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www.ewh.ieee.org/tc/its

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SOCIETY NEWS

From the Editor

by Yaobin Chen

Summer (for most of you) is almost over. I hope you have had a relaxing and productive summer and will be ready for the fall semester (for those who work and study in universities). During the summer, several ITSS sponsored conferences were held successfully with your support and participation. You will find brief reports from those conferences in this issue. I would also like to bring your attention to the two important announcements in the Society News section: (1) 2012 Call for Nominations of Awards and (2) Call for Nominations of BoG. I hope you will have the opportunity to nominate those who deserve such recognitions in our research community. As usual, we have also included a section of Transactions on ITS Abstracts that have been recently accepted for publication in the ITS Transactions. I am pleased to announce that the number of subscribers continues to grow. I strongly encourage all of you to submit ITS related items to the Newsletter.
Purpose and Selection Criteria

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.

Application Materials

Each application must consist of the following materials:

(1) A 5-page summary statement providing sufficient detail for evaluation of the innovations and impacts of the work.

(2) At least 3 letters of recommendation from the recognized peer researchers, customers or users of the developed application, and organizations attesting to its significance and impact.

Please email applications before December 31, 2011 to ITSS Vice President of Membership: jason.geng@ieee.org.

Dedicated selection committees will evaluate the applications for the IEEE ITS Awards and propose candidates for final approval by the ITSS Board of Governors.
Call for Nominations to the Board of Governors

In accordance with the IEEE ITSS Constitution and Bylaws, society members have the ability to nominate individuals to be added to the ballot for election to the Board of Governors (BOG). If possible, at least 8 willing individuals will be on the ballot that is distributed to the society members by August 31. Completed ballots must be returned by October 15. The 5 individuals who receive the most votes will begin serving 3-year terms on January 1.

The Board of Governors is the governing body of the society. There are currently two meetings each year they must attend – one teleconference in spring and one in-person meeting in fall in conjunction with ITSC. There are 15 BOG members in the society, with 5 elected each year to serve 3-year terms. There are also 9 additional BOG members known as the Executive Committee, which are nominated and elected by the current BOG.

Please send all Board of Governors nominations to the ITSS Past President Bill Scherer (wts@virginia.edu). Please include the nominee’s full name, affiliation, title, and contact information.

If you have questions about the nomination or election process, please contact the VP Administrative Activities Jeffrey Miller (jmiller@uaa.alaska.edu).
The 2011 IEEE Intelligent Vehicles Symposium (IV’11) was held in Baden-Baden, Germany. Since its inauguration in Tokyo, in 1990, IV has earned the reputation as the premier annual event in the world for intelligent vehicles with participants from academia, industry, government, and research institutes coming together to present their accomplishments, to learn from another, and to discuss the future of this exciting field.

The year 2011 marks the 125th anniversary of the invention of the Patent-Motorwagen Nummer 1 in 1886 by Carl Benz, an alumnus of the nearby Politechnikum Karlsruhe, today’s KIT. For more than a century, the automobile has now been of huge importance for industry and academia in and far beyond the federal state of Baden-Württemberg.

The IV11 call for papers led to 328 submissions and 4 special session proposals. 192 submissions including 1 special session of these were selected for publication in a rigorous review process conducted by a consortium led by the Program Chair, Klaus Dietmayer, and two Program Co-Chairs Jeffrey Miller and Onur Altintas supported by 51 members in the Program Committee.

On Sunday preceding the main symposium, three workshops were offered:
(1) ‘Online signal processing on multi-core platforms,’ organized by Benjamin Ranft, Oliver Denninger, and Jeffrey Ohta;
(2) ‘Towards Models of Interactive Pedestrian Behavior for Intelligent Vehicles,’ organized by Cristobal Curio, and
(3) ‘How can new sensor technologies impact next generation safety systems?’ organized by Erwin Schoitsch

The main symposium is characterized by a single session format so that all attendees remain in a single room for multilateral communications in an informal atmosphere. The presentations included a special session on ‘State of the Art and Challenges of Autonomous Driving’ organized by Sören Kammel and Jan Becker. Keynote talks have been given on ‘Intelligent Tools for Intelligent Vehicles: ROS, OpenCV, PCL,’ by Victor Eruhimov; on ‘Human factors for intelligent vehicles – experiences and new challenges,’ by Berthold Färber; and on ‘ECO-Friendly Intelligent Transportation Systems: How Far Can We Improve Vehicle Fuel Economy and Reduce Emissions using ITS?’ by Matthew Barth.

The social program led the participants through some historical sites of Baden-Baden. The reception was held in and in front the historical theatre. The banquet was commenced at the Trinkhalle and proceeded in the Kurhaus. In his banquet speech Ralf Herrtwich fostered discussions by posing the question ‘Is Your Car Smarter Than You?’
The symposium has been accompanied by an exhibition organized under the leadership of the Exhibition Chair, Markus Maurer. It displayed the latest devices, tools and technologies in intelligent vehicles.

The banquet aperitif was taken in the Trinkhalle before having dinner in the Kurhaus.
For many experts in the field the on-the-road demonstrations of latest vehicles from research and industry were a highlight. The Demonstration Chair, Hermann Winner, has organized this event nearby Baden-Baden. Participants were able to experience perception, cooperative assistance functions, and autonomous maneuvers in more than 10 vehicles.

Gathering of the teams at the demonstration day

Martin Roser, Henning Lategahn, and Hannes Harms have completed the Organizing Committee as Finance Chair, Publication Chair, and Local Arrangements Chair, respectively, and enthusiastically stepped in wherever required.

339 participants from 33 countries led by Germany, Japan, France, USA, Korea, and China attended the main symposium. 79 attendees were present at the workshops, and 158 participants experienced the rides in demonstration vehicles.

A Selection Committee composed of 5 international experts from academia and industry has presented best paper awards for the best oral contribution to Vincent Drevelle as well as the best poster contribution to Martin Roser.

IV11 has been successful in gathering international researchers, academicians, practitioners, and students from universities, industry, and government agencies to discuss research and applications for Intelligent Vehicles and Intelligent Infrastructures in a stimulative ambience. We hope IV11 provides the participants pleasant memories of the time spent in Baden-Baden situated in the black forest near the cradle of the automobile.

More pictures from IV11 are available at the symposium website http://www.mrt.kit.edu/iv2011

Christoph Stiller, General Chair,
Klaus Dietmayer, Program Chair,
Hermann Winner, Demonstration Chair
Markus Maurer, Exhibition Chair
The 2011 IEEE International Conference on Vehicular Electronics and Safety (ICVES 2011), was held in Beijing, China, on July 10-12, 2011. This conference was held concurrently with the 2012 IEEE International Conference on Service Operations and Logistics, and Informatics, and the 2012 IEEE International Conference on Intelligence and Security Informatics.

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, the conference was well attended by more than 70 researchers and experts from more than 10 countries and regions in the world. 92 papers were submitted from 16 countries including Brazil, China, Czech Republic, Germany, India, Iran, Japan, Jordan, Malaysia, Spain, Sweden, Taiwan, Thailand, Turkey, United Kingdom, and USA. The final technical program included 14 sessions with 58 accepted papers after a rigorous peer review process.
The conference program also included a special session on “Global Perspectives of Active Safety Systems Research and Developments” with three panelists: Dr. Glenn Widmann from Delphi Electronics and Safety, USA, Prof. Keqiang Li from Tsinghua University, China, and Prof. Fang Chen from Chalmers University of Technology, Sweden. The special session was very interactive and provided international researchers a great platform to share with each other current research and development activities in transportation active safety and explore collaborative opportunities for future research and developments in the field.

In addition to the well-organized technical program, the conference is honored to have three distinguished keynote speeches by Prof. Chongqing Guo from the National Natural Science Foundation of China, Prof. Glenn R. Widmann from Delphi Electronics and Safety in USA, and Prof. Ali Hessami from Vega Systems in UK.

The ICVES organizing committee is 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, 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 will extend our thanks to the keynote speakers, reviewers, and volunteers for their valuable contributions to this conference.
Dr. Glenn Widmann of Delphi Electronics and Safety delivers a keynote speech at the Opening Ceremony.

Attendees listen to a presentation at the conference.

The 2012 IEEE ICVES will be held in Istanbul, Turkey next summer. We hope you will have the chance to participate and present your research results at the conference.
2011 IEEE International Conference on Service Operations and Logistics, and Informatics Report

Gang Xiong, General Chair

During July 10-12, the 2011 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI2011; http://www.ieeesoli.org/) was held at Friendship Hotel, Beijing, China.

With several years of continuous efforts and improvements, SOLI has become an influential event and good communication platform for the scholars, researchers and practitioners from academic institutions, universities and industrial companies all over the world, focusing mainly on service operations, as well as logistics and informatics.

This year, 144 papers were submitted to the conference, mainly from Brazil, Canada, China, Egypt, Finland, France, Germany, India, Italy, Japan, Korea, Norway, Singapore, Taiwan, United Kingdom, USA. 71 papers were accepted after a strict peer review process, mainly from industrial companies like IBM, academic institutions like Chinese Academy of Science, universities and others. And 62 papers were invited to give oral presentations, 9 papers were invited to provide posters. Acturally, about 52 authors came to Beijing to attend the conference and give the oral presentations. So, IEEE SOLI 2011 is successful and with high quality.

A special session named “Intelligent Rail Transportation” is organized separately by Beijing Jiao Tong University, which will become independent IEEE International Conference on Intelligent Rail Transportation (IEEE ICIRT) in the future. In addition to the well-organized technical program, IEEE SOLI 2011 is honored to have three distinguished keynote speeches by Prof. Chongqing Guo from NSFC (The National Natural Science Foundation of China) in China, Prof. Glenn R. Widmann from Purdue School of Engineering and Technology in USA, and Prof. Ali Hessami from Vega Systems in UK.

