/women/newsletter](http://www.ieee.org/membership_services/membership/women/newsletter)

PARTNERSHIP ELEMENTS:
- Sponsoring society to provide information
- WIE to incorporate into and distribute newsletter

**WIE Posters ($5,000)**

IEEE WIE created several “I Change the World. I am an Engineer.” posters. Several colleges and universities have asked that these be translated to other languages. Support IEEE WIE efforts in creating new posters in other languages. Your society logo will be included on the posters and an opportunity will be provided to highlight women from your society.


PARTNERSHIP ELEMENTS:
- Sponsoring society to provide potential poster candidates
- WIE to coordinate production and distribution

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Expand the IEEE community by reaching women engineers! Contact Keyana Tennant.

call: 732.981.3423
e-mail: women@ieee.org
info: [http://www.ieee.org/women](http://www.ieee.org/women)
Expand the IEEE community by reaching women engineers! Contact Keyana Tennant.

call: 732.981.3423

e-mail: women@ieee.org

info: http://www.ieee.org/women

IEEE WIE INTERNATIONAL LEADERSHIP CONFERENCE

PARTNERSHIP OPPORTUNITIES

Promotional Items
($5,000-$10,000) Increase your visibility at a reasonable price by sponsoring promotional items to be distributed to any requesting affinity groups (420+ worldwide).

PARTNERSHIP ELEMENTS:
- Sponsoring society to provide logo artwork
- Sponsoring society to identify promotional item preferred
- WIE to coordinate production and distribution

Travel Grants
(any amount) Highlight your society as key partner for of the WIE International Leadership Conference and/or other IEEE conferences. Frequently throughout the year, WIE receives requests from students around the world for support to attend an IEEE conference.

Awards & Scholarships
(any amount) Highlight your society as key partner of WIE by sponsoring one of the WIE awards (these include the student branch affinity group of the year, the affinity group of the year, WIE inspiring student of the year, and WIE inspiring member of the year.
The IEEE is seeking nominations for the IEEE Innovation in Societal Infrastructure Award. This award was established in 2011 and is sponsored by Hitachi, Ltd. and IEEE Computer Society. It is presented to an individual, team, or multiple recipients up to three. It is for significant technological achievements and contributions to the establishment, development, and proliferation of innovative societal infrastructure systems through the application of information technology with an emphasis on distributed computing systems. The prize consists of a bronze medal, certificate, and cash honorarium. For further details, see http://www.ieee.org/about/awards/tfas/isi_award.html. If you have good candidates for nomination, please contact Matt Barth (barth@ee.ucr.edu).

Matthew Barth
ITSS President-Elect
TRAMAN21 - An ERC Advanced Investigator Grant on Traffic Management for the 21st Century

By Prof. Markos Papageorgiou, Technical University of Crete, Chania, Greece

The European Research Council (http://erc.europa.eu) awards yearly some 300 Advanced Investigator Grants across all scientific disciplines. TRAMAN21 (Traffic Management for the 21st Century) was awarded in 2012 to the author of this note and started its investigations in March 2013. In a nutshell, the main objective of TRAMAN21 is to develop the foundations and first steps that will pave the way towards a new era of future motorway traffic management research and practice, which is indispensable in order to accompany, complement and exploit the evolving deployment of various vehicle automation and communication systems (VACS). This note presents briefly the motivation and scope of TRAMAN21. For more details, interested readers are invited to visit the project’s web site www.traman21.tuc.gr.

Motorway Traffic Congestion: In contrast to the spectacular IT (Information Technology) advances that enable the virtually instantaneous transfer of huge amounts of data around the globe, the daily physical transportation of persons and goods in and around metropolitan areas remains an (increasingly) serious, in fact threatening, problem for modern societies, that calls for drastic solutions. In particular, the daily appearance of extended motorway congestion in Europe and elsewhere degrades substantially the nominal infrastructure capacity at the rush hours, i.e. at the only time this capacity is actually needed, causing excessive delays, substantial environmental pollution and reduced traffic safety. The consequences of this serious infrastructure degradation are enormous for the economic and social life of affected metropolitan areas. The European Commission estimates that the yearly cost of road traffic congestion in Europe exceeds € 120 billion. “New technologies for vehicles and traffic management will be the key to lower transport emissions in the EU as in the rest of the world” according to the European Commission. For a number of reasons, the currently applied traffic management measures on motorways have a positive, but often limited impact on the heavily congested motorway traffic conditions. The significant congestion problem of modern societies must be addressed in a comprehensive way that accounts for gradually emerging and future ground-breaking new capabilities of individual vehicles and the infrastructure.

Emerging Vehicle Automation and Communication Systems (VACS): During the last decade, there has been an enormous interdisciplinary effort by the automobile industry as well as by numerous research institutions around the world to plan, develop, test and start deploying a variety of Vehicle Automation and Communication Systems (VACS) that are expected to revolutionize the features and capabilities of individual vehicles within the next decades. VACS are mainly developed to significantly improve traffic safety and may be classified in three main categories as follows:
TRAMAN21 - An ERC Advanced Investigator Grant on Traffic Management for the 21st Century

By Prof. Markos Papageorgiou, Technical University of Crete, Chania, Greece

- **In-Vehicle Systems** address functions within individual vehicles, such as: a variety of new sensors, diverse ADAS (Advanced Driver Assistance Systems) aiming at supporting the driver in specific safety-critical situations, active green driving, longitudinal and lateral vehicle control, lane change and merging assistants, fully autonomously driving vehicles.
- **Vehicle-Infrastructure-Integration (Cooperative) Systems** (Figure 1) are developed to enable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. The messages received by the vehicles include traffic information, warnings, alarms, but may also include commands, such as vehicle speed commands or speed limits to be automatically enforced.
- **Vehicle Platooning Systems** involve a variety of options for semi-automatic forming of closely-spaced vehicle platoons, aiming at more convenient, safe, fuel-efficient and traffic-efficient driving.

![Figure 1: Sketch of vehicle-infrastructure integration system.](image)

VACS cover a wide spectrum, ranging from relatively weak driver support to highly automated driving. They are typically developed or envisaged to benefit the individual vehicle and driver, often without a clear view or understanding for the implications, potential advantages and disadvantages they may have for the resulting, accordingly modified traffic characteristics or for the opportunities they may offer via appropriately adapted traffic management actions and strategies.
Due to a diversity of reasons (technical, legal, economic, administrative), it is widely recognised that VACS will be introduced gradually during the next decades; first, in the sense of a gradual increase of the vehicle automation level; and, second, in the sense of a gradual increase of the percentage of equipped vehicles (penetration rate). In addition, the precise vehicle automation scenario, which will factually materialise over the next decades, is hardly predictable, as it depends on diverse factors which may influence the specific innovation path in an unpredictable way. On the other hand, it is quite certain that, whatever the precise form of the VACS innovation path will turn out to be, the characteristics of traffic flow will be continuously changing during the next decades due to the gradual introduction of VACS, and this brings along the necessity and continuously growing opportunities for accordingly adapted or utterly new traffic management actions and strategies.

**TRAMAN21 Scope:** Several new vehicles are already equipped with a number of VACS, such as ACC (Adaptive Cruise Control). Several car manufacturers have announced the market introduction of highly automated vehicles within less than a decade. Individual drivers may be willing to pay the surplus amount for emerging VACS to increase their personal safety and convenience. However, highly intelligent vehicles competing for the notoriously limited space on motorways may give rise to dumb and inefficient traffic flow behaviour and congestion increase if the expected VACS evolution is not accompanied by appropriate traffic management measures which will exploit the new opportunities to ensure a sustainable and efficient traffic flow on the motorways in the decades to come.

For example, guiding individual equipped vehicles to time-shorter routes (to avoid congested network parts) may be beneficial under low penetration scenarios. However, as the percentage of vehicles receiving routing instructions increases, the proposed alternative routes may become congested themselves, and the traffic situation at network level may deteriorate. As another example, longitudinal vehicle control (ACC) should not only serve the convenience of the drivers of equipped vehicles, but also ensure that the resulting traffic flow capacity and dynamics do not deteriorate (in fact improve, when needed). Similarly, maximum speed advice or commands adopted by individual equipped vehicles for safety or fuel-economy purposes may be appropriately exploited to also improve the traffic conditions, both locally and network-wide. In short, appropriate traffic management actions should reconcile the benefits offered to the drivers of VACS-equipped vehicles with global network-wide traffic performance in a way that is robust to the changing penetration rate. Expressed in economic terms, the pursued TRAMAN21 work will contribute to reconcile the individual driver incentives to acquire VACS with tangible societal benefits.
The aforementioned main objective of TRAMAN21 is decomposed in a number of interacting activities as follows:

- A comprehensive overview and analysis is being undertaken for VACS that are either virtually available, or under development, or in an initial research stage, or just being envisaged. Specific suggestions for exploitation of potentially available features with high potential for improved traffic management will be identified and worked out in detail.

- A second axis of TRAMAN21 developments is traffic flow modelling in presence of VACS. A microscopic modelling effort augments available vehicle car-following and lane-changing models to enable the consideration of specific VACS. A macroscopic modelling effort employs appropriate methods (e.g. gas-kinetic approaches) to derive macroscopic traffic flow models under the impact of incorporated specific VACS at different penetration rates.

- A third, particularly critical TRAMAN21 activity is the development of a generic structure and related generic principles for traffic management in the presence of VACS. The control structure will comprise a number of modules; and its elements will be substantiated using powerful Automatic Control and Optimisation methods; and will be demonstrated (using the developed models) for several selected VACS scenarios.

- A final significant ingredient of TRAMAN21 is an actual field test aiming at demonstrating the feasibility and efficiency of the aforementioned control system development at local level under real conditions. The unavoidable difficulty that relevant VACS are currently not available for traffic-level experimentation, will be circumvented by using conventional actuators, such as VSL (variable speed limit) signs and further tools, albeit in innovative ways that mimic the potential speed commands of future VACS.
The 2013 IEEE International Conference on Vehicular Electronics and Safety (ICVES) was held in Dongguan, China, on July 28-30, 2013. This conference was held concurrently with the 2013 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI), and the China Summit on Intelligent Enterprises (CSIE).

ICVES is an annual forum sponsored by the IEEE Intelligent Transportation Systems (ITS) Society. It brings together an international community of experts to discuss the new research results, perspectives of future developments, and innovative applications related to vehicular electronics and safety.

This year, 79 papers were submitted from China, Germany, and Taiwan, and 30 papers were accepted according to the comments of reviewers. The conference was honored to have two distinguished keynote speeches by Dr. Rangachari Anand from the IBM T. J. Watson Research Center and Professor Lixin Tang from the Logistics Institute of Northeastern University.

The ICVES organizing committee was grateful to IEEE Intelligent Transportation Systems Society, National Natural Science Foundation of China, and Chinese Academy of Sciences for their sponsorship. A special acknowledgement goes to the Institute of Automation and the Cloud Computing Center, Chinese Academy of Sciences, for the local coordination and management. Thanks are also given to 20 international program committee members and reviewers for preparing an excellent technical program. Finally, we extend our thanks to the keynote speakers, reviewers, and volunteers for their valuable contributions to this conference.
Prof. Yanqing Gao introduced the technical program of ICVES at the opening ceremony.

Dr. Rangachari Anand gave a keynote speech.
The 2013 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI) was held in Dongguan, China, on July 28-30, 2013. This conference was held concurrently with the 2013 IEEE International Conference on Vehicular Electronics and Safety (ICVES), and the China Summit on Intelligent Enterprises (CSIE).

With the rapid progress of information technology and modern management theories, service operations and logistics has been paid more attention, which is a multidisciplinary research area includes computer science, industrial engineering, operations research, management science, cognitive science, and etc.. SOLI is an annual conference. It not only brings together researchers from the fields of Service Operations and Logistics, and Informatics, but also develops and nurtures a community for the scholars, researchers and practitioners from academic institutions, universities and industrial companies all over the world.

This year, about 200 papers were submitted to the conference from 12 countries and regions, and 104 papers including 37 student papers were accepted after a strict peer review process. The final technical program included 10 sessions with 50 oral presentations. The organizing committee invited Dr. Rangachari Anand from the IBM T. J. Watson Research Center and Professor Lixin Tang from the Logistics Institute of Northeastern University to be the keynote speakers. Their topics were “The next generation of enterprise knowledge management systems for the IT service industry” and “Production-logistics planning and scheduling in the steel industry”, respectively. The SOLI Organizing Committee was grateful to INFORMS, ITSS (Intelligent Transportation Systems Society), IBM, CAA (Chinese Association of Automation), NSFC (National Nature Science Foundation of China) and CAS (Chinese Academy of Sciences) for their sponsorships of the conference. A special acknowledgement is due to the Institute of Automation and Cloud Computing Center, Chinese Academy of Sciences, who mainly organized IEEE SOLI 2013 together.

Three excellent papers were selected by the award committee leading by Dr. Xiuqin Shang. Best Conference Paper Award was presented to Jun Wang, Kush R. Varshney, Aleksandra Mojsilović, Dongping Fang, and John H. Bauer, from IBM Thomas J. Watson Research Center, for their paper “Expertise Assessment with Multi-Cue Semantic Information”. Best Application Paper Award was presented to Gianmario Motta, Daniele Sacco, Alessandra Belloni, Linlin You, from Dept. of Industrial and Information Engineering, University of Pavia, for their paper “A system for green personal integrated mobility: a research in progress”. Best Student Paper Award was presented to Duan Yanjie, Zhu Fenghua, Xiong Gang, Li Yuantao, Lv Yisheng, from Institute of Automation, Chinese Academy of Sciences, for their paper “Improved information feedback in symmetric dual-channel traffic”.

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October 2013
In addition, one book named like “Big Data and Smart Service Systems” is editing with about 10 papers selected from IEEE SOLI 2013. The book will be published by Springer Press this year.

Prof. Gang Xiong gave a welcome speech at the opening ceremony.

Dr. Rangachari Anand gave a keynote speech.
Prof. Lixin Tang gave a keynote speech.

Prof. Fei-Yue Wang introduced 3D printing and social manufacturing.
Conference Report

2013 IEEE Int. Conference on Service Operations and Logistics, and Informatics
28-30 July, Dongguan, Guangdong, China
Gang Xiong, General Chair
Xiwei Liu, Program Chair

Academician of Chinese Academy of Engineering, Prof. Li Guojie, Prof. Yike Guo and Dr. Rangachari Anand present awarded to the authors of excellent conference papers.
Call for Papers

2014 IEEE Intelligent Vehicles Symposium
Sponsored by the IEEE Intelligent Transportation Systems Society
June 8 - 11, 2014, Ypsilanti, Michigan, USA

THE INTELLIGENT VEHICLES SYMPOSIUM (IV’14) is a premier annual forum sponsored by the IEEE INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY (ITSS). Researchers, practitioners, and students from universities, industry, and government agencies are invited to discuss research and applications for Intelligent Vehicles and Vehicle-Infrastructure Cooperation. The technical presentations are characterized by a single oral session and multiple poster sessions where all attendees can exchange ideas in an informal atmosphere. Tutorials will be offered on the first day followed by three days of presentations and a vehicle demonstration day. An exhibition area will be available for the presentation of products and projects.

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 / Intelligent Robotic Vehicles
- Image, Radar, Lidar Signal Processing
- Information Fusion
- Vehicle Control
- Telematics
- Human Factors and HMI
- Electric and Hybrid Technologies
- Novel Interfaces and Displays
- Intelligent Vehicle Software Infrastructure

SPECIAL and TUTORIAL SESSIONS are encouraged. Organizers should contact Prof. Daniel J Dailey at dan@uw.edu or Prof. S. Tsugawa at tsugawa@meijo-u.ac.jp.

PAPER SUBMISSION
Manuscripts must be electronically submitted through the conference website www.ieeeiv.net. Submitted manuscripts should be at most six (6) pages in IEEE two-column format, including figures, tables, and references. Please use the templates at Manuscript Templates for Conference Proceedings available from the conference website to prepare your manuscript. All submissions MUST be in PDF format.

IMPORTANT DATES
Special Session Proposal-------------------------January 10, 2014
Paper submission deadline----------------------January 10, 2014
Notification of acceptance---------------------March 14, 2014
Final Paper Submission-------------------------April 11, 2014
The 17th International IEEE Conference on Intelligent Transportation Systems

The IEEE Conference on Intelligent Transportation Systems is the annual flagship conference of the IEEE Intelligent Transportation Systems Society. IEEE ITSC 2014 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 tests. IEEE ITSC 2014 is organized by the State Key Laboratory of Management and Control for Complex Systems (SKL-MCCS) at the Institute of Automation, Chinese Academy of Sciences (CASIA).

General Chairs
Nanning Zheng
Fei-Yue Wang

Program Chairs
Daniel Zeng
Christoph Stiller

Program Co-Chairs
Azim Eskandarian (North America)
Brendan Morris (North America)
Javier Sánchez Medina (Europe)
Kyongsu Yi (Asia)
Yibing Yang (Asia)

Local Chair
Xinzhu Zhang
Qingdao Municipal Government

Topics
The technical areas include but are not limited to the following:

- Artificial Transportation Systems
- 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 conference website.

Important Dates
Please visit the conference website at http://www.itsc2014.org/ for the deadlines.

IEEE ITSC 2014 will be held together with the 2014 IEEE International Conference on Service Operations and Logistics, and Informatics.
The EU COST Action project MULTITUDE (www.multitude-project.eu) is pleased to announce its Final Conference that is taking place December 4th-6th in Naples, Italy. Over the last 4 years the project, which has addressed the topic of calibration and validation in traffic simulation models has attempted to develop, implement and promote the use of methods and procedures for supporting users to apply available traffic simulation models correctly, effectively and repeatably.

The objectives of the final conference are to disseminate the scientific outcomes of the Action and to foster the discussion and the scientific investigation on the topic of the management of the uncertainty in traffic simulation. Its impacts on the transportation engineering practice and on the transportation decision making process will be debated, in particular, during the first day in a round table with eminent participants from academia and both the consultant and the client worlds. Three keynote speeches and a number of invited presentations will follow, covering many theoretical and practical aspects including calibration, validation, sensitivity analysis in traffic and pedestrian simulation, and traffic control.

For further details please visit: http://www.multitude-project.eu/
This section lists upcoming ITS-related conferences, workshops, or exhibits. Contributions are welcome; please send announcements to itsconfs@ce.unipr.it.

### 2013

**October 14-18**  
20th World Congress on ITS  
Tokyo, Japan  
http://www.itsworldcongress.jp

**October 16-18**  
13th International Conference on ITS Telecommunication  
Tampere, Finland  
http://www.itst2013.org/

**October 23-25**  
2013 IEEE Vehicular Electronics Conference (VEC)  
Santa Clara Convention Center  
Silicon Valley, CA, USA  
http://www.vec-ievc.org/

**November 3-7**  
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2013)  
Tokyo Big Sight, Tokyo, Japan  
http://www.iros2013.org

**November 9-13**  
17th IRF World Meeting and Exhibition  
Riyadh, Saudi Arabia  
http://irfnews.org/files/pdfs/121016_IRF_bro_H_WEB.pdf

### 2014

**10-11 January, 2014**  
8th International Conference on Intelligent Systems and Control (ISCO 2014)  
Coimbatore - 641 032, Tamilnadu, India
April 8-10, 2014
SAE 2014 World Congress & Exhibition
Detroit, Michigan, USA

April 28-30, 2014
13th ITS Asia Pacific Forum 2014
Auckland, New Zealand
Submission due by: October 30
http://www.itsasiapacificforum2014.co.nz/

May 18-21, 2014
IEEE Vehicular Technology Conference: VTC2014-Spring
Seoul, Korea
Submission due by: 6 October 2013
http://www.ieeevtc.org/vtc2014spring/

May 31-June 5, 2014
2014 IEEE International Conference on Robotics and Automation (ICRA 2014)
Hong Kong, China
http://www.icra2014.com

June 1-4, 2014
IEEE International Symposium on Industrial Electronics (ISIE 2014)
Istanbul, Turkey
Submission due by: November 30, 2013
http://www.isie.boun.edu.tr

June 4-7, 2014
10th ITS European Congress
Helsinki, Finland
http://www.itsineurope.com/its10

June 8-11, 2014
The 2014 IEEE Intelligent Vehicles Symposium
Ypsilanti, MI, USA
Submission due by: January 10, 2014
http://www.ieeeiv.net