The SOLI Organizing Committee is grateful to INFORMS, ITSS (Intelligent Transportation Systems Society), NSFC and CAS (Chinese Academy of Sciences) for their sponsorships of the conference. A special acknowledgement is due to the Institute of Automation, Chinese Academy of Sciences, and National University of Defense Technology, who mainly organized IEEE SOLI 2011 together; and the 61 International Program Committee Members and more than 300 reviewers for preparing an excellent technical program and ensuring the technical quality of IEEE SOLI 2011. Thanks are also given to Prof. Feiyue Wang, who leads us to organize the conference. Our sincere appreciation also goes to all authors including those whose papers were not included in the program. And, finally, we will extend our thanks to the keynote speakers, reviewers and volunteers for their valuable contributions to this conference.

Based on the Award Committee leading by Dr. Xiwei Liu, Best Conference Paper Award is presented to Weishan Dong, Xin Zhang, Zhongbo Jiang, Wei Sun, Lexing Xie, and Arun Hampapur, from IBM Research, for their paper “Detect Irregularly Shaped Spatio-Temporal Clusters for Decision Support”. Best Application Paper Award is presented to Dennis Güttinger, Eicke Godhardt, and Andreas Zinnen, from SAP AG, SAP Research and University of Luxembourg, for their paper
“Online Strategies for Optimizing Medical Supply in Disaster Scenarios”. Best Student Paper Award is presented to Akram Zouggari and Lyes Benyoucef, from INRIA Nancy-grand Est, COSTEAM Project, for their paper “Simulation based Fuzzy Tool for Supplier Selection with Order Allocation”.

In addition, one book named like “Service Science, Management and Engineering” is editing with about 15 papers selected from IEEE SOLI 2011. The book will be published by Springer Press this year.

Last but not least, thanks all for your contribution to IEEE SOLI 2011! And, welcome you to join IEEE SOLI 2012, which will be held in Suzhou, one of southeastern China's captivating cities, described by many as 'Heaven on Earth'.

Participants of session “Informatics and Information Systems II: Modeling & Implementation”, where Session Chair is Prof. Timo Nyberg from FINLAND.
Prof. Glenn R. Widmann presents Best Conference Paper Award to Dr. Weishan Dong
Feiyue Wang, General Co-Chair
Daniel Zeng, Program Co-Chair

The 2011 IEEE International Conference on Intelligence and Security Informatics (ISI2011; http://www.ieeeisi.org/) was held in Beijing Friendship Hotel, Beijing, China on July 9-12.

Intelligence and Security Informatics (ISI) research is an interdisciplinary research field involving academic researchers in information technologies, computer science, public policy, bioinformatics, medical informatics, and social and behavior studies as well as local, state, and federal law enforcement and intelligence experts, and information technology industry consultants and practitioners to support counterterrorism and national/international security missions of anticipation, interdiction, prevention, preparedness and response to terrorist acts. IEEE ISI 2011 was hosted by the Institute of Automation, Chinese Academy of Sciences and University of Arizona. The four-day conference program included paper presentation sessions, a poster session, a plenary panel, and four workshops. These workshops include the First International Workshop on Software Security and Protection (SSP), the Sixth Pacific Asia Workshop on Intelligence and Security Informatics (PAISI), the Third International Workshop on Social Computing (SOCO), and the First International Symposium on System Informatics and Engineering (ISSIE). The technical program of the main ISI conference included 29 long papers, 14 short papers, and 10 poster papers. Contributing authors came from sixteen countries and regions, including Australia, Canada, China, Denmark, España, Hong Kong SAR, India, Israel, Japan, Latvia, Republic of Korea, Saudi Arabia, Singapore, Turkey, United States, and Uruguay. The Proceedings of the IEEE ISI 2011 also included 8 papers accepted by SOCO and 28
papers accepted by ISSIE. PAISI’s papers were published under a separate volume from Springer in its Lecture Notes in Computer Science.

Prof. Chongqing Guo, an academician of the Chinese Academy of Engineering and a professor from Tongji University, Prof. Glenn R. Widmann from Purdue School of Engineering and Technology in USA, and Prof. Ali Hessami from Vega Systems in UK presented three keynote speeches on “IT Redefining Services”, “Advances in Active Safety Systems to Improve Vehicle Safety” and “Intelligent Railway Transportation Safety & Security– A Systems Approach,” respectively.

Academician Chongqing Guo delivered his keynote speech

Prof. Feiyue Wang, the general chair of IEEE ISI 2011, presented the IEEE 2011 Research Achievement & Leadership Award in Intelligence and Security Informatics to Prof. Hsinchun Chen from the University of Arizona. Prof. Christian Collberg, the Program chair of IEEE ISI 2011, presented 2011 Best Paper Award to Dr. Richard Colbaugh from Sandia National Laboratories, New Mexico Institute of Mining and Technology and Prof. Kristin Glass from New Mexico Institute of Mining and Technology for their paper “Proactive Defense for Evolving Cyber Threats.” The IEEE ISI 2011 Best Paper Honorable Mention went to Drs. Xiaofeng Wang and Donald E. Brown from University of Virginia for their paper “The Spatio-Temporal Generalized Additive Model for Criminal Incidents”.
Prof. Feiyue Wang presented the IEEE 2011 Research Achievement & Leadership Award in Intelligence and Security Informatics to Prof. Hsinchun Chen
IEEE INTERNATIONAL TRANSPORTATION FORUM

DRAWS PARTICIPANTS FROM FIVE CONTINENTS

VIENNA—June 29-July 1, 2011, one hundred fifty engineers, scientists, academics, and practitioners, from Europe, North America, Asia, Africa, and South America gathered in Vienna, Austria to discuss how best to achieve integrated sustainable transportation systems. The Forum, sponsored jointly by four IEEE Societies — the Aerospace and Electronic Systems Society, the Intelligent Transportation Systems Society, the Oceanic Engineering Society, and the Vehicular Technology Society — offered provocative presentations, lively discussion, and visionary futures about sustainable transportation systems that create economic opportunity and improve access to basic human needs.

AustriaTech’s Reinhard Pfliegl (far left) served as local host and Europe Co-Chair for the Forum, held at the Messe Wien Exhibition & Congress Center. As General Chair, the USA’s Charles Herget (center) coordinated overall Forum planning and design. Program Chair Matthew Barth (right) assembled speakers, topics, and over 100 technical papers that ensured a comprehensive view of integrated and sustainable transportation systems.

In his opening address, keynote speaker Martin Wachs (at right) from the RAND Corporation and the University of California at Berkeley, asserted that “global sustainability is probably the greatest challenge to transportation policymakers.” Wachs stated that policy makers must deal with 1) living within limits imposed by available resources and the carrying capacity of our environment, 2) addressing the interconnections among the economy, social wellbeing, and the environment, and 3) equitably distributing resources and opportunities for advancement across places and among generations. According to Wachs “mobility is perhaps the single greatest global force in the quest for equality of opportunity” because it offers improved access to better health care, education,
economic opportunity, and social connectivity. Wachs’ thoughtful perspective set the stage for discussion throughout the remainder of the Forum.

The Forum, built around policy issues, strategies, technology, and integration/logistics, included panel presentations, plenary discussions, technical papers, and an Electronic Interactive Information Marketplace (EIIM) where Forum participants could present and discuss their work with others. In addition, the Forum offered a special ITS Energy Symposium where representatives from the European Community, the USA, and Japan met to discuss ways to promote and facilitate cooperation between the EU, Japan and the US on assessment of ITS and CO₂ emissions and to work toward trilateral agreement on a framework within which a common assessment methodology can be defined.

**DAY ONE— PANELS**

Each of the four panel sessions began with opening comments by panelists, with about one-half of the panel session reserved for plenary discussion, comments, and questions for the panelists, yielding a more interactive experience and an opportunity for all Forum participants to engage in the conversation. Following are brief summaries of panelists’ key ideas and comments.

**POLICY**

Panelists Paul Verhoef, Head of Unit, DG MOVE, European Commission, Brian Cronin, U.S. DOT Research in Innovative Technology Administration (RITA), Ulla Rasmussen, President, European Federation for Transport and Environment, Herbert Kasser, Ministry of Transport, Austria, Takayuki Oba, MLIT Director of ITS, Japan, and Martin Wachs, RAND Corp., UC-Berkeley, USA, presented perspectives and visions for integrated sustainable transportation systems, building on the idea of mobility as key to equal opportunity. Key points made by the policy panel include 1) the importance of a global level-playing field, efficient multimodal intercity core transportation networks, and clean urban transport and commuting, 2) the need for a better understanding of the trade-offs between how an environmentally-optimized transportation system operates and how a mobility/throughput-optimized transportation network operates, and 3) the observation that, unless the entire CO₂ footprint is considered (including point sources where energy is generated), measures may be meaningless.

**STRATEGIES**

The strategy panel, comprised of Marcia Pincus, U.S. DOT RITA, John Du, GM Research Institute, China, and Anton Plimon, CEO Austrian Institute of Technology, Austria, offered insight into how the international community can pursue desired policy outcomes. For example U.S. DOT’s Pincus explained how, if vehicle to vehicle and vehicle to roadside (or to other infrastructure) can be proven
as a concept, we will have a new paradigm for global gains in mobility and sustainability, using accurate, real-time information to guide decision making for everything from vehicle safety and efficiency to vehicle routing and infrastructure operation. GM’s Du showed advanced vehicle designs that will increase options for personal mobility in ways that integrate and optimize energy sources, vehicles, and connectivity. AIT’s Plimon recognized opportunities for dramatic improvements in traffic safety through driver assistance and, autonomous systems, especially for high risk drivers. Plimon also noted discontinuities in current business models and in how risks are allocated — which must be addressed if the advanced technologies that can enable integrated sustainable transportation systems are to implemented successfully.

TECHNOLOGY
Technology panel members Brian Cronin, U.S. DOT RITA, Michel Parent, INRIA, France, Atsushi Fukuda, Nihon University, Japan, Alex Robinson, Head of Engineering, Bombardier Transportation, Germany, and Wolfgang Steiger, VW Research, ERRAC, Germany described innovations that can accelerate the rate at which sustainable mobility becomes widely available. Panel members noted that societal challenges are driving change — de-carbonization, reliability, safety & security, global competitiveness — and thus the need for technology solutions that facilitate needed changes. For example, growing demand for mobility in Shanghai, along with the focused efforts of key decision makers and technologists, led to implementation of the world’s largest subway system in fifteen years from planning to operation. One panelists envisioned “a connected transportation environment around vehicles of all types, the infrastructure, and portable devices to serve the public good by leveraging technology to maximize safety, mobility, and environmental performance.” Individual road vehicles with full automatic capability will be part of an optimized transportation system, resulting in integrated trips – including various forms of “micro-mobility” (e.g., powered bicycles) for traveling the “last mile.” In the end, panelists agreed that integrated sustainable transportation involves multiple integrated technologies and individual and collective changes in behavior needed to achieve CO₂ reduction goals.

INTEGRATION
The fourth panel considered issues of integration and logistics as they relate to integrated sustainable transportation systems. Panelists Michael Smith, University of Virginia, USA, Bin Ning, Beijing Jiaotong University, China, Wei-Bin Zhang, UC-Berkeley, USA, and Peter Sonnabend, Deutsche Post, Germany, addressed integration of actors, modes, information, and responsibility driven by reality, necessity, efficiency, and sustainability. Panelists observed that Integrated Transportation Systems include rail, air, highway, waterway, pipeline, city transportation systems, and area transportation systems. Integrated, real-time, multimodal traveler information can help travelers make mode choice decisions, resulting in more efficient use of existing transportation infrastructure, and in turn, reduce congestion and associated vehicle emissions. Panelists also recognized that the system
boundaries for integrated systems are artifacts of convenience needed to understand and address issues of concern and should be set based on a clear understanding of user needs and constraints.

DISCUSSION
Following each panel, the plenary discussion raised questions and offered comments about both the panelists’ opening statements and related topics. Comments from Forum participants included, for example,

- Development and implementation of Integrated Sustainable Transportation Systems (ISTS) is more of a policy issue than a technology issue
- We need consensus in the Intelligent Transportation Systems community to overcome the slow progress in implementation.
- There must be forces working on preventing or impeding implementation—are there obvious conflicts of interests?
- Are there pressure groups in the wrong direction? Who is interested in preserving the status quo?
  - Automotive industry—ISTS will reduce the number of vehicles
  - Petroleum industry—ISTS will reduce petrol/gasoline consumption
- We have to sell our issue! It seems boring now—we have to make it “sexy” to seduce people to make alternative decisions!
- We need sustainable funding mechanisms to support responsible choice.
- We need mutually defined “use cases” and common language
- Are people willing to engage and feel passion? We need insight into attitude change (e.g., from social scientists and psychologists).
- Each geographic region brings specific strengths to the table—need to engage others.
- Nuclear power should be considered as part of the solution to provide clean, safe, sustainable alternatives to fossil fuels for generating the electricity needed to power zero emission vehicles and meet other needs for electrical power.
- “Provisional mobility”—being able to choose; integration—need to have greater choice; sustainable—make responsible choices.
- Broaden the discussion to include urban planners
- Measurement challenges—need to agree on footprint; use satellites to monitor sustainability effects of mobility, almost on-line.

The lively discussion following each panel session reflected the diversity in the backgrounds and experience of Forum participants, including regional differences and differences in technical background and interest.

DAY TWO—TECHNICAL TRACKS

TECHNICAL PRESENTATIONS AND PAPERS
The technical tracks covered the spectrum of research on integrated and sustainable transportation systems with many—and sometimes conflicting—views and goals. Some emphasize transportation as
a means to achieving equality opportunity; others focus on energy (e.g., alternative fuels) and sustainability (e.g., CO2 emissions), while others seek ways to make transport more efficient and safer (e.g., traveler information, transportation systems management). These different views co-exist and advances come from synergies and complementary solutions driven by different values, perspectives, needs and efforts. The technical track and EIIM topics are provided at the Forum website at https://its.papercept.net/conferences/conferences/FISTS11/program/FISTS11_ContentListWeb_2.html.

The research surrounding integrated and sustainable transportation systems comes from a variety of different fields, confirming that the topic is an important issue for future generations. From policy to technology to algorithms, researchers approach integrated transportation systems in different ways. Using and sharing information available through “connected vehicle” initiatives make transportation systems smarter, greener and safer. Emerging characteristics of the next generation transportation consumers and providers reflect both comfort with and a desire to take advantage of new technologies, particularly for making information available to the average driver. Research teams from different fields are engaged in various aspects of ISTS using disparate techniques, with the general trend of utilizing new information and technologies as they become available.

**ELECTRONIC INTERACTIVE INFORMATION MARKETPLACE (EIIM)**

The EIIM proved to be an attractive feature of the Forum, encouraging one-on-one and several-on-one interactions with researchers and service providers. The EIIM sessions, held concurrent with planned refreshment breaks, were designed to permit service providers and researcher to describe, demonstrate, and display their products, services, and research activities. These included emerging technologies as well as algorithms, simulations, and interfaces designed to take advantage of information obtained through connected vehicles, instrumented infrastructure, and information networks.

**ITS ENERGY SYMPOSIUM**

The ITS Energy Symposium brought together representatives from the European Union, Japan, and the US to review European Commission, Japan, and US activities, examine emissions modeling efforts, and discuss emerging automation technologies. The objectives of the symposium were to promote and facilitate co-operation between the EU, Japan and the U.S. on assessment of ITS and
Bilateral and trilateral working relationships encourage interactions at the policy level and at the operational level where collaborative projects are developed and implemented.

CO2 emissions and to provide trilateral agreement on a framework for defining a common assessment methodology. The intent was not to produce the methodology; but to formulate policy advice in terms of a roadmap and a joint research agenda for further activities. Participants reviewed European initiatives (the Green Car Initiative & FP7 related projects), a US initiative (the AERIS program), and a Japan initiative (METI Energy ITS project) and discussed goals for the coming years and how best to approach the challenges for an integrated approach given differences in focus, goals, and technologies.

GALA DINNER AND COMMENTS BY JOHN HORSLEY, AASHTO EXECUTIVE DIRECTOR

Day Two of the Forum concluded with a well-attended gala dinner at the Wiener Rathauskeller in Vienna’s historic Rathaus (City Hall — see http://www.wien.gv.at/english/cityhall/) where Forum participants gathered for excellent food, drink, and informal conversation, highlighted by Reinhard Pfiegl’s brief history lesson and John Horsley’s excellent presentation.

Following introductions by Charles Herget and Wei Ben Zhang, Horsley, Executive Director of the
The Wiener Rathauskeller served as an excellent venue for the Forum’s gala dinner.

American Association of State Highway and Transportation Officials (AASHTO), offered his vision of how we will achieve integrated sustainable transportation systems. Horsley offered five points that he sees as critical to sustainable transportation. First, both vehicle and fuel technology are important in reducing GHG emission; second, we need transport strategies that encourage use of transit, passenger rail, and other modes that reduce VMT; third, we must finance a balanced system to achieve fiscal sustainability and reduce dependence on roadways; fourth, we must use advanced materials to build and maintain infrastructure through recycled and reused materials; and fifth, we must establish sustainable funding mechanisms through methods such as VMT pricing, tolling, and variable pricing.

DAY THREE—FORUMS ON GLOBAL CHALLENGES—GLOBAL ACTIONS AND ON A ROADMAP TOWARDS A SUSTAINABLE TRANSPORTATION SYSTEM

GLOBAL CHALLENGES—GLOBAL ACTIONS

In this first of two forums, panelists Marcia Pincus, Martin Wachs, Emilio Davila-Gonzales, and Manfreid Seitz responded to two questions.

The first question presented to the panel: what are the major global challenges to advancing integrated sustainable transportation systems? Panelists’ responses, often in the form of questions, were

- Are individuals willing to make the trade-offs necessary to achieve integrated sustainable transportation systems?
- We need to recognize our differences and leverage our different abilities as we approach the challenges—disciplinary, technical, cultural, economic, social.
- We need to develop and build consensus around mutually defined objectives and strategies and related processes and use cases.
- Providing choices to enhance quality of life
- Extend more choices to individuals, families, firms, but make them responsible choices. Those with “no choice” (typically developing and poorer nations) need more choices that offer access to education, health care, economic activity, etc; those with many choices (or who might be offered many choices) need to be influenced to make appropriate choices (e.g., more conscience of the effect of their choices on social, environmental, and economic considerations)
- How can we measure the CO2 footprint at the national level? Can we use satellite imagery to monitor and manage CO2 emissions?
Can we use ISTS to reduce transportation-related fatalities?
How do we get citizens to think about mobility choices?
Can we relate increases in demand to increases in fuel costs?
We face different problems in different regions of the world, but can we identify global challenges?
Transport is part of the solution to developing society and its economy – it not an end in itself—and we have challenges across society
Need to capitalize on available technologies, strategies, concepts, and best practices that are working now.
Urbanization is continuing to take place and we need to understand how best to accommodate mobility needs of increasing urbanization.
Will we be able to handle the effects of climate change? We can invest in clean transport to reduce those effects but can we afford the cost of mitigation if we choose to ignore the effects of climate change – natural disaster and other events that threaten people and our natural and build environment.