June 23-28, 2014
18th International Forum on Advanced Microsystems for Automotive Applications (AMAA 2014)
Kaiserin Friedrich-House, Berlin (Germany)
Submission due by: November 1st
http://www.amaa.de/
27th IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2014)
Columbus, OH, USA
Submission due by: November 1st
http://www.pamitc.org/cvpr14/

September 7-11, 2014
ITS World Congress 2014 - Detroit
Detroit, MI, USA
http://www.itsa.org/events/2014-world-congress

September 14-17, 2014
IEEE Vehicular Technology Conference: VTC2014-Fall
Vancouver, Canada
Not yet open
http://www.ieeevtc.org/vtc2014fall/

October 7-10, 2014
2014 IEEE Multi-Conference on Systems and Control
Antibes Congress Center, Nice/Antibes, France
Submission due by: April 1, 2014
http://www.msc2014.org/

November 20-21, 2014
VISIGRAPP 2014: 9th International Joint Conference on Computer Vision, Imaging and Computer Graphic Applications
http://www.visigrapp.org/

November 14-15, 2014
ICTTE 2014: International Conference on Traffic and Transportation Engineering
Italy, Venice
https://www.waset.org/conferences/2014/italy/ictte/index.php

November 20-21, 2014
ICIAP 2014: International Conference on Image Analysis and Processing
Capetown, South Africa
https://www.waset.org/conferences/2014/capetown/iciap/
Abstracts of forthcoming papers on IEEE Transactions on ITS

A BURST EFFORT BROADCAST APPROACH OF MPEG-4 VIDEO TRANSMISSION FOR INTER-UHICLE COMMUNICATION

CHU, YUNG-CHENG; HUANG, FRED NEN-FU

Efficient and real-time video broadcasting helps to increase driving safety and traveling fun for drivers. However, it is hard to structure vehicles into permanent network topologies and schedules to broadcast video streaming real-time in inter-vehicle communication (IVC) in a high-mobility vehicular environment. In order to achieve this, we have designed a burst effort broadcast (BEB) approach for IVC, which considers the challenges of high mobility and multi-hop broadcast, as well as the features of MPEG-4 video streams to adapt to highway scenarios. The BEB approach is distributed real-time without protocol overheads, and comprises a queuing procedure and scheduling scheme. The queuing procedure is of the pre-process of video transmission including the video shaping of groups of pictures (GOPS) and sequential re-ordering video frames. Based on the queuing procedure, a mobility-adaptive scheduler is applied to handle the broadcast and re-broadcast of the video stream. The concept of macro-scopic broadcast is utilized to increase the broadcast performance and video perceived quality of service (PQoS) as well as to reduce the number of unnecessary redundant broadcasts. As an evaluation, the real MPEG-4 video was conducted in simulation and the broadcast performance was compared with another protocol by the metrics of peak signal to noise ratio (PSNR) and loss of video frames in different broadcasting scenarios, and the results were analyzed. The simulation proved that this approach is an efficient multi-hop broadcast solution that does indeed provide a realistic solution to promote a higher degree of video PQoS on highways.

A CAR POOLING MODEL AND SOLUTION METHOD WITH STOCHASTIC VEHICLE TRAVEL TIMES

YAN, SHANGYAO; CHEN, CHUN-YING; CHANG, SHENG-CHIEH

Car pooling is one method that can be easily instituted and can help to resolve a variety of problems that continue to plague urban areas, ranging from energy demands and traffic congestion to environmental pollution. However, most car pooling organizations currently use a trial-and-error process, in accordance with the projected vehicle travel times, for car pooling, which is neither effective nor efficient. In other words, stochastic disturbances arising from variations in vehicle travel times in actual operations are neglected. In the worst case scenario, where vehicle travel times fluctuate wildly during operations, the planned schedule could be disturbed enough to lose its optimality. Therefore, we constructed a stochastic car pooling model that considers the influence of stochastic travel times. The model is formulated as an integer multiple commodity network flow problem. Since real problem sizes can be huge, it could be difficult to find optimal solutions within a reasonable period of time. Therefore, we develop a solution algorithm to solve the model. To test how well the model and the solution algorithm can be applied to the real world, we also developed a simulation-based evaluation method. To test the model and the solution algorithm, a case study is performed based upon data reported from a past study carried out in northern Taiwan. The results show that the model and solution algorithm are good and could be useful for car pooling practices.
A DESCRIPTIVE BAYESIAN APPROACH TO MODELING AND CALIBRATING DRIVERS’ EN-ROUTE DIVERSION BEHAVIOR

XIONG, CHENFENG; ZHANG, LEI

This paper presents a Bayesian approach for modeling and calibrating drivers’ en-route route changing decision with behavior data collected from laboratory driving simulators and field blue-tooth detectors. The behavior models are not based on assumptions of perfect rationality. Instead, a novel descriptive approach based on naive Bayes rules is proposed and demonstrated. The en-route diversion model is first estimated with behavior data from a driving simulator. Subsequently, the model is re-calibrated for Maryland, based on blue-tooth detector data, and applied to analyze two dynamic message sign (DMS) scenarios on I-95 and I-895. This calibration method allows researchers and practitioners to transfer the en-route diversion model to other regions based on local observations. Future research can integrate this en-route diversion model with microscopic traffic simulators, dynamic traffic assignment models, and/or activity/agent-based travel demand models for various traffic operations and transportation planning applications.

A VISION BASED SYSTEM FOR MONITORING THE LOSS OF ATTENTION IN AUTOMOTIVE DRIVERS

DASGUPTA, ANIRBAN; GEORGE, ANJITH; HAPPY, S L; ROUTRAY, AUROBINDA

On-board monitoring of the alertness level of an automotive driver has been a challenging research in transportation safety and management. In this paper, we propose a robust real-time vision-based algorithm which has been implemented on-board on an embedded platform to monitor the loss of attention of the driver during day as well as night driving conditions. The PERcentage of eye CLOSure (PERCLOS) has been used as the indicator of the level of alertness. In our approach, the face is detected using Haar-like features and tracked using a Kalman Filter. The Eyes are detected using Principal Component Analysis (PCA) during day time and the block Local Binary Pattern (LBP) features during night. Finally the eye state is classified as open or closed using Support Vector Machines (SVM). In-plane and off-plane rotations of the driver’s face have been compensated using Affine and Perspective Transformation respectively. Compensation in illumination variation is carried out using Bi-Histogram Equalization (BHE). We have implemented the algorithm on a Single Board Computer (SBC) having 1 GB RAM, 1.66 GHz clock, Windows Embedded XP operating system. The system is found to be robust under varying on-board conditions.

A WIRELESS ACCELEROMETER-BASED AUTOMATIC VEHICLE CLASSIFICATION PROTOTYPE SYSTEM

MA, WENTENG; XING, DANIEL; MCKEE, ADAM; BAJWA, RAVNEET; FLORES, CHRISTOPHER; FULLER, BRIAN; VARAIYA, PRAVIN

Automatic Vehicle Classification (AVC) systems provide data about vehicle classes that are used for many purposes. This paper describes a prototype axle count and spacing AVC system using wireless accelerometers and magnetometers. The accelerometers detect vehicle axles and the magnetometers report vehicle arrivals and departures and estimate speed. The prototype system is installed on I-80 at Pinole, CA and tested under various traffic conditions. Video images and reports from a nearby commercial Weigh-In-Motion (WIM) station provide ground truth to evaluate the performance of the system, including classification, axle spacing and vehicle counts. The results show the prototype AVC system is reliable in classifying vehicles even under congested traffic with 99% accuracy.
**ACTUATOR-REDUNDANCY-BASED FAULT DIAGNOSIS FOR FOUR WHEEL INDEPENDENTLY ACTUATED ELECTRIC VEHICLES**

WANG, RONGRONG; WANG, JUNMIN

This paper presents a real-time actuator-redundancy-based fault diagnosis approach for four wheel independently actuated (FWIA) in-wheel motor electric ground vehicles. The tire-road friction coefficient (TRFC), which is usually unknown, needs to be accurately estimated to calculate the in-wheel motor torque and evaluate the fault in real-time. An observer is applied to each of the in-wheel motors to generate a TRFC estimate from the respective wheel. The individual estimates of the TRFC are merged using a voting scheme, which can reject the erroneous estimate from the faulty motor. Then the resulting accurate TRFC estimate is adopted to calculate the residual for each of the in-wheel motors and to detect the possible actuator fault. Experimental results from a prototype FWIA electric ground vehicle are given to show the effectiveness of the proposed fault diagnosis method.

**AN EVENT-TRIGGERED RECEDING-HORIZON SCHEME FOR PLANNING RAIL OPERATIONS IN MARITIME TERMINALS**

CABALLINI, CLAUDIA; PASQUALE, CECILIA; SACONE, SIMONA; SIRI, SILVIA

This paper proposes a planning approach to optimize railway operations in seaport terminals by adopting a queue-based discrete-time model of the considered system. Firstly, a mixed-integer linear mathematical programming problem is solved in order to optimize the timing of import trains and the use of the handling resources devoted to the rail port operations. Secondly, in order to deal with unexpected situations or uncertainty in estimating some data necessary to the planning, an event-triggered receding-horizon planning approach is proposed in which the finite horizon optimization problem is solved whenever a critical event happens or the real values of some problem data significantly differ from the predicted ones. Both these planning approaches are tested on data based on a real terminal and deeply discussed in the paper.