The second question the panelists addressed was: what are the most important global actions we can take to advance integrated sustainable transportation systems? Their responses to this question offered insight into where we might make progress toward realizing ISTS:

Focus on how we can succeed rather than the problems we have and the barriers we face
Consider and “Open Challenge” similar to DARPA’s challenge for autonomous vehicles – invite respondents to think boldly and offer innovative responses
Integrated Sustainable Transportation is more complex than “cutting the wire” (e.g., as in the introduction of Wi-Fi) – ISTS is much more complex and the Wi-Fi metaphor is not helpful because it does not adequately address the human dimension – three billion people making individual decisions.
We’ve just “scratched the surface” at this Forum; we’ve taken the first step and need to proceed to the next – how do we bring behavior scientists and others who understand how to facilitate attitudinal change?
We have limited our thinking regarding integration – need to consider land use, urban form, policy, financing (especially in poorer countries).
Goals are great but must know how to accomplish them; now let’s talk about operationalization of solutions we believe are promising.
May want to co-sponsor a forum with other professional groups, e.g., environmental, policy, planning.
Integration approach with many different players – with users, information, vehicles – on an international basis.
Need to figure out how to move ideas and proven concepts from research to market.
Need a framework for decision making that can leverage the effects of V2X.
More outspoken debate, greater public awareness of the issues.
Wide-scale implementation of available solutions.
New policy instruments – business models, implementation strategies.
International cooperation – new synergies that leverage intellectual resources, promote competition for finding solutions, and “channel” human attitudes.
Stronger voice from the scientific community to offer solutions and help make a compelling case
THE WAY AHEAD
This first Forum on Integrated and Sustainable Transportation Systems progress in technology, policy, and practices as well as both needs and opportunities for addressing economic, environmental, and energy concerns where mobility is a principal factor. Forum participants generally agreed that the Forum should continue, but expand to include a broader constituency and even greater diversity in experience and perspective, especially professionals who understand urban planning, behavioral change, and outreach and marketing. Participants suggested a bi-annual or tri-annual Forum that draws from this diverse group and affords an opportunity to measure progress toward realizing Integrated Sustainable Transportation Systems and to clarify direction and goals for further development and implementation.

CLOSING THOUGHTS
In looking back over the Forum, perhaps there are some broad observations that might help us adjust our “mental models” to accommodate new ways of thinking about advancing integrated sustainable transportation systems. Some areas we might consider are:

- **Embracing the concept of outscoping and generalizing the problem** to gain deeper understanding before pursing or selecting a specific solution, recognizing that neither we nor the system users fully understand the problems we attempt to solve. We must engage others who bring experience, expertise and perspectives that are less likely to emerge in a gathering of engineers and scientists. This may mean going to others’ “turf” - e.g., attending and participating in meetings where planners, policy makers, and operators typically gather and soliciting their input and sharing our ideas.

- **Recognizing and responding to the idiosyncrasies of the decision making process in public policy** – elected officials need compelling evidence expressed in understandable language so that they can garner the support needed to make decisions that are in the best interest of their constituencies. Elected officials and senior appointed officials and senior managers must take into consideration issues and constituencies that go beyond technical, fiscal, and operational feasibility. We must get on their agenda, make our case, and understand and address their concerns.

- **Understanding the concept of autonomous interdependence for both technical and behavior strategies** We are unlikely to find single solutions that fit all needs and thus must tailor solutions to individual needs but within the context of a framework that leverages common infrastructure and capability.

- **Viewing ISTS as a “portfolio” of technologies, strategies, policies, and practices with some more effective than others - rather than a single point or “optimal” solution**. The task is identifying and “translating” promising solutions within the portfolio into wide scale practice, giving more attention to “translational research” in transportation as is occurring in health care and other fields.
Accepting the notion that ISTS is an “emergent” system rather than a “designed” system. We do not know what outcomes our actions will produce but we do know some actions that are likely to produce positive results. We have many examples of technologies and social changes that have had remarkable positive effects far beyond what we imagined but also some negative effects that we failed to anticipate and avoid.

Thinking of our solution approach in terms of “strategic positioning” rather than finding a solution. We need technologies, policies, strategies, and practices in place that can exploit opportunities to move us toward more sustainable and more effective mobility for people and goods – and we need to spend time “preparing the soil” (both in terms of public awareness and sound evidence) to enable decision makers to take advantage of these opportunities.

Submitted by Michael C. Smith, University of Virginia-Charlottesville, mcs5f@virginia.edu
IEEE Intelligent Vehicles Symposium
June 3-7, 2012, Alcalá de Henares, Spain
Sponsored by the IEEE Intelligent Transportation Systems Society

Call for Papers

THE INTELLIGENT VEHICLES SYMPOSIUM (IV’12) is the premier annual forum sponsored by the IEEE INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY (ITSS). Researchers, academicians, 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 session format so that all attendees remain in a single room for multilateral communications in an informal atmosphere. Tutorials will be offered on the first day followed by three days of presentations and a vehicle demonstration day. An exhibition area will be available for the presentation of products and projects, as well as for small demonstrations.

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
- Assistive Mobility Systems
- 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

Manuscripts of 6 pages in PDF format must be electronically submitted for peer-review in IEEE standard-format. For detailed submission instructions visit the conference website www.robeseafe.es/iv2012

Important Dates
- Special Session Proposal: January 16th, 2012
- Paper submission deadline: January 16th, 2012
- Notification of acceptance: March 15th, 2012
- Final paper submission: April 15th, 2012

Contact
For proposal of a special session, demonstration, and exhibition contact the organization committee at iv2012@robeseafe.es

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Vol.13 No.3 July 2011
The 2012 IEEE International Conference on Vehicular Electronics and Safety (ICVES’12) which is an annual forum sponsored by the IEEE Intelligent Transportation Systems Society will take place in İstanbul during July 24-27, 2012.

The motto for ICVES’12 is: Let’s meet where the continents meet. İstanbul connecting the two continents of Europe and Asia and being a cross-road of civilizations for many centuries is an ideal location for the IEEE International Conference on Vehicular Electronics and Safety. The conference venue is Military Museum and Cultural Center located at the center of Istanbul.

ICVES is the Conference the ITS Society has specifically identified for presentations on Electric Vehicles, Hybrid and Plug-In Hybrid Vehicle related presentations. Researchers in these areas are especially encouraged to submit their latest results and attend.

Important Dates
Paper submission deadline: Feb. 15, 2012
Notification of acceptance: May. 15, 2012
Camera-ready manuscript due for proceedings: June. 1, 2012
Workshop proposal manuscript deadline: June. 8, 2012

IEEE ICVES’12
http://www.ICVES2012.gsu.edu.tr
For e-mail correspondence: icves2012@gsu.edu.tr

TOPICS:
- Active and Passive Safety Systems
- Telematics
- Vehicular Power Networks
- X-By Wire Technology
- System-On-a-Chip
- Vehicular Sensor
- Vehicle Bus
- Sensor Network
- Electro Magnetic Compatibility
- Inter-Vehicular Network
- Vehicle Testing
- Vehicle Hardware /Software System
- Navigation and Localization Systems
- Vehicular Measurement Technology
- Vehicular Signal Processing
- Micro-electromechanical Systems
- Image Sensor
- Vehicle/Engine Control
- Embedded Operation System
- Driver Assistance Driving Systems
- Adaptive Cruise Control Systems
- Pattern Recognition for Vehicles
- Human Machine Interaction
- Diagnostics on Line
- Virtual/Digital System
- Others
First Call for Papers:

The 2012 IEEE International Electrical Vehicle Conference (IEVC)
Technology, Engineering, Standards – Challenges and Opportunities

March 4-8, 2012
Greenville, South Carolina, USA
Sponsored by IEEE and CUICAR (Clemson University International Center of Automotive Research)

The first IEEE International Electrical Vehicle Conference provides a true cross-organizational platform to exchange information among thought leaders of the fast-growing electric mobility ecosystem and to discuss new trends in technology, engineering, standards and deployment aspects on a global scale. IEVC is a venue for electrical vehicle engineers, component and infrastructure system developers, manufacturers, utility experts, corporate executives, technical analysts, researchers, educators, entrepreneurs, venture capitalists, legislators, regulators and standardization experts to share a joint interest in the transformation of the transportation industry via electrification.

Of specific interest for this conference are papers related but not limited to the following areas:

- EV system architecture concepts for passenger, service and utility vehicles (BEV, PHEV, HEV, FCEV)
- Innovations in EV component design
- EV motor drives and controllers
- EV high voltage wiring
- Heating and cooling systems for EV’s
- Innovations in EV energy storage solutions (e.g. battery chemistry, ultra capacitor, fuel cell, battery management system)
- EV systems modeling, simulation and testing
- AC and DC conductive charging, wireless charging, smart charging, fast charging
- Power grid and renewable energy resource interfacing for EV mass deployment
- Design for manufacturing for EV mass production
- EV fleet and infrastructure asset management
- Design for EV maintainability
- Information Technology and Communication services for the EV ecosystem
- Global standards development for EVs and their impact on EV deployment, R&D and manufacturing
- Trends in EV deployment, supply chain and manufacturing
- EV-related educational programs for engineers, legislators and the public

More information on technical sessions, registration for the conference, paper submission, hotel reservations and the conference location is available on the IEVC 2012 website at http://electricvehicle.ieee.org/.

Extended abstract submission deadline is October 15, 2011.
Conference Calendar

This section lists upcoming ITS-related conferences, workshops, or exhibits. Contributions are welcome; please send announcements to itsconf@ce.unipr.it.

2011

August 23-25
IEEE 11th International Conference on ITS Telecommunications
St. Petersburg, Russia
http://www.itst2011.org/

August 28-September 2
18th IFAC World Congress
Milano, Italy
http://www.ifac2011.org/

September 5-8
IEEE Vehicular Technology Conference Fall 2011
San Francisco, CA

September 5-9
First International Symposium on Future Active Safety Technology
Tokyo, Japan
http://www.fast-zero11.info/

September 8,9
IIID Traffic & Transport 2011
Vienna Austria
http://www.iiid-expertforum.net/

September 14-16
16th International Conference on Image Analysis and Processing
Ravenna, Italy
http://avires.dimi.uniud.it/iciap201

September 25-30
IEEE/RSJ International Conference on Intelligent Robots and Systems
San Francisco, CA
http://www.iros2011.org/

October 5-7
International IEEE Conference on Intelligent Transportation Systems
Washington DC, USA
http://www.seas.gwu.edu/itsc2011/index.html

October 16-20
18th World Congress on Intelligent Transport Systems
Orlando, FL
http://www.itsworldcongress.org/

October 19-22
11th International Conference on Transport Systems Telematics
Katowice-Ustro, Poland

November 2-4
CAR 2011, The International Congress on Automotives
Pitesti, Romania
http://car.upit.ro/

November 7-9
The 2nd IASTED International Conference on Robotics
Pittsburgh, USA
http://www.iasted.org/conferences/home-752.html

November 23-26
KSAE Annual Conference and Exhibition
Dajeon Convention Center (Dajeon), Korea

2012

February, 24-26
VISIGRAPP 2012 7th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications
Rome, Italy
Submission due by October 11, 2011
http://www.visigrapp.org/

March 4-8
2012 IEEE International Electrical Vehicle Conference (IEVC)
Technology, Engineering, Standards – Challenges and Opportunities
Greenville, South Carolina, USA
http://electricvehicle.ieee.org
Extended Abstract Registration: 23:59 EST October 15, 2011

May 14-18
2012 IEEE International Conference on Robotics and Automation
St. Paul, USA
Submissions due by: September 16, 2011
http://www.icra2012.org/

June 3-7
2012 IEEE Intelligent Vehicles Symposium
Alcalá de Henares, Spain
www.robesafe.es/iv2012
Special Session Proposal: January 16th, 2012
Paper submission deadline: January 16th, 2012

July 24-27
2012 IEEE International Conference on Vehicular Electronics and Safety (ICVES12)
Istanbul, Turkey
http://www.ICVES2012.gsu.edu.tr
Paper submission deadline: Feb 15, 2012

September 16-19, 2012
2012 IEEE Intelligent Transportation Systems Conference
Anchorage, Alaska, USA
Submissions due by March 31, 2012
http://www.itsc2012.com
Announcements

Online Course: Introduction to Artificial Intelligence

Offered by Professors Sebastian Thrun and Peter Norvig
Oct - Dec 2011. Sign up now at ai-class.org

This course is the online version of Stanford CS211 Introduction to Artificial Intelligence. Students can sign up and take this course for free. All lectures are offered online, and students will have to take the same homework assignments and exams as Stanford students taking CS221 on campus. Anyone taking this course can interact with the instructors online. Plus, students are graded the same way as Stanford students, so you can compare your skills and knowledge to Stanford advanced undergraduate and graduate students. Enroll (for free) and learn about AI from two of the pioneers in the field. The course starts Oct 2, 2011. Sign up now at http://ai-class.org.
A Computational Market for Distributed Control of Urban Road Traffic Systems

Vasirani, M.; Ossowski, S.;

In the last decade, economic approaches based on computational markets have been proposed as a paradigm for the design and control of complex sociotechnical systems, such as urban road traffic systems. The control problem of an urban road traffic system can be modeled as a distributed resource-allocation problem to apply market-based techniques as solution methods. In this paper, we design a competitive computational market, where driver agents trade the use of the capacity inside the intersections with intersection manager agents. We show how the market dynamics influence the drivers’ behavior, leading to a more efficient use of the urban road traffic system, in terms of lower average travel times and less congestion.

Growing Artificial Transportation Systems: A Rule-Based Iterative Design Process

Jinyuan Li; Shuming Tang; Xiqin Wang; Wei Duan; Fei-Yue Wang;

Artificial transportation systems (ATS) are an extension of traffic simulations that deal with transportation issues from the complex systems perspective in a systematic and synthetic way. A rule-based iterative ATS design process is presented in this paper, together with a prototype based on the multiagent platform-Swarm and the methods and results of computational experiments conducted on it. Both emergence-based observation and statistical analysis are used to evaluate those results. This paper demonstrates the ability of ATS to generate traffic phenomena from simple consensus rules and the possibility of designing a growing ATS with readily available multiagent tools.

A Multiagent Approach to the Dynamic Enactment of Semantic Transportation Services

Fernandez, A.; Ossowski, S.;

Due to the inherent distribution of transportation management domains, multiagent approaches to the construction of decision support systems (DSSs) are popular. In this paper, we propose to complement multiagent DSS for transportation management by a service-oriented computing approach. In particular, we describe how organizational models can be used for service description and discovery. Our main contribution refers to the
integration of agent organizations and services for transportation management to facilitate the on-the-fly adaptation, fault tolerance, and extensibility of the intelligent transport systems (ITS) architecture. We apply our approach to two real-world applications in the transportation management domain.

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**A Game-Engine-Based Platform for Modeling and Computing Artificial Transportation Systems**

*Qinghai Miao; Fenghua Zhu; Yisheng Lv; Changjian Cheng; Cheng Chen; Xiaogang Qiu;*

A game-engine-based modeling and computing platform for artificial transportation systems (ATSs) is introduced. As an important feature, the artificial-population module (APM) is described in both its macroscopic and microcosmic aspects. In this module, each person is designed similarly to the actors in games. The traffic-simulation module (TSM) is another important module, which takes advantage of Delta3D to construct a 3-D simulation environment. All mobile actors are also managed by this module with the help of the dynamic-actor-layer (DAL) mechanism that is offered by Delta3D. The platform is designed as agent-oriented, modularized, and distributed. Both modules, together with components that are responsible for message processing, rules, network, and interactions, are organized by the game manager (GM) in a flexible architecture. With the help of the network component, the platform can be constructed to implement a distributed simulation. Finally, four experiments are introduced to show functions and features of the platform.

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**Integration of Driving and Traffic Simulation: Issues and First Solutions**

*Punzo, V.; Ciuffo, B.;*

Driving simulators are very suitable test beds for the evaluation and development of intelligent transportation systems (ITSs). However, the impact of such systems on the behavior of individual drivers can properly be analyzed through driving simulators only if autonomous vehicles in the driving scenario move according to the system under evaluation. This condition means that the simulation of the traffic surrounding the interactive vehicle should already take into account the driver's behavior as affected by the system under analysis. Currently, this “loop” is not properly tackled, because the effects on individuals and traffic are, in general, separately and, often, independently evaluated. The integration of traffic and driving simulations, instead, may provide a more consistent solution to this challenging evaluation problem. It also opens up new scenarios for enhancing the credibility of both traffic modeling and driving simulation and for their combined development. For instance, because drivers directly interact with driver/traffic models in a driving simulation environment, such models may also be tested against nonnormative behavior, and this case seems the only way to test driver/traffic models for safety applications. Based on this idea, this paper describes the integration of a driving simulation engine known as SCANeR and a traffic-flow microsimulation model known as AIMSUN. Methodological and technical issues of such integration are first presented, and future enhancements for higher consistency of the simulation environments are finally envisaged.
A Decentralized Approach for Anticipatory Vehicle Routing Using Delegate Multiagent Systems


Advanced vehicle guidance systems use real-time traffic information to route traffic and to avoid congestion. Unfortunately, these systems can only react upon the presence of traffic jams and not to prevent the creation of unnecessary congestion. Anticipatory vehicle routing is promising in that respect, because this approach allows directing vehicle routing by accounting for traffic forecast information. This paper presents a decentralized approach for anticipatory vehicle routing that is particularly useful in large-scale dynamic environments. The approach is based on delegate multiagent systems, i.e., an environment-centric coordination mechanism that is, in part, inspired by ant behavior. Antlike agents explore the environment on behalf of vehicles and detect a congestion forecast, allowing vehicles to reroute. The approach is explained in depth and is evaluated by comparison with three alternative routing strategies. The experiments are done in simulation of a real-world traffic environment. The experiments indicate a considerable performance gain compared with the most advanced strategy under test, i.e., a traffic-message-channel-based routing strategy.

Urban Transit Coordination Using an Artificial Transportation System

Lefei Li; Han Zhang; Xiaofang Wang; Wei Lu; Zongping Mu;

An urban transit system usually consists of several modes, including busses, streetcars, a subway, and light rail. Unfortunately, coordination among different modes remains a challenging problem. Difficulties arise when modifying the transit network structure on a strategic level or when synchronizing timetables on a tactical level. Traditional transit network design and timetabling intend to solve a network-optimization problem based on static origin-destination (OD) information, with passenger assignment as a subproblem. In this paper, we propose an artificial urban transit system (AUTS) based on agent-based modeling and simulation. With AUTS, which is a special type of artificial transportation system (ATS), we are able to dynamically model the passenger's behavior and route choice and use the system to predict transit demand on a simplified transit network. The AUTS has the following important potential applications: forecasting transit flow; setting key parameters for urban transit networks - such as service frequencies and the capacity of subway trains - evaluating alternative modifications to subway rail and bus routes; and predicting the impact of special/emergency events to the transit network. We create a demonstration system of the Beijing transit network and present its applications in experiments.

A Model of Risk-Sensitive Route-Choice Behavior and the Potential Benefit of Route Guidance
In this paper, we present a simulation-based investigation of the potential benefit of route-guidance information in the context of risk-sensitive travelers. We set up a simple two-route scenario where travelers are repeatedly faced with risky route-choice decisions. The risk averseness of the travelers is implicitly controlled through a generic utility function. We vary both the travelers' sensitivity toward risk and the equipment fraction with route-guidance devices and show that the benefits of guided travelers increase with their sensitivity toward risk.