**AN ONLINE SELF-LEARNING ALGORITHM FOR LICENSE PLATE MATCHING**

DE OLIVEIRA NETO, FRANCISCO; HAN, LEE; JEONG, MYONG K (MK)

License Plate Recognition (LPR) technology is a mature yet imperfect technology used for automated toll collection and speed enforcement. The portion of license plates that can be correctly recognized and matched at two separate stations is typically in the range of 35% or less. Existing methods for improving the matching of plate recognized by LPR units rely on intensive manual data reduction, such that the misread plates are manually entered into the system. Recently, an advanced matching technique that combines Bayesian probability and Levenshtein text-mining techniques was proposed to increase the accuracy of automated license plate matching. The key component of this method is what we called the association matrix, which contains the conditional probabilities of observing one character at one station for given observed character at another station. However, the estimation of the association matrix relies on manually extracted ground truth of large number of plates, which is a cumbersome and tedious process. To overcome this drawback, in this study we propose an ingenious novel self-learning algorithm that eliminates the need for extracting ground truth manually. These automatically learned association matrices are found to perform well in correctness in plate matching in comparison with those generated from the painstaking manual method. Furthermore, these automatically learned association matrices outperform their manual counterparts in reducing false-matching rates. The automatic self-learning method is also cheaper and easier to implement and continues to improve and correct itself over time.
ANALYTICAL HIERARCHY PROCESS USING FUZZY INFERENCE TECHNIQUE FOR REAL TIME ROUTE GUIDANCE SYSTEM

LI, CAIXIA; ANAVATTI, SREENATHA; RAY, TAPABRATA

This paper focuses on an optimum route search function in the in-vehicle routing guidance system. For a dynamic route guidance system (DRGS), it should provide dynamic routing advice based on real-time traffic information and traffic conditions, such as congestions and roadwork. However, considering all these situations in traditional methods makes it very difficult to identify a valid mathematical model. In order to realize the dynamic route guidance system, this paper proposes the analytical hierarchy process (AHP) using Fuzzy inference technique based on the real-time traffic information. This AHP-FUZZY approach is a multi-criteria combination system. The nature of the AHP-FUZZY approach is pair-wise comparison, which is expressed by the fuzzy inference techniques, to achieve the weights of the attributes. The hierarchy structure of the AHP-FUZZY approach can greatly simplify the definition of decision strategy and represent the multiple criteria explicitly, and the fuzzy inference technique can handle the vagueness and uncertainty of the attributes and adaptively generate the weights for the system. Based on the AHP-FUZZY approach, a simulation system is implemented in the route guidance system and the process is analyzed.

AUTOMATED DETECTION OF DRIVER FATIGUE BASED ON ENTROPY AND COMPLEXITY MEASURES

ZHANG, CHI; WANG, HONG; FU, RONGRONG

This paper presents a real-time method based on various entropy and complexity measures for detection and identification of driving fatigue from recorded electroencephalogram (EEG), electromyogram (EMG) and electrooculogram (EOG) signals. The complexity features were used to distinguish whether the subjects are experienced drivers by calculating the Lempel-Ziv complexity (LZC) of EEG Approximate Entropy. Different threshold values can be set for the two kinds of drivers individually. The entropy-based features namely Wavelet Entropy (WE), the peak-to-peak value of Approximate Entropy (PP-ApEn), and the peak-to-peak value of Sample Entropy (PP-SampEn) were extracted from the collected signals to estimate the driving fatigue stages. We proposed Wavelet Entropy in a sliding window (WES), peak-to-peak value of Approximate Entropy in a sliding window (PP-ApEnS), and peak-to-peak value of Sample Entropy in a sliding window (PP-SampEnS) for real-time analysis of driver fatigue. The real-time features obtained by WE, PP-ApEn, and PP-SampEn with sliding window were applied to artificial neural network (ANN) for training and testing the system which gives four situations for the fatigue level of the subjects: normal state, mild fatigue, mood swing, and excessive fatigue. Then the driver fatigue level can be determined in real time. The accuracy of estimation is about 96.5-99.5%. Receiver operating characteristic (ROC) curve was used to present the performance of the neural network classifier. The Area under the ROC curve (AUC) is 0.9931. The results show the developed method is valuable for the application of avoiding some traffic accidents caused by driver’s fatigue.

CODING OR NOT: OPTIMAL MOBILE DATA OFFLOADING IN OPPORTUNISTIC VEHICULAR NETWORKS

LI, YONG; JIN, DEPENG; WANG, ZHAOCHENG; ZENG, LIEGUANG; CHEN, SHENG

To cope with explosive vehicular traffics and ever-increasing application demands in the vehicular cellular network, opportunistic vehicular networks are used to disseminate mobile data by high-capacity device-to-device communication, which offloads significant traffic from the cellular network. In the current opportunistic vehicular data transmission, coding-based schemes are proposed to address the challenge of opportunistic contact. However, whether coding techniques can be beneficial in the context of vehicular mobile data offloading is still an open
problem. In this work, we establish a mathematical framework to study the problem of coding based mobile data offloading under realistic network assumptions, where 1) mobile data items are heterogeneous in terms of size; 2) mobile users have different interests to different data; and 3) the storage of offloading participants is limited. We formulate the problem as a users’ interests satisfaction maximisation problem with multiple linear constraints of limited storage. Then, we propose an efficient scheme to solve the problem by providing a solution that decides when the coding should be used and how to allocate the network resources in terms of contact rate and offloading helpers’ storage. Finally, we show the effectiveness of our algorithm through extensive simulations using two real vehicular traces.

**COOPERATIVE ADAPTIVE CRUISE CONTROL IN REAL TRAFFIC SITUATIONS**

**MILANÉS, VICENTE; SHLADOVER, STEVE; SPRING, JOHN; NOWAKOWSKI, CHRISTOPHER; KAWAZOE, HIROSHI; NAKAMURA, MASAHI DE**

Intelligent vehicle cooperation based on reliable communication systems contributes not only to reducing traffic accidents, but also to improving traffic flow. Adaptive Cruise Control (ACC) systems can gain enhanced performance by adding vehicle-vehicle wireless communication to provide additional information to augment range sensor data, leading to Cooperative ACC (CACC). This paper presents the design, development, implementation and testing of a CACC system. It consists of two controllers, one to manage the approaching maneuver to the leading vehicle and the other to regulate car-following once the vehicle joins the platoon. The system has been implemented on four production Infiniti M56s vehicles, and this paper details the results of experiments to validate the performance of the controller and its improvements with respect to the commercially available ACC system.

**DISTRIBUTED PARTICLE FILTER FOR URBAN TRAFFIC NETWORKS USING A PLATOON BASED MODEL**

**MARINICA, NICOLAE; SARLETTE, ALAIN; BOEL, RENE K.**

Raw measurement data are too noisy to directly obtain queue and traffic flow estimates usable for feedback control of urban traffic. In this paper we propose a recursive filter to estimate traffic state by combining the real-time measurements with a reduced model of expected traffic behavior. The latter is based on platoons rather than individual vehicles, in order to achieve faster implementations. This new model is used as a predictor for real-time traffic estimation using the particle filtering framework. As it becomes infeasible to let a truly large traffic network be managed by one central computer, with which all the local units would have to communicate, we also propose a distributed version of the particle filter where the local estimators exchange information on flows at their common boundaries. We assess the quality of our platoon-based particle filters, both centralized and distributed, by comparing their queue-size estimates with the true queue-sizes in simulated data.

**DYNAMIC CONTROL OF AIRPORT DEPARTURES: ALGORITHM DEVELOPMENT AND FIELD EVALUATION**

**SIMAIKIS, IOANNIS; SANDBERG, MELANIE; BALAKRISHNAN, HAMSA**

This paper proposes dynamic programming based algorithms for controlling the departure process at congested airports. These algorithms, called Pushback Rate Control protocols, predict the departure throughput of the airport, and recommend a rate at which to release aircraft from their gates in order to control congestion. The paper describes
the design and field-testing of a variant of Pushback Rate Control at Boston airport in 2011, and the development of a
decision-support tool for its implementation. The analysis of data from the field trials shows that during 8 four-hour
test periods, fuel use was reduced by an estimated 9 US tons (2,650 US gallons), and taxi-out times were reduced by
an average of 5.3 min for the 144 flights that were held at the gate.

ENVELOPE LEVEL CROSSING RATE AND AVERAGE FADE DURATION OF NON-ISOTROPIC
VEHICLE-TO-VEHICLE RICEAN FADING CHANNELS

CHENG, XIANG; WANG, CHENG-XIANG; AI, BO; AGGOUNE, HADI

This paper proposes a generic geometry-based stochastic model for non-isotropic scattering vehicle-to-vehicle (V2V)
Ricean fading channels. From the proposed model, the level crossing rate (LCR) and average fade duration (AFD) are
derived. These expressions are sufficiently general and include many well-known existing LCRs and AFDs as special
cases. The derived LCR and AFD are further investigated in more detail in terms of some selected important
parameters, e.g., the shape of the scattering region (two-ring or ellipse), mean angle, angle spread, and directions
of movement of the Tx and Rx (same or opposite direction). In addition, in this paper the impact of the vehicular traffic
density on the LCR and AFD for non-isotropic scattering V2V Ricean fading channels is investigated
for the first time. Excellent agreement is achieved between the theoretical LCRs/AFDs and relevant measured data,
demonstrating the utility of the proposed model.

ESTIMATING DYNAMIC QUEUE DISTRIBUTION IN SIGNALIZED NETWORK THROUGH A
PROBABILITY GENERATING MODEL

LU, YANG; YANG, XIANFENG

Most existing discussions regarding to the time dependent distribution of queue length was undertaken in the context
of isolated intersections. However computing queue length distributions for a signalized network with generic
topology is very challenging because such process involves convolution and non-linear transformation of random
variables which is analytically intractable. To address such issue, this study proposes a stochastic queue model
considering the strong interdependencies between adjacent intersections using probability generating function as a
mathematical tool. Various traffic flow phenomena including queue formation and dissipation, platoon dispersion,
flow merging and diverging, queue spillover and downstream blockage are formulated as stochastic events and their
distributions are computed iteratively through a stochastic network loading procedure. Both theoretical derivation
and numerical investigations are presented to demonstrate the effectiveness of the proposed approach in analyzing
the delay and queues of signalized networks under different congestion levels.

ESTIMATING SPEED USING A SIDE-LOOKING SINGLE-RADAR VEHICLE DETECTOR

JENG, SHYR-LONG; LU, H.P.; CHIENG, W.H.

This paper presents a side-looking single-beam microwave vehicle detector system for estimation of per-vehicle speed
and length. The proposed vehicle detector system is equipped with a 2D range-Doppler FMCW radar using a squint
angle. The associated Fourier processing is based on the inverse synthetic aperture radar (ISAR) algorithm, which can
extract the range and speed information of each vehicle using a single-beam frequency modulated continuous wave
(FMCW) radar. The simulation and experimental results show accurate estimations of vehicle speed and length. The
measurement errors of speed and length were approximately ±4 km/h and ±1 m respectively. The proposed method
has excellent detection capability for small moving targets, such as bikes and pedestrians, at speeds down to 5 km/h. A commercial 10.6GHz radar with necessary signal processing modifications was used in the experiments.