**Autonomous Pedestrian Collision Avoidance Using a Fuzzy Steering Controller**

*Llorca, D.F.; Milanes, V.; Alonso, I.P.; Gavilan, M.; Daza, I.G.; Perez, J.; Sotelo, M.A.;*

Collision avoidance is one of the most difficult and challenging automatic driving operations in the domain of intelligent vehicles. In emergency situations, human drivers are more likely to brake than to steer, although the optimal maneuver would, more frequently, be steering alone. This statement suggests the use of automatic steering as a promising solution to avoid accidents in the future. The objective of this paper is to provide a collision avoidance system (CAS) for autonomous vehicles, focusing on pedestrian collision avoidance. The detection component involves a stereo-vision-based pedestrian detection system that provides suitable measurements of the time to collision. The collision avoidance maneuver is performed using fuzzy controllers for the actuators that mimic human behavior and reactions, along with a high-precision Global Positioning System (GPS), which provides the information needed for the autonomous navigation. The proposed system is evaluated in two steps. First, drivers' behavior and sensor accuracy are studied in experiments carried out by manual driving. This study will be used to define the parameters of the second step, in which automatic pedestrian collision avoidance is carried out at speeds of up to 30 km/h. The performed field tests provided encouraging results and proved the viability of the proposed approach.

**Incremental Online Object Learning in a Vehicular Radar-Vision Fusion Framework**

*Zhengping Ji; Luciw, M.; Juyang Weng; Shuqing Zeng;*

In this paper, we propose an object learning system that incorporates sensory information from an automotive radar system and a video camera. The radar system provides coarse attention for the focus of visual analysis on relatively small areas within the image plane. The attended visual areas are coded and learned by a three-layer neural network utilizing what is called in-place learning: Each neuron is responsible for the learning of its own processing characteristics within the connected network environment, through inhibitory and excitatory connections with other neurons. The modeled bottom-up, lateral, and top-down connections in the network enable sensory sparse coding, unsupervised learning, and supervised learning to occur concurrently. This paper is applied to learn two types of encountered objects in multiple outdoor driving settings. Cross-validation results show that the overall recognition
accuracy is above 95% for the radar-attended window images. In comparison with the un-coded representation and purely unsupervised learning (without top-down connection), the proposed network improves the overall recognition rate by 15.93% and 6.35%, respectively. The proposed system is also compared favorably with other learning algorithms. The result indicates that our learning system is the only one that is fit for incremental and online object learning in a real-time driving environment.

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**Reinforcement Learning With Function Approximation for Traffic Signal Control**

*Prashanth, L.A.; Bhatnagar, S.*

We propose, for the first time, a reinforcement learning (RL) algorithm with function approximation for traffic signal control. Our algorithm incorporates state-action features and is easily implementable in high-dimensional settings. Prior work, e.g., the work of Abdulhai, on the application of RL to traffic signal control requires full-state representations and cannot be implemented, even in moderate-sized road networks, because the computational complexity exponentially grows in the numbers of lanes and junctions. We tackle this problem of the curse of dimensionality by effectively using feature-based state representations that use a broad characterization of the level of congestion as low, medium, or high. One advantage of our algorithm is that, unlike prior work based on RL, it does not require precise information on queue lengths and elapsed times at each lane but instead works with the aforementioned described features. The number of features that our algorithm requires is linear to the number of signaled lanes, thereby leading to several orders of magnitude reduction in the computational complexity. We perform implementations of our algorithm on various settings and show performance comparisons with other algorithms in the literature, including the works of Abdulhai and Cools, as well as the fixed-timing and the longest queue algorithms. For comparison, we also develop an RL algorithm that uses full-state representation and incorporates prioritization of traffic, unlike the work of Abdulhai. We observe that our algorithm outperforms all the other algorithms on all the road network settings that we consider.

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**Decoupled Conflict-Resolution Procedures for Decentralized Air Traffic Control**

*Devasia, S.; Iamratankul, D.; Chatterji, G.; Meyer, G.*

This paper addresses the challenge of designing provably safe conflict-resolution procedures (CRPs) that are decentralized and decoupled from each other. The main contribution of this paper is identifying necessary and sufficient conditions to decouple CRPs. Additionally, this paper demonstrates the existence of decentralized en-route CRPs that satisfy the identified decoupling conditions for each local conflict and, thereby, guarantee global conflict resolution. An advantage of the proposed CRPs is that they do not require a reduction in the aircraft flow levels in the intersecting routes for conflict resolution, which can aid in increasing the efficiency of en-route air traffic control.
Balancing of Queues or Waiting Times on Metered Dual-Branch On-Ramps

Papamichail, I.; Papageorgiou, M.;

Metered dual-branch on-ramps may feature strongly different (relative) queues or waiting times on each of their branches. Different methods are developed to balance the queues or relative queues or waiting times on both branches. The methods are evaluated and compared based on extensive microscopic simulations. As a by-product, a waiting-time estimation and control method for metered ramps is also developed. The developed methods are implemented in the operational ramp-metering system of the Monash Freeway (Melbourne, Australia). The developed concepts are also applicable to other kinds of traffic control problems involving merging traffic streams.

An Intelligent Multifeature Statistical Approach for the Discrimination of Driving Conditions of a Hybrid Electric Vehicle

Xi Huang; Ying Tan; Xingui He;

As a new kind of vehicle with low fuel cost and low emissions, the hybrid electric vehicle (HEV) has been paid much attention in recent years. The key technique in the HEV is adopting the optimal control strategy for the best performance. As the premise, correct driving condition discrimination has an extremely important significance. This paper proposes an intelligent multifeature statistical approach to automatically discriminate the driving condition of the HEV. First, this approach periodically samples the driving cycle. Then, it extracts multiple statistical features and tests their significance by statistical analysis to select effective features. Afterward, it applies a support vector machine (SVM) and other machine-learning methods to intelligently and automatically discriminate the driving conditions. Compared with others, the proposed approach can compute fast and discriminate in real time during the whole HEV running mode. In our experiments, it reaches an accuracy value of 95%. As a result, our approach can completely mine the valid information from the data and extract multiple features that have clear meanings and significance. Finally, according to the prediction experiment by a neural network, the fitting experiment by the autoregressive moving average model, and the simulation results of the control strategy, it turns out that our proposed approach raises the efficiency of considerably controlling the HEV.

Variational Inference for Infinite Mixtures of Gaussian Processes With Applications to Traffic Flow Prediction

Shiliang Sun; Xin Xu;

This paper proposes a new variational approximation for infinite mixtures of Gaussian processes. As an extension of the single Gaussian process regression model, mixtures of
Gaussian processes can characterize varying covariances or multimodal data and reduce the deficiency of the computationally cubic complexity of the single Gaussian process model. The infinite mixture of Gaussian processes further integrates a Dirichlet process prior to allowing the number of mixture components to automatically be determined from data. We use variational inference and a truncated stick-breaking representation of the Dirichlet process to approximate the posterior of hidden variables involved in the model. To fix the hyperparameters of the model, the variational EM algorithm and a greedy algorithm are employed. In addition to presenting the variational infinite-mixture model, we apply it to the problem of traffic flow prediction. Experiments with comparisons to other approaches show the effectiveness of the proposed model.

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**Automatic Road Environment Classification**

*Tang, I.; Breckon, T.P.*

The ongoing development of autonomous vehicles and adaptive vehicle dynamics present in many modern vehicles has generated a need for road environment classification - i.e., the ability to determine the nature of the current road or terrain environment from an onboard vehicle sensor. In this paper, we investigate the use of a low-cost camera vision solution capable of urban, rural, or off-road classification based on the analysis of color and texture features extracted from a driver’s perspective camera view. A feature set based on color and texture distributions is extracted from multiple regions of interest in this forward-facing camera view and combined with a trained classifier approach to resolve two road-type classification problems of varying difficulty - {off-road, on-road} environment determination and the additional multiclass road environment problem of {off-road, urban, major/trunk road and multilane motorway/carriageway}. Two illustrative classification approaches are investigated, and the results are reported over a series of real environment data. An optimal performance of ~90% correct classification is achieved for the {off-road, on-road} problem at a near real-time classification rate of 1 Hz.

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**Automatic Traffic Signs and Panels Inspection System Using Computer Vision**

*Gonzalez, A.; Garrido, M.A.; Llorca, D.F.; Gavilan, M.; Fernandez, J.P.; Alcantarilla, P.F.; Parra, I.; Herranz, F.; Bergasa, L.M.; Sotelo, M.A.; Revenga de Toro, P.*

Computer vision techniques applied to systems used on road maintenance, which are related either to traffic signs or to the road itself, are playing a major role in many countries because of the higher investment on public works of this kind. These systems are able to collect a wide range of information automatically and quickly, with the aim of improving road safety. In this context, the correct visibility of traffic signs and panels is vital for the safety of drivers. This paper describes an approach to the VISUAL Inspection of Signs and panEls ("VISUALISE"), which is an automatic inspection system, mounted onboard a vehicle, which performs inspection tasks at conventional driving speeds. VISUALISE allows for an improvement in the awareness of the road signaling state, supporting planning and decision...
making on the administration's and infrastructure operators' side. A description of the main computer vision techniques and some experimental results obtained from thousands of kilometers are presented. Finally, the conclusions of the system are described.

**Automated On-Ramp Merging System for Congested Traffic Situations**

*Milanes, V.; Godoy, J.; Villagra, J.; Perez, J.*

Traffic merging in urban environments is one of the main causes of traffic congestion. From the driver's point of view, the difficulty arises along the on-ramp where the merging vehicle's driver has to discern whether he should accelerate or decelerate to enter the main road. In parallel, the drivers of the vehicles already on the major road may have to modify their speeds to permit the entrance of the merging vehicle, thus affecting the traffic flow. This paper presents an approach to merging from a minor to a major road in congested traffic situations. An automated merging system that was developed with two principal goals, i.e., to permit the merging vehicle to sufficiently fluidly enter the major road to avoid congestion on the minor road and to modify the speed of the vehicles already on the main road to minimize the effect on that already congested main road, is described. A fuzzy controller is developed to act on the vehicles' longitudinal control - throttle and brake pedals - following the references set by a decision algorithm. Data from other vehicles are acquired using wireless vehicle-to-infrastructure (V2I) communication. A system installed in the infrastructure that is capable of assessing road traffic conditions in real time is responsible for transmitting the data of the vehicles in the surrounding area. Three production vehicles were used in the experimental phase to validate the proposed system at the facilities of the Centro de Automática y Robótica with encouraging results.