**FAST AND SECURE MULTI-HOP BROADCAST SOLUTIONS FOR INTER-VEHICULAR COMMUNICATION**

BEN JABALLAH, WAFA; CONTI, MAURO; MOSBAH, MOHAMED; PALAZZI, CLAUDIO

Inter-vehicular communication (IVC) is an important emerging research area that is expected to contribute considerably to traffic safety and efficiency. In this context, many possible IVC applications share the common need for fast multihop message propagation, including information such as position, direction, speed, etc. Yet, it is crucial for such data exchange system to be resilient to security attacks. Conversely, a malicious vehicle might inject incorrect information into the inter-vehicle wireless links leading to life and money losses, or to any other sort of adversarial selfishness (e.g., traffic redirection for the adversarial’s benefit). In this work we analyze attacks to the state of the art IVC based safety applications. Furthermore, this analysis leads us to design a Fast and Secure Multi-hop Broadcast Algorithm (FS-MBA) for vehicular communication, which results resilient to the aforementioned attacks.

**MODELING AND FORECASTING THE URBAN VOLUME USING STOCHASTIC DIFFERENTIAL EQUATIONS**

TAHAMASBI, RASOOL; HASHEMI, MEHDI

Traffic flow prediction can be used for the management of traffic control systems, and can be applied towards improving traffic light split times at intersections. In this article, we developed a methodology for the short-term prediction of traffic flow using the Stochastic Differential Equation (SDE). Since the current volume depends on the previous short term volume and also on time, we used the Hull-White model. With the proposed method, a flexible short-term prediction of volume is suggested. It is possible to simulate traffic conditions easily and also detect incidents precisely. This method is applied in Tehran’s highways, and the obtained results are compared to the previous artworks. Our results offered a better fit to the traffic volume.

**MODULAR DESIGN OF URBAN TRAFFIC LIGHT CONTROL SYSTEMS BASED ON SYNCHRONIZED TIMED PETRI NETS**

HUANG, YI-SHENG; WENG, YI-SHUN; ZHOU, MENGCHU

Timed Petri nets (TPNs) have been utilized as a visual formalism for the modeling of complex discrete event dynamic systems. It illuminates the features on describing properties of causality and concurrency. Moreover, it is well-known that synchronized timed Petri net (STPN) allows us to present all of the concurrent states in complex TPN. In this paper, we propose a new methodology to design and analyze an urban traffic network control system by using STPN. In addition, the applications of STPN to eight-phase, six-phase and two-phase traffic light control systems are modularized. The advantage of the proposed approach is the clear presentation of traffic lights’ behaviors in terms of conditions and events that cause the phases alternations. In additional, the size of can urban traffic network control system can easily be extended with our proposed modular technique. The analysis of the control models is performed to demonstrate how the models enforce the lights’ transitions by a reachability graph method.
MULTI-OBJECTIVE, DEPARTURE RUNWAY SCHEDULING USING DYNAMIC PROGRAMMING

MONTOYA, JUSTIN; RATHINAM, SIVAKUMAR; WOOD, ZACHARY

At busy airports, air traffic controllers seek to find schedules for aircraft at the runway that aim to minimize delays of the aircraft while maximizing runway throughput. In reality, finding optimal schedules by a human controller is hard to accomplish since the number of feasible schedules available for the scheduling problem is quite large. In this article, we pose this problem as a multi-objective optimization problem with respect to total aircraft delay and runway throughput. Using principles of multi-objective dynamic programming, we develop an algorithm to find a set of Pareto-optimal solutions that completely specify the non-dominated frontier. In addition to finding these solutions, this article provides a proof of the algorithm's correctness, and gives an analysis of its performance against a baseline algorithm using the operational data for a model of the Dallas/Fort Worth International Airport.

NOVEL SPEED BUMPS DESIGN AND OPTIMIZATION FOR ENERGY HARVESTING FROM TRAFFIC

PIRISI, ANDREA; MUSSETTA, MARCO; GRIMACCIA, FRANCESCO; ZICH, RICCARDO

In recent years the increase of computational capability and the development of innovative multi-physics techniques has determined a growing interest towards modeling and optimization in engineering system design for green energy applications. In this field, advanced soft computing techniques can be applied by engineers to several problems and used in optimization process to find out the best design and thus to improve the system performance. These techniques also promise to give new impulse to research on renewable systems and, especially in the last five years, on the so called Energy Harvesting Devices (EHDs). This paper presents the optimization of a Tubular Permanent Magnet-Linear Generator used for applications of energy harvesting from traffic. The optimization process is developed by means of hybrid evolutionary algorithms to reach the best overall system efficiency and the impact on the environment and transportation systems. Finally, an experimental validation of the designed EHD prototype is presented.

OBSERVABILITY ANALYSIS OF COLLABORATIVE OPPORTUNISTIC NAVIGATION WITH PSEUDORANGE MEASUREMENTS

KASSAS, ZAHER; HUMPHREYS, TODD

The observability analysis of a collaborative opportunistic navigation (COpNav) environment whose states may be partially-known is considered. A COpNav environment can be thought of as a radio frequency signal landscape within which one or more radio frequency receivers locate themselves in space and time by extracting and possibly sharing information from ambient signals of opportunity (SOPs). Such receivers, whether vehicle-mounted or integrated into hand-held devices, exploit signal diversity to improve navigation and timing robustness compared to stand-alone Global Positioning System (GPS) receivers in deep urban, indoor, or otherwise GPS-hostile environments. Available SOPs may have a fully-known, partially-known, or unknown characterization. In the present work, the receivers are assumed to draw only pseudorange-type measurements from the SOPs. Separate observations are fused to produce an estimate of each receiver’s position, velocity, and time (PVT). Since not all SOP states in the COpNav environment may be known a priori, the receivers must estimate the unknown SOP states of interest simultaneously with their own PVT. This paper establishes the minimal conditions under which a COpNav environment consisting of multiple receivers and multiple SOPs is completely observable. Moreover, in scenarios where the COpNav environment is unobservable, the unobservable directions in the state space are specified. Simulation and experimental results are presented to confirm the theoretical observability conditions.
OBSERVATION OF VEHICLE AXLES THROUGH PASS-BY NOISE: A STRATEGY OF MICROPHONE ARRAY DESIGN

MARMAROLI, PATRICK; CARMONA, MIKAEL; ODOBEZ, JEAN-MARC; FALOURD, XAVIER; LISSEK, HERVÉ

This paper focuses on road traffic monitoring using sounds and proposes, more specifically, a microphone array design methodology for observing vehicle trajectory from acoustic-based correlation functions. In a former work, authors have shown that combining generalized cross-correlation (GCC) functions and a particle filter (PF) onto the audio signals acquired simultaneously by two sensors placed near the road allows the joint estimation of speed and wheelbase length of road vehicles as they pass-by. This is mainly due to the broadband nature of the tyre/road noise which makes their spatial dissociation possible by means of an appropriate GCC processor. At the time, nothing has been said about the best distance to chose between the sensors. A methodology is proposed here to find this optimum, which is expected to improve the observation quality and thus the tracking performance. Theoretical developments of this paper are partially assessed with preliminary experiments.

OBSERVER-BASED ROBUST CONTROL OF VEHICLE DYNAMICS FOR ROLLOVER MITIGATION IN CRITICAL SITUATIONS

HAMID, DAHMANI; OLIVIER, PAGES; EL HAJJAJI, AHMED; NAWAL, DARAOUI

This paper describes a vehicle dynamics fuzzy control design to improve stability and minimize the rollover risk of the vehicle in critical situations. To obtain a robust controller, several aspects that directly affect the behavior of the vehicle have been considered. Nonlinearities of the lateral forces have been considered by using a Takagi-Sugeno (TS) representation, changes in road friction have been taken into account by introducing parameter uncertainties, finally the road bank angle is considered as an unknown input in the used vehicle dynamics model. A TS observer has been proposed and designed with unmeasurable premise variables in order to consider the unavailability of the sideslip angle measurement. The observer and controller gains are simultaneously obtained by solving the proposed Linear Matrix Inequalities (LMI) constraints. A fishhook test is conducted in CarSim simulator in order to illustrate the performance of the designed controller.

ON OPTIMALITY CRITERIA FOR REVERSE CHARGING OF ELECTRIC VEHICLES

STÜDLI, SONJA; GRIGGS, WYNITA; CRISOSTOMI, EMANUELE; SHORTEN, ROBERT

Ever increasing expectations regarding the penetration level of electric vehicles (EV) are driving several areas of research related to EV charging. One topic of interest treats EVs not only as controllable loads, but also as storage systems, which can be used to mitigate the load on the grid during peak times by offering power. This is known as vehicle to grid (V2G). Since returning energy to the grid affects mobility patterns, V2G has an associated environmental cost. In this paper, to investigate this issue, we formulate the problem of returning electrical load to the grid as an optimisation whose goal is to return the desired energy in a fashion that minimises the cost on the environment. We show that this optimisation is highly complex and in some circumstances the cost of V2G can be prohibitive.
PERSPECTIVES ON FUTURE TRAFFIC CONTROL AIDED BY VEHICULAR COMMUNICATION

LI, LI; WEN, DING; YAO, DANYA (DANIEL)

During the last 60 years, incessant efforts had been made to improve the efficiency of traffic control systems to meet ever increasing traffic demands. A novel trend among these efforts is to deploy vehicle-to-vehicle communications and/or vehicle-to-infrastructure communications to coordinate vehicles and traffic signals in real-time. In this paper, we aim to give a perspective of some research frontiers in this trend, identifying early stage key technologies and discussing the possible improvements that will be enabled. We give the prominence to scheduling based intersection control approaches that emerged recently, since they indicate that design philosophies for traffic control systems is undergoing a transition from feed-back character to feed-forward character. Besides, we also discuss two cultures in traffic controller design: using rich information that may be redundant or using concise information that is necessary.

PORTABLE ROADSIDE SENSORS FOR VEHICLE COUNTING, CLASSIFICATION AND SPEED MEASUREMENT

TAGHVAEEYAN, SABER; RAJAMANI, RAJESH

This paper focuses on the development of a portable roadside sensor system for measurement of traffic flow rate, vehicle speeds and vehicle classification. The sensor system consists of wireless anisotropic magnetic devices which do not require to be embedded in the roadway – The devices are placed next to the roadway and measure traffic in the immediately adjacent lane. An algorithm based on a magnetic field model is proposed to make the system robust to the errors created by larger vehicles driving in the nonadjacent lane. Speed measurement is based on calculation of cross-correlation between longitudinally spaced sensors. Fast computation of cross-correlation is enabled by using frequency domain signal processing techniques. An algorithm to automatically correct for any small misalignment of the sensors is utilized. A high accuracy differential GPS is used as a reference and the results show that maximum error of the speed estimates is less than 2.5% over the entire range of 5 – 60 mph. Vehicle classification is done based on the magnetic length and an estimate of the average vertical magnetic height of the vehicle. Finally it is shown that the sensor system can be used to reliably count the number of right-turns at an intersection with an accuracy of 95%. The developed sensor system is compact, portable, wireless and inexpensive. Data is presented from a large number of vehicles on a regular busy urban road in the Twin Cities in Minnesota.

PREDICTION OF TRAFFIC FLOW AT THE BOUNDARY OF A MOTORWAY NETWORK

WANG, YUBIN; VRANCKEN, JOS; VAN SCHUPPEN, JAN

For online traffic control at traffic control centers there is a need for predictions of the traffic flow during a short horizon, say 30 minutes ahead. For this effort predictions are needed of the traffic inflow into the network at motorways on the network boundary and at on-ramps. The paper presents an adaptive prediction algorithm for the inflows into the network in regular traffic situations based on stochastic control theory. The prediction algorithm is based on an adaptive prediction algorithm of T. Bohlin. The algorithm is designed and tested on traffic flow data of the ring road of Amsterdam. The results shows that the algorithm provides robust predictions of traffic demand with relatively small errors for the next 30 minutes in a large-scale, real-time environment.
PROBABILISTIC AIRCRAFT MID-AIR CONFLICT RESOLUTION USING STOCHASTIC OPTIMAL CONTROL

LIU, WEIYI; HWANG, INSEOK

This paper studies the problem of aircraft mid-air conflict resolution which is a key technology to enable the coordinated and decentralized air traffic control envisioned in the Next Generation Air Transportation System (NextGen). The method proposed in this paper is based on stochastic optimal control which is able to incorporate uncertainties in both aircraft and wind dynamics. The proposed numerical algorithm uses a Markov Chain (MC) to approximate the continuous-time aircraft and wind dynamics, then the optimal control law is derived based on the MC. The proposed algorithm is able to resolve the conflicts between aircraft and moving convective weather regions. For conflict resolution between pairs of aircraft, a decomposition technique is proposed to reduce the computational complexity of the numerical algorithm. Simulations show that the proposed algorithm provides robustness against uncertainties in the system and is suitable for real applications.

PROBABILISTIC INTEGRATION OF INTENSITY AND DEPTH INFORMATION FOR PART-BASED VEHICLE DETECTION

MAKRIS, ALEXANDROS; PERROLLAZ, MATHIAS; LAUGIER, CHRISTIAN

In this work an object class recognition method is presented. The method uses local image features and follows the part based detection approach. It fuses intensity and depth information in a probabilistic framework. The depth of each local feature is used to weigh the probability of finding the object at a given distance. To train the system for an object class only a database of images annotated with bounding boxes is required, thus automatizing the extension of the system to different object classes. We apply our method to the problem of detecting vehicles from a moving platform. The experiments with a dataset of stereo images in an urban environment show a significant improvement in performance when using both information modalities.

REAR-VIEW VEHICLE DETECTION AND TRACKING FOR COMPLEX URBAN SURVEILLANCE BY COMBINING MULTIPLE PARTS

TIAN, BIN; LI, YE; LI, BO; WEN, DING

Traffic surveillance is an important topic in intelligent transportation systems (ITS). Robust vehicle detection and tracking is one challenging problem for complex urban traffic surveillance. This paper proposes a rear-view vehicle detection and tracking method based on multiple vehicle salient parts using a stationary camera. We show that spatial modeling of these vehicle parts is crucial for overall performance. First, the vehicle is treated as an object composed of multiple salient parts, including the license plate and rear-lamp. These parts are localized using their distinctive color, texture and region features. Further more, the detected parts are treated as graph nodes to construct a probabilistic graph using a Markov random field (MRF) model. After that, the marginal posterior of each part is inferred using loopy belief propagation (LBP) to get final vehicle detections. Finally, the vehicles’ trajectories are estimated using a Kalman filter (KF) and a tracking-based detection technique is realized. Experiments in practical urban scenarios are carried out under various weather conditions. It can be shown that our method adapts to partial occlusion and various lighting conditions. Experiments also show that our method can achieve real-time performance with an average vehicle detection rate of 95% and an average vehicle tracking rate of 90%.
RECEIVER AUTONOMOUS INTEGRITY MONITORING OF GNSS SIGNALS FOR ELECTRONIC TOLL COLLECTION

SALÓS, DANIEL; MARTINEAU, ANAÍS; MACABIAU, CHRISTOPHE; BONHOURE, BERNARD; KUBRAK, DAMIEN

Various Road User Charging (RUC) mechanisms are used to control the traffic and its resulting pollution, as well as revenue sources for reinvestment in the road infrastructure. Among them, Electronic Toll Collection (ETC) systems based on user positions estimated with Global Navigation Satellite Systems (GNSS) are particularly attractive due to their flexibility and reduced roadside infrastructure in comparison to other systems like tollbooths. Because GNSS positioning may be perturbed by different errors and failures, ETC systems, as liability critical applications, should monitor the integrity of GNSS signals in order to limit the use of faulty positions and the consequent charging errors. The integrity monitoring systems have been originally designed for civil aviation, so they need to be adapted to the ETC requirements. This paper studies the use of Receiver Autonomous Integrity Monitoring (RAIM), which are algorithms run within the GNSS receiver, and therefore easier to tune to ETC needs than other systems based on external information. The Weighted Least Squares Residuals (WLSR) RAIM used in civil aviation is analyzed, and an algorithm modification for ETC is proposed. Simulations demonstrate that the proposed RAIM algorithm has a superior level of availability over civil aviation based RAIM procedures, particularly in urban environments.

REDUCING THE ERROR ACCUMULATION IN CAR-FOLLOWING MODELS CALIBRATED WITH VEHICLE TRAJECTORY DATA

JIN, JING; YANG, DA; RAN, BIN

With the development of probe vehicle technologies and the emerging connected vehicle technologies, applications and models using trajectory data for calibration and validation increase significantly. However the error accumulation issue accompanied with the calibration process has not be fully investigated and addressed. This paper explores the mechanism and countermeasures of the error accumulation problems of car-following models calibrated with microscopic vehicle trajectory data. In this study, we first derive the error dynamic model based on an acceleration based generic car-following model formulation. The stability conditions for the error dynamic model are found to be different from the model stability conditions. Therefore, adjusting feasible ranges of model parameters in car-following model calibration to ensure model stability cannot guarantee the error stability. However, directly enforcing those error stability conditions can be ineffectiveness, especially when explicit formulations are difficult to obtain. To overcome this issue, we propose several countermeasures that incorporate error accumulation indicators into the error measures used in the calibration. Numerical experiments are conducted to compare the traditional and the proposed error measures through the calibration of five representative car-following models, i.e., GM (General Motors), Bando, Gipps, FRESIM, and IDM (Intelligent Driver) models, using field trajectory data. The results indicate that the weighted location MAE (mean absolute error) and the location MAE with crash rate penalty can achieve the best overall error accumulation performance for all five models. Meanwhile, traditional error measures, velocity MAE and velocity Theil's U, also achieve satisfactory error accumulation performance for FRESIM and IDM models, respectively.

REVIEW OF MICROSCOPIC LANE-CHANGING MODELS AND FUTURE RESEARCH OPPORTUNITIES

RAHMAN, MIZANUR; CHOWDHURY, MASHRUR; XIE, YUANCHANG; HE, YIMING

Driver behavior, particularly lane-changing behaviors have an important effect on the safety and throughput of the roadway-vehicle based transportation system. Lane-changing models are a vital component of various microscopic
traffic simulation tools, which are extensively used and playing an increasingly important role in Intelligent Transportation Systems (ITS) studies. The authors conducted a detailed systematic review and comparison of existing microscopic lane-changing models for computer simulation, to provide a better understanding of respective properties including strengths and weaknesses of the state-of-the-art lane-changing models and to identify potential for model improvement using existing and emerging data collection technologies. Many models have been developed in the last few decades to capture the uncertainty in lane change modeling; however, lane-changing behavior in the real-world is very complex due to driver distraction (e.g., texting, cellphone or smartphone use), environmental (e.g., pavement condition, lighting condition) and geometric (e.g., horizontal curve, vertical curve) factors of the roadway, which have not been adequately considered in existing models. To address this issue and to improve the accuracy of lane-changing models, large and detailed microscopic vehicle trajectory datasets are needed. Possible measures to improve the accuracy and reliability of lane-changing models are also discussed in this paper.

ROBUST CONTROL FOR URBAN ROAD TRAFFIC NETWORKS

TETTAMANTI, TAMÁS; LUSPAY, TAMÁS; KULCSÁR, BALÁZS; PÉNI, TAMÁS; VARGA, ISTVÁN

The aim of the presented research is to elaborate a traffic-responsive optimal signal split algorithm taking uncertainty into account. The traffic control objective is to minimize the weighted link queue lengths within an urban network area. The control problem is formulated in a centralized rolling-horizon fashion where unknown but bounded demand and queue uncertainty influences the prediction. An efficient, constrained minimax optimization is suggested to obtain the green time combination which minimizes the objective function when worst case uncertainty appears. As an illustrative example, a simulation study is carried out to demonstrate the effectiveness and computational feasibility of the robust predictive approach. By using real-world traffic data and microscopic traffic simulator, the proposed robust signal split algorithm is analyzed and compared to well-tuned fixed-time signal timing and to nominal predictive solutions under different traffic conditions.

ROBUST VEHICLE SIDESLIP ANGLE ESTIMATION THROUGH A DISTURBANCE REJECTION FILTER THAT INTEGRATES A MAGNETOMETER WITH GPS

YOUNG, JONG-HWA; PENG, HUEI

This paper presents a cost-effective method which estimates the vehicle sideslip angle for a wide range of surface frictions and road bank angles by combining measurements of a magnetometer, Global Positioning System (GPS), and Inertial Measurement Unit (IMU). To reject disturbances in the magnetometer, a new stochastic filter is designed and integrated on the Kalman Filter framework. The significant latency in a low-cost GPS velocity measurement is addressed by “measurement shifting”, and biases in the IMU measurements are estimated through state augmentation. Dual Kalman Filters are employed in the sensor fusing framework. A comprehensive simulation study was conducted to prove the feasibility of the method. Finally, the performance and accuracy are verified through extensive experiments.