**A Multiple-Goal Reinforcement Learning Method for Complex Vehicle Overtaking Maneuvers**

*Ngai, D.C.K.; Yung, N.H.C.*

In this paper, we present a learning method to solve the vehicle overtaking problem, which demands a multitude of abilities from the agent to tackle multiple criteria. To handle this problem, we propose to adopt a multiple-goal reinforcement learning (MGRL) framework as the basis of our solution. By considering seven different goals, either Q-learning (QL) or double-action QL is employed to determine action decisions based on whether the other vehicles interact with the agent for that particular goal. Furthermore, a fusion function is proposed according to the importance of each goal before arriving to an overall but consistent action decision. This offers a powerful approach for dealing with demanding situations such as overtaking, particularly when a number of other vehicles are within the proximity of the agent and are traveling at different and varying speeds. A large number of overtaking cases have been simulated to demonstrate its effectiveness. From the results, it can be concluded that the proposed method is capable of the following: 1) making correct action decisions for overtaking; 2) avoiding collisions with other vehicles; 3) reaching the target at reasonable time; 4) keeping almost steady speed; and 5) maintaining almost steady heading angle. In
addition, it should also be noted that the proposed method performs lane keeping well when not overtaking and lane changing effectively when overtaking is in progress.

**Interval Macroscopic Models for Traffic Networks**

Gning, A.; Mihaylova, L.; Boel, R.K.

The development of real-time traffic models is of paramount importance for the purposes of optimizing traffic flow. Inspired by the compositional model (CM) and the METANET model, this paper proposes an interval approach for macroscopic traffic modeling. We develop an interval CM (ICM) and an interval implementation of the METANET model (IMETANET) that provide a natural way of predicting traffic flows without the assumption of uniform distribution of vehicles in a cell. The interval macroscopic models are suitable for real-time applications in road networks and can be part of road traffic surveillance and control systems. The performances of the interval approaches are investigated for both the ICM and the IMETANET models. The efficiency of the interval models is demonstrated over simulated data, and as well as over real traffic data from Motorway Incident Detection and Automatic Signalling (MIDAS) data sets from the United Kingdom.

**Prediction Intervals to Account for Uncertainties in Travel Time Prediction**


The accurate prediction of travel times is desirable but frequently prone to error. This is mainly attributable to both the underlying traffic processes and the data that are used to infer travel time. A more meaningful and pragmatic approach is to view travel time prediction as a probabilistic inference and to construct prediction intervals (PIs), which cover the range of probable travel times travelers may encounter. This paper introduces the delta and Bayesian techniques for the construction of PIs. Quantitative measures are developed and applied for a comprehensive assessment of the constructed PIs. These measures simultaneously address two important aspects of PIs: 1) coverage probability and 2) length. The Bayesian and delta methods are used to construct PIs for the neural network (NN) point forecasts of bus and freeway travel time data sets. The obtained results indicate that the delta technique outperforms the Bayesian technique in terms of narrowness of PIs with satisfactory coverage probability. In contrast, PIs constructed using the Bayesian technique are more robust against the NN structure and exhibit excellent coverage probability.

**Real-Time Freeway Network Traffic Surveillance: Large-Scale Field-Testing Results in Southern Italy**

Yibing Wang; Coppola, P.; Tzimitsi, A.; Messmer, A.; Papageorgiou, M.; Nuzzolo, A.;
This paper reports on some large-scale field-testing results of a real-time freeway network traffic surveillance tool that has recently been developed to enable a number of real-time traffic surveillance tasks. This paper first introduces the related network traffic flow model and the approaches employed to traffic state estimation, traffic state prediction, and incident alarm. The field testing of the tool for these surveillance tasks in the A3 freeway of 100 km between Naples and Salerno in southern Italy is then reported in some detail. The results obtained are quite satisfactory and promising for further future implementations of the tool.

Analytical Evaluation of the Error in Queue Length Estimation at Traffic Signals From Probe Vehicle Data

Comert, G.; Cetin, M.;

Probe vehicle data are increasingly becoming more attractive for real-time system state estimation in transportation networks. This paper presents analytical models for the real-time estimation of queue lengths at traffic signals using the fundamental information (i.e., location and time) that probe vehicles provide. For a single queue with Poisson arrivals, analytical models are developed to evaluate how error changes in queue length estimation as the percentage of probe vehicles in the traffic stream varies. When the overflow queue is ignored, a closed-form solution is obtained for the variance of the estimation error. For the more general case with the overflow queue, a formulation for the error variance is presented, which requires the marginal probability distribution of the overflow queue as the input. In addition, an approximate model is presented for the latter case, which yields results that are comparable with the exact solution. Overall, the formulations presented here can be used to assess the error in queue length estimation from probe data without conducting simulation runs for various scenarios of probe vehicle market-penetration rates and congestion levels.

Online Driver Distraction Detection Using Long Short-Term Memory


Lane-keeping assistance systems for vehicles may be more acceptable to users if the assistance was adaptive to the driver's state. To adapt systems in this way, a method for detection of driver distraction is needed. Thus, we propose a novel technique for online detection of driver's distraction, modeling the long-range temporal context of driving and head tracking data. We show that long short-term memory (LSTM) recurrent neural networks enable a reliable subject-independent detection of inattention with an accuracy of up to 96.6%. Thereby, our LSTM framework significantly outperforms conventional approaches such as support vector machines (SVMs).

Vehicle Detection and Tracking in Car Video Based on Motion Model
This paper aims at real-time in-car video analysis to detect and track vehicles ahead for safety, autodriving, and target tracing. This paper describes a comprehensive approach to localizing target vehicles in video under various environmental conditions. The extracted geometry features from the video are continuously projected onto a 1-D profile and are constantly tracked. We rely on temporal information of features and their motion behaviors for vehicle identification, which compensates for the complexity in recognizing vehicle shapes, colors, and types. We probabilistically model the motion in the field of view according to the scene characteristic and the vehicle motion model. The hidden Markov model (HMM) is used to separate target vehicles from the background and track them probabilistically. We have investigated videos of day and night on different types of roads, showing that our approach is robust and effective in dealing with changes in environment and illumination and that real-time processing becomes possible for vehicle-borne cameras.

Driver Inattention Monitoring System for Intelligent Vehicles: A Review

Yanchao Dong; Zhencheng Hu; Uchimura, K.; Murayama, N.;

In this paper, we review the state-of-the-art technologies for driver inattention monitoring, which can be classified into the following two main categories: 1) distraction and 2) fatigue. Driver inattention is a major factor in most traffic accidents. Research and development has actively been carried out for decades, with the goal of precisely determining the drivers' state of mind. In this paper, we summarize these approaches by dividing them into the following five different types of measures: 1) subjective report measures; 2) driver biological measures; 3) driver physical measures; 4) driving performance measures; and 5) hybrid measures. Among these approaches, subjective report measures and driver biological measures are not suitable under real driving conditions but could serve as some rough ground-truth indicators. The hybrid measures are believed to give more reliable solutions compared with single driver physical measures or driving performance measures, because the hybrid measures minimize the number of false alarms and maintain a high recognition rate, which promote the acceptance of the system. We also discuss some nonlinear modeling techniques commonly used in the literature.

EasiTia: A Pervasive Traffic Information Acquisition System Based on Wireless Sensor Networks

Rui Wang; Lei Zhang; Rongli Sun; Jibing Gong; Li Cui;

Traffic information acquisition is often implemented by video cameras or inductive loops, which is expensive or inconvenient from installation and maintenance perspectives. We designed and implemented a pervasive traffic information acquisition system based on wireless sensor networks called EasiTia. Unlike existing solutions, the implementation of the system does not require extra devices in the road infrastructure or vehicle, nor the excavation of the road surfaces. EasiTia can easily be deployed at roadsides. It is of low cost and resource efficient. Our contributions are given as follows: 1) To deal with low signal-to-
noise ratios (SNRs) and stochastic disturbances in traffic information acquisition, we proposed and implemented a cross-correlation-based vehicle-detection algorithm. 2) To resolve the problems of data association, vehicle velocity calculation, and vehicle identification, we proposed a collaborative traffic information processing mechanism in the EasiTia system. Based on real road environment experimental analysis, we demonstrate that EasiTia is an applicable and cost-effective candidate for a pervasive traffic information acquisition system.

Comments on “Optimal Fault-Tolerant Path-Tracking Control for 4WS4WD Electric Vehicles”

Potluri, R.;

In this correspondence, we point out an error in the mathematical model of a four-wheeled steering and four-wheeled drive vehicle in the paper “Optimal Fault-Tolerant Path-Tracking Control for 4WS4WD Electric Vehicles" (IEEE Trans. Intell. Transp. Syst., vol. 11, no. 1, pp. 237-243, Mar. 2010). This model forms the basis of the above paper. We derive the correct version of the model.

Impact of Ambulance Dispatch Policies on Performance of Emergency Medical Services

Cheng Siong Lim; Mamat, R.; Braunl, T.;

In ambulance location models, fleet size and ambulance location sites are two critical factors that emergency medical service (EMS) managers can control to ensure efficient delivery of the system. The ambulance relocation and dispatch policies that are studied in dynamic ambulance relocation models also significantly contribute to improving the response time of EMS. In this paper, we review dynamic ambulance relocation models from the perspective of dispatch policies. The connection between the reviewed ambulance dispatch policies and real-life policies is highlighted. Our ambulance model is based on the modified maximal covering location problem (MCLP). It is used to examine the commonly used dispatch policy and the proposed method of free-ambulance exploitation to further improve urgent call response time. Simulation results show that the proposed method can reduce the response time of urgent calls, especially during low-ambulance-supply period. We also compared the performance of EMS with and without reroute-enabled dispatch.