SELF-ADAPTIVE TOLLING STRATEGY FOR ENHANCED HIGH OCCUPANCY TOLL LANE OPERATIONS

ZHANG, GUOHUI; WANG, YINHAI
In this paper, a Self-Adaptive Tolling Strategy (SATS) is developed for dynamically and systematically enhancing High Occupancy Toll (HOT) lane system operations. This strategy enhances the overall system performance of both the HOT and General Purpose (GP) lanes by better utilizing the HOT lane capacity while maintaining high speed and/or high travel-time reliability for HOT lane traffic when GP lanes are congested. To formulate SATS, the Lighthill-Whitham-Richards (LWR) kinematic wave model is used to characterize HOT lane traffic flow evolution and the unilateral Laplace transform is used to convert system representation from time domain to frequency domain. Then an adaptive tolling controller is designed with both the Proportional (P) and Integral (I) control components. Real-time traffic measurements including lane occupancy, average speed, and flow rate are utilized for toll rate calculations. Following a dual-phase control scheme, the appropriate flow rate for HOT lane utilization is computed and the corresponding toll is estimated backward. To examine the effectiveness of the proposed tolling strategy, microscopic traffic simulation experiments are conducted using VISSIM. The experiment results demonstrate that the proposed tolling strategy performs reasonably well in improving the overall operations of HOT lane systems under various traffic conditions.

**SENSOR FUSION BASED VACANT PARKING SLOT DETECTION AND TRACKING**

SUHR, JAE KYU; JUNG, HO GI

This paper proposes a vacant parking slot detection and tracking system that fuses the sensors of an around view monitor (AVM) system and ultrasonic sensor-based automatic parking system. The proposed system consists of three stages: parking slot marking detection, parking slot occupancy classification, and parking slot marking tracking. The parking slot marking detection stage recognizes various types of parking slot markings using AVM image sequences. It detects parking slots in individual AVM images by exploiting a hierarchical tree structure of parking slot markings and combines sequential detection results. The parking slot occupancy classification stage identifies vacancies of detected parking slots using ultrasonic sensor data. Parking slot occupancy is probabilistically calculated by treating each parking slot region as a single cell of the occupancy grid. The parking slot marking tracking stage continuously estimates the position of the selected parking slot while the ego-vehicle is moving into it. During the tracking, AVM images and motion sensor-based odometry are fused together in the chamfer score level to achieve robustness against inevitable occlusions caused by the ego-vehicle. In the experiments, it is shown that the proposed method can recognize the positions and occupancies of various types of parking slot markings and stably track them under practical situations in a real-time manner. The proposed system is expected to help drivers conveniently select one of the available parking slots and support the parking control system by continuously updating the designated target positions.

**SHORTEST PATH FINDING PROBLEM IN STOCHASTIC TIME-DEPENDENT ROAD NETWORKS WITH STOCHASTIC FIRST-IN-FIRST-OUT PROPERTY**

CHEN, BI YU; LAM, WILLIAM; LI, QINGQUAN; SUMALEE, AGACHAI; YAN, KE

As the travel times in road network are dynamic and uncertain, it is difficult and time-consuming to search for the least expected time path in large-scale networks. This paper addresses the problem of finding the least expected time path in stochastic time-dependent (STD) road networks. A stochastic travel speed model is proposed to represent STD link travel times. It is proved that the link travel times in STD networks satisfy the stochastic first-in-first-out (S-FIFO) property. Based on this S-FIFO property, an efficient multi-criteria A* algorithm is proposed to exactly determine the least expected time path in STD networks. Computational results using several large-scale road networks show that the proposed algorithm has a significant computational advantage over the existing solution algorithms without the S-FIFO property.
SPEED AND TEXTURE: AN EMPIRICAL STUDY ON OPTICAL FLOW ACCURACY IN ADAS SCENARIOS

ONKARAPPA, NAVEEN; SAPPA, ANGEL

Increasing mobility in everyday life has led to the concern on the safety of automotives as well as human life. Computer vision has become a valuable tool for developing driver assistance applications targeting such a concern. Many of such vision based assisting systems rely on the motion estimation where optical flow has shown its potentiality. A variational formulation of optical flow that achieves dense flow field involves a data term and regularization terms. Depending on the image sequence the regularization has to be weighted appropriately for a better accuracy of the flow field. Since a vehicle can be driven in different kinds of environments, roads and speeds, optical flow estimation has to be accurately computed in all such scenarios. In the current work, first we present the polar representation of optical flow, which is quite suitable for driving scenarios due to the possibility it offers to update regularization factors independently. Then, we study the influence of vehicle speed and scene texture on optical flow accuracy. Further, we also analyze the relationships of these specific characteristics on a driving scenario (vehicle speed and road texture) with the regularization weights in optical flow for a better accuracy. As required by the work in this paper, we have generated several synthetic sequences along with ground-truth flow fields.

STOCHASTIC CHARACTERIZATION OF INFORMATION PROPAGATION PROCESS IN VEHICULAR AD-HOC NETWORKS

ZHANG, ZIJIE; MAO, GUOQIANG; ANDERSON, BRIAN

This paper studies the information propagation process in wireless communication networks formed by vehicles traveling on a highway. Corresponding to different lanes of the highway and different types of vehicles, we consider that vehicles in the network can be categorized into a number of traffic streams, where the vehicles in the same traffic stream have the same speed distribution while the speed distributions of vehicles in different traffic streams are different. We analyze the information propagation process of the above vehicular network and obtain an analytical formula for the information propagation speed. Using the formula, one can straightforwardly study the impact of parameters such as radio range, vehicular traffic density, vehicular speed distribution and the time variation of vehicular speed on the information propagation speed. The accuracy of the analytical results is validated using simulations.

STRUCTURAL SIGNATURES FOR PASSENGER VEHICLE CLASSIFICATION IN VIDEO

THAKOOR, NINAD; BHANU, BIR

This paper focuses on a challenging pattern recognition problem of significant industrial impact: classifying vehicles from their rear videos as observed by a camera mounted on top of a highway with vehicles traveling at high speed. To solve this problem, the paper presents a novel feature called structural signature. From a rear view video, a structural signature recovers the vehicle side profile information which is crucial in its classification. As a vehicle moves away from a camera, its surfaces deform differently based on their relative orientation to the camera. This information is used to extract the structure of a vehicle which captures the relative orientation of vehicle surfaces and the road surface. The paper presents a complete system which computes the structural signatures and uses them for classification of passenger vehicles into sedans, pickups and Minivans/SUVs in highway videos. It analyzes the performance of the proposed system on a large video dataset.
STUDY OF THE TRACK-TRAIN CONTINUOUS INFORMATION TRANSMISSION PROCESS IN HIGH-SPEED RAILWAY

LINHAI, ZHAO; BAIGEN, CAI; JUNJIE, XU; YIKUI, RAN

In the experiments and practical applications in high-speed railway, it is observed that the carrier frequency of the sampled signal in track circuit reader (TCR) is changed with train speed and it goes beyond the upper permissive range prescribed for jointless track circuit (JTC) in some cases. This can directly affect the availability of train target speed in train control system and thus have an effect in the generation of distance-to-go profile. It not only reduces the safety and efficiency of train traveling, but also limits the improvement of train speed. To find out the primary cause of the deviation in carrier frequency of the sampled signal in TCR (CFSST), this paper models the track-to-train continuous information transmission process (TTCITP) using transmission line theory based on the structures and principles of JTC and TCR. Then the influences on the sampled signal in TCR from train speed are analyzed and the relation between the deviation in CFSST and train speed is derived. Experimental results in high-speed railway have verified the correctness of the analysis and the study can provide a strong theoretical basis for improving safety level of railway traffic. Moreover, it can be a good reference for other countries where the similar track circuits are applied.

SUPPORT VECTOR NUMBER REDUCTION: SURVEY AND EXPERIMENTAL EVALUATIONS

JUNG, HO GI; KIM, GAHYUN

Although a support vector machine (SVM) is one of the most frequently used classifiers in the field of intelligent transportation system and shows competitive performances in various problems, it has the disadvantage of requiring relatively large computations in the testing phase. To make up for this weakness, diverse methods have been researched to reduce the number of support vectors determining the computations in the testing phase. This paper is intended to help engineers using SVM to easily apply support vector number reduction to their own particular problems by providing a state of the art survey and quantitatively comparing three implementations belonging to post-pruning which exploits the result of a standard SVM. In particular, this paper confirms that the support vector number of a pedestrian classifier using histogram of oriented gradient (HOG)-based feature and radial basis function (RBF) kernel-based SVM can be reduced by more than 99.5% without any accuracy degradation using iterative preimage addition which can be downloaded from the Internet.

TACTICAL DRIVING BEHAVIOUR WITH DIFFERENT LEVELS OF AUTOMATION

KIRCHER, KATJA; LARSSON, ANNIKA; HULTGREN, JONAS

The study investigated how different types of automation affect tactical driving behaviour, depending on trust in the system. Previous research indicates that drivers wait for automation to act, delegating the monitoring of the traffic situations. This would be especially true for those who have more trust in automation. Behavioural and gaze data from 30 participants driving an advanced simulator were recorded in four driving conditions: manual driving, intentional car following, ACC and ACC with adaptive steering. Measures of trust in the systems were recorded with a questionnaire. Three fairly common traffic events requiring a driver response were analysed. Trust in automation was high amongst the participants, and no associations between trust levels and behaviour could be found. Drivers seem to make informed choices on when to let the automation handle a situation, and when to switch it off manually or via the vehicle controls. If drivers did not expect the system to be able to handle the situation, they usually resumed control before the automation reached its limits. If the automation was expected to be able to deal with the situation, control was usually not resumed. Also, situations were dealt with in a tactically different manner with automation than without. Controlling the car with automation systems is, thus, accepted by drivers as being a different undertaking than driving in manual mode.
TEXT DETECTION AND RECOGNITION ON TRAFFIC PANELS FROM STREET-LEVEL IMAGERY USING VISUAL APPEARANCE

GONZÁLEZ, ÁLABO; BERGASA, LUIS M.; YEBES, JOSE

Traffic signs detection and recognition has been thoroughly studied for a long time. However, traffic panel detection and recognition still remains a challenge in computer vision due to its different types and the huge variability of the information depicted in them. This paper presents a method to detect traffic panels in street-level images and to recognize the information contained on them, as an application to Intelligent Transportation Systems (ITS). The main purpose can be to make an automatic inventory of the traffic panels located in a road to support road maintenance and to assist drivers. Our proposal extracts local descriptors at some interest keypoints after applying blue and white color segmentation. Then, images are represented as a Bag of Visual Words and classified using Naive Bayes or SVM. This visual appearance categorization method is a new approach for traffic panel detection in the state-of-the-art. Finally, our own text detection and recognition method is applied on those images where a traffic panel has been detected, in order to automatically read and save the information depicted in the panels. We propose a language model partly based on a dynamic dictionary for a limited geographical area using a reverse geocoding service. Experimental results on real images from Google Street View prove the efficiency of the proposed method and give way to using street-level images for different applications on ITS.

THE PROCESS OF INFORMATION PROPAGATION ALONG A TRAFFIC STREAM THROUGH INTER-VEHICLE COMMUNICATION

WANG, WEI; LIAO, SHAOYI; LI, XIN; REN, JIMMY

This paper proposes a model to calculate the average speed of transmission of IVC messages in general traffic stream on highways in the early stage of deploying DTIS. The model helps explain the relationship between average IVC message speed and traffic parameters like equipped vehicle density, traffic flow speed and traffic direction. Simulation results are used to verify the correctness of the model. This model needs a much shorter calculation time than simulation. Moreover, the theoretical analysis helps provide more insightful explanations of the phenomenon for IVC performance analysis. The results of this paper would help people better understand the design criteria for distributed traffic information systems.

TOWARDS A REAL-TIME PEDESTRIAN DETECTION BASED ON A DEFORMABLE TEMPLATE MODEL

PEDERSOLI, MARCO; GONZÁLEZ, JORDI; HU, XU; ROCA, XAVIER

Most advanced driving assistance systems already include pedestrian detection systems. Unfortunately, there is still a trade-off between precision and real-time: for a reliable detection an excellent precision-recall, such a trade-off is needed to detect as many pedestrians as possible while, at the same time, avoiding too many false alarms; also a very fast computation is needed for fast reactions to dangerous situations. Recently, novel approaches based on deformable templates have been proposed, since these show a reasonable detection performance, although computationally too expensive for real-time performance. In this work we present a system for pedestrian detection based on a hierarchical multi resolution part-based model. The proposed system is able to achieve state-of-the-art detection accuracy, due to the local deformations of the parts, while exhibiting a speed-up of more than one order of magnitude thanks to a fast coarse-to-fine inference technique. Moreover, our system explicitly infers the level of resolution available so that the detection of small examples is feasible with a very reduced computational cost. We conclude this contribution by presenting how a GPU optimized implementation of our proposed system is suitable for real-time pedestrian detection in terms of both accuracy and speed.
TWO DIMENSIONAL SENSOR SYSTEM FOR AUTOMOTIVE CRASH PREDICTION

TAGHVAEEYAN, SABER; RAJAMANI, RAJESH

This project focuses on the use of magnetoresistive and sonar sensors for imminent collision detection in cars. The magnetoresistive sensors are used to measure the magnetic field from another vehicle in close proximity, so as to estimate relative position, velocity and orientation of the vehicle from the measurement. An analytical formulation is first developed for the planar variation of the magnetic field from a car as a function of two dimensional position and orientation. While this relationship itself can be used to estimate position and orientation, a challenge is posed by the fact that the parameters in the analytical function vary with the type and model of the encountered car. Since the type of vehicle encountered is not known apriori, the parameters in the magnetic field function are unknown. The use of both sonar and magnetoresistive sensors and an adaptive estimator is shown to address this problem. While the sonar sensors do not work at very small inter-vehicle distance and have low refresh rates, their use during a short initial time duration leads to a reliable estimator. Experimental results are presented for both a laboratory wheeled car door and for a full scale passenger sedan. Experimental results show that planar position, relative angular position and orientation can be accurately estimated for a range of relative motions at different oblique angles.

UNDERSTANDING BICYCLE DYNAMICS AND CYCLIST BEHAVIOR FROM NATURALISTIC FIELD DATA

DOZZA, MARCO; FERNANDEZ, ANDRE

As technology advances, motorized vehicles employ newer, more intelligent systems to improve drivers’ safety and mobility. The evolution of these systems is supported by increasingly accurate models for driver behavior and vehicle dynamics. Despite the significant role of non-motorized vehicles such as bicycles in traffic accidents, the evolution of in-vehicle intelligent systems has no counterpart for bicycles. Part of the reason is that, to date, models for bicyclist behavior are absent, and models for bicycle dynamics limited. This paper presents a platform for collecting field data from bicycles, and shows how such data can support the development of intelligent systems by offering novel insights into bicycle dynamics and bicyclist behavior.

UTILIZING MICROSCOPIC TRAFFIC AND WEATHER DATA TO ANALYZE REAL-TIME CRASH PATTERNS IN THE CONTEXT OF ACTIVE TRAFFIC MANAGEMENT

YU, RONGJIE; ABDEL-ATY, MOHAMED; AHMED, MOHAMED; WANG, XUESONG

This study investigates the effects of microscopic traffic, weather, and roadway geometric factors on the occurrence of specific crash types for a freeway. The I-70 Freeway was chosen for this study since Automatic Vehicke Identification (AVI) and weather detection systems are implemented along this corridor. A main objective of this study is to expand the purpose of the existing ITS system to incorporate traffic safety improvement and suggest Active Traffic Management (ATM) strategies by identifying the real-time crash patterns. Crashes have been categorized as rear-end, sideswipe, and single-vehicle crashes. AVI segment average speed, real-time weather data, and roadway geometric characteristics data were utilized as explanatory variables in this study. First, binary logistic regression models were estimated to compare single- with multi-vehicle crashes and sideswipe with rear-end crashes. Then, a hierarchical logistic regression model which simultaneously fits two conditional logistic regression models for the three crash types has been developed. Results from the models indicate that single-vehicle crashes are more probable to occur in snow seasons, at moderate slopes, three-lane segments, and under free-flow conditions; while the sideswipe crash occurrence differs from rear-end crashes with the visibility situation, segment number of lanes, grades and their directions (up or down). Furthermore, the innovative way of estimating two conditional logistic regression models simultaneously in the Bayesian framework fits correlated the data structure well. Conclusions from
this study imply that different active traffic management strategies should be designed for three- and two-lane roadway sections and also considering the seasonal effects.

**VEHICLE RE-IDENTIFICATION WITH SELF-ADAPTIVE TIME WINDOWS FOR REAL-TIME TRAVEL TIME ESTIMATION**

**WANG, JIANKAI; SUMALEE, AGACHAI; PANWAI, SAKDA**

This paper proposes a vehicle re-identification system (VRI) with self-adaptive time windows to estimate the mean travel time for each time period on the freeways under traffic demand and supply uncertainty. To capture the traffic dynamics in real-time application, the inter-period adjusting based on the exponential smoothing technique is introduced to define an appropriate time window constraint for the VRI system. In addition, intra-period adjusting technique is also employed to handle the non-predictable traffic congestions. To further reduce the negative effect caused by the mismatches, a post-processing process including the thresholding and stratified sampling, is performed on the travel time data that derived from the VRI system. Several representative simulation tests are carried out to evaluate the performance of the proposed VRI against the potential changes in traffic conditions, e.g. recurrent traffic congestion, freeway bottlenecks and traffic incidents. The results show that this method can perform well under traffic demand and supply uncertainty.

**VEHICULAR TRAJECTORY OPTIMIZATION FOR COOPERATIVE COLLISION AVOIDANCE AT HIGH SPEEDS**

**TOMAS-GABARRON, JUAN-BAUTISTA; EGEA-LOPEZ, ESTEBAN; GARCIA-HARO, JOAN**

Traffic safety is a key aspect in new generation Intelligent Transportation Systems. Among other areas, an active field of research is Cooperative Collision Avoidance (CCA), where vehicles cooperatively calculate trajectories under tight time constraints to avoid colliding under specific road-traffic domains (overtaking, intersections, etc.). Particularly, in this work we analyze the problem of collision avoidance in scenarios where high-speed vehicles need to generate evasive maneuvers within very short time intervals to avoid or at least mitigate an hypothetical (multiple) collision. We pose this as a Multiobjective Optimization Problem (MOP) and simplify it by considering only lateral motion for the optimization process, thus having to solve a one-dimensional trajectory-generation problem. The routes of vehicles are optimized according to a weighted aggregation functional that: (i) maximizes the lateral distances between vehicle-vehicle and vehicle-obstacle pairs at the time of overcoming the obstacles, (ii) minimizes the lateral speeds at the end of the path, and (iii) minimizes the instantaneous lateral acceleration (inertia) along the maneuver. In addition, we compute trajectories by following an optimization strategy that divides the problem into a set of independent subproblems which are optimized in parallel by using a gradient-descent based methodology. From this set of solutions, the most suitable option, according to our selected criteria, is chosen. Results show the utility of our approach and its flexibility to compute evasive trajectories adapted to different requirements. Additionally, a simulation of the mechanical response of the vehicles during the evasive maneuvers is conducted.

**WILL THE PEDESTRIAN CROSS? A STUDY ON PEDESTRIAN PATH PREDICTION**

**KELLER, CHRISTOPH; GAVRILA, DARIU**

Future vehicle systems for active pedestrian safety will not only require a high recognition performance, but also an accurate analysis of the developing traffic situation. In this paper, we present a study on pedestrian path prediction
and action classification at short, sub-second time intervals. We consider four representative approaches: two novel approaches (based on Gaussian Process Dynamical Models and Probabilistic Hierarchical Trajectory Matching) that use augmented features derived from dense optical flow, and two approaches as baseline that use positional information only (Kalman Filter and its extension to Interacting Multiple Models). In experiments using real stereo data obtained from a vehicle, we investigate the accuracy of path prediction and action classification at various time horizons, the effect of various errors (image localization, vehicle ego-motion estimation) and the benefit of the proposed approaches. The scenario of interest is that of a crossing pedestrian, who might stop or continue walking at the road curbside. Results indicate similar performance of the four approaches on walking motion, with near-linear dynamics. During stopping, however, the two newly proposed approaches, with non-linear and/or higher-order models and augmented motion features, achieve a more accurate position prediction of 10-50 cm at a time horizon of 0-0.77 s around the stopping event.
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