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Simulation of the Effects of Different Urban Environments on GPS Performance Using Digital Elevation Models and Building Databases

Costa, E.;
A simulation model is proposed to represent the channel of the Global Positioning System (GPS). Initially, a digital elevation model, building databases, and a vegetation model are processed to generate azimuth–elevation maps of path states (clear, shadowed, and blocked) for a large number of observers. At each simulation step, satellite positions are updated, and azimuths and elevations of paths from observers to satellites are calculated. Signal strengths and range errors are assigned to paths with the aid of random number generators for each path state. This information is processed to determine the statistics of the channel. It will be shown that model predictions are able to display good agreement with the results from an experimental campaign carried out for validation purposes. The simulation model will then be applied to a large number of observers deployed along two routes in densely urbanized areas in the city of Rio de Janeiro, Brazil (22.8$^{\circ}$S, 43.3$^{\circ}$W), with buildings displaying different height distributions to quantitatively show how the most probable number of available satellites, the probability that four or more satellites are simultaneously available (that is, that positions can be fixed), and the position errors change with the average building height and for vehicles in static and kinematic modes. In combination with the comparison between measurement and prediction results, this indicates that the simulation model is an efficient and flexible tool for studying and planning satellite-based location and navigation applications with accuracy and sensitivity, which will be used in future developments of mitigation techniques of multipath effects, leading to improved performance of intelligent transportation systems.

**DHP Method for Ramp Metering of Freeway Traffic**

*Zhao, D.; Bai, X.; Wang, F.-Y.; Xu, J.; Yu, W.*

This paper presents the design of dual heuristic programming (DHP) for the optimal coordination of ramp metering in freeway systems. Specifically, we implement the DHP method to solve both recurrent and nonrecurrent congestions with queuing consideration. A coordinated neural network controller is achieved by the DHP method with traffic models. Then, it is used for verifications with different traffic scenarios. Simulation studies performed on a hypothetical freeway indicate that the achieved neural controller maintains good control performance when compared with the classical ramp metering algorithm ALINEA. We emphasize that these neural controllers can be developed offline by using approximate traffic models. This offline mechanism avoids the risks of instability that incur during continual online training. We also discuss some real-time implementation issues.

**Experimental Evaluation of Autonomous Driving Based on Visual Memory and Image-Based Visual Servoing**

*Diosi, A.; Šegvič, S.; Remazeilles, A.; Chaumette, F.*

In this paper, the performance of a topological–metric visual-path-following framework is investigated in different environments. The framework relies on a monocular camera as the only sensing modality. The path is represented as a series of reference images such that each neighboring pair contains a number of common landmarks. Local 3-D geometries are reconstructed between the neighboring reference images to achieve fast feature prediction. This condition allows recovery from tracking failures. During navigation, the robot is
controlled using image-based visual servoing. The focus of this paper is on the results from a number of experiments that were conducted in different environments, lighting conditions, and seasons. The experiments with a robot car show that the framework is robust to moving objects and moderate illumination changes. It is also shown that the system is capable of online path learning.

An Advanced Cooperative Path Prediction Algorithm for Safety Applications in Vehicular Networks
Lytrivis, P.; Thomaidis, G.; Tsogas, M.; Amditis, A.;

Vehicular ad hoc networks (VANETs) are in the heart of current and future automotive research. Most of the current vehicular safety applications are based on sensors installed on the vehicle, e.g., radars and lasercanners. Due to the evolution of wireless networks, there is a tendency to exploit the cooperation among vehicles to enhance road safety through the related applications. Path prediction of a driver's own vehicle and other vehicles is crucial for road safety. Path prediction can assist the driver in having an enhanced perception of the road environment and of the intention of other neighboring drivers. In this paper, an advanced cooperative path prediction algorithm is presented. This algorithm gathers position, velocity, acceleration, heading, and yaw rate measurements from all connected vehicles to calculate their future paths. In addition, map data with regard to the road geometry and, in particularly, the road curvature are used to enhance the path prediction algorithm. Comparative results of the path prediction, with and without wireless communications, are discussed. In addition, the algorithm is adapted for use in the emergency-electronic-brake-lights application. The results of this adaptation are also presented. This paper is another contribution in highlighting the advantages and, at the same time, the challenges of using communications among road users.

Stochastic Model-Based Heuristics for Fast Field of View Loss Recovery in Urban Traffic Management Through Networks of Video Cameras
Istin, C.; Pescaru, D.; Doboli, A.;

This paper proposes two new heuristic methods for real-time distributed traffic monitoring through video cameras. The goal is to minimize the field-of-view (FOV) loss of the cameras due to dynamic obstacles while considering the timing constraints of the application. The methods utilize different cost functions to select the cameras used in FOV loss recovery. The cost functions are based on a new stochastic model for traffic monitoring, including the dynamics of mobile obstacles, unreliable communication, and resolution and timing constraints. The first cost function addresses deterministic situations by capturing the tradeoff between the quality of recovery and the imposed timing constraints. The second cost function captures stochastic aspects, such as a camera being obstructed by obstacles or experiencing data losses due to unreliable communication. Experiments show that the two methods offer reliable FOV loss recovery for a large variety of conditions. The methods are fast and scale well with the number of monitored cars and cameras. The average FOV loss
recovery of the deterministic heuristic is 52%, but the resulting coverage remains close to 100% most of the time, whereas without the recovery scheme, the coverage drops to about 60% about half the time. For time-constrained unreliable communication, the stochastic heuristic offers coverage that is only about 15% less than if communication is unrestricted.

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**Time Synchronization Errors in Loosely Coupled GPS-Aided Inertial Navigation Systems**

*Skog, I.; Händel, P.*

The effects of data time synchronization errors in a loosely coupled Global-Positioning-System (GPS)-aided inertial navigation system (INS) are studied and quantified in terms of the increased mean square error (MSE) of the navigation solution. An expression for evaluating the MSE of the navigation solution, given the vehicle trajectory and the model of the INS error dynamics, is derived. Thereafter, a software-based time synchronization method, where the time synchronization error is included as a state to be estimated by the data integration filter, is proposed. A practical approach to the implementation of the proposed time synchronization method is also briefly described. Moreover, an expression for the MSE of the navigation solution in the system that employs the proposed synchronization method is derived. Finally, through simulations and tests with real-world data, the correctness of the derived MSE expressions is validated, and the application of the proposed synchronization method is shown. The test results show that, with the proposed synchronization approach, a data time synchronization, which is accurate to the order of a few milliseconds, can be achieved.

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**A New Multiobjective Signal Optimization for Oversaturated Networks**

*Lertworawanich, P.; Kuwahara, M.; Miska, M.*

This paper presents a new methodology for optimizing the signal timing controls of oversaturated networks based on the cell transmission model and a goal programming technique with multiple objectives. The proposed model accounts for intersection spillovers, equity in delays, and system throughputs. This new formulation is solved by genetic algorithms to obtain signal timing plans. A case study with a nine-intersection network and a comparison between the proposed model and the throughput-maximizing strategy are examined. It is found that the new method can efficiently minimize spillovers, balance delay equity, and provide reasonable system throughputs in their respective order for oversaturated networks. The result also indicates that the throughput-maximizing strategy does not always yield minimum spillovers for oversaturated networks and occasionally provides a larger difference in average link delay at a spillover intersection than the proposed model does.
A Mathematical Model for Urban Traffic and Traffic Optimization Using a Developed ICA Technique

Khorani, V.; Razavi, F.; Disfani, V. R.;

This paper proposes a mathematical model for the traffic of metropolises, which can further be optimized to efficiently control the traffic. This model takes into account all the parameters that can have an effect on the traffic, e.g., escape rates (ERs) of intersections and paths. Moreover, to optimize the proposed model, the imperialist competitive algorithm (ICA) is used. It will be shown that the optimization of the mathematical model proposed in this paper for urban traffic not only reduces the traffic but prevents any kind of traffic standstill in the city as well. In addition, this method uniformly distributes the traffic in the city so that the maximum potential of the city’s infrastructure can be used. This model makes it possible to reduce the number of cars in the under-construction streets through a manual change in a coefficient called the ER. Finally, the mathematical model is simulated and analyzed for two cities with nine and 18 intersections using non-real-time and real-time simulations. These simulations are carried out on software developed in accordance with the optimization presented in this paper (http://tinyurl.com/TSBVK). The results obtained from the simulations demonstrate that the model proposed is appropriate for traffic control and is flexible enough to be expanded for all kinds of infrastructure.

Predicting Pedestrian Counts in Crowded Scenes With Rich and High-Dimensional Features

Zhang, J.; Tan, B.; Sha, F.; He, L.;

Estimating the number of pedestrians in surveillance images and videos has important applications in intelligent transportation systems. This problem is particularly challenging when the scenes are densely crowded, in which the techniques of tracking a single pedestrian has limited effectiveness. Alternative approaches employ statistical learning algorithms to infer pedestrian counts directly from visual features computed on images or scenes. In this paper, we describe a system for predicting pedestrian counts that significantly extends the utility of those ideas. Our approach incorporates a richer set of features for statistical modeling. While these features give rise to regression problems in a high-dimensional space, we leverage learning techniques to reduce dimensionality while still attaining high accuracy for predicting the number of pedestrians. Empirical results have validated our strategy. Specifically, our system outperforms state-of-the-art methods on standard benchmark tasks by a large margin.

Optimization of Taxiway Routing and Runway Scheduling

Clare, G. L.; Richards, A. G.;

This paper describes a mixed-integer linear programming optimization method for the coupled problems of airport taxiway routing and runway scheduling. The receding-horizon formulation and the use of iteration in the avoidance constraints allows the scalability of the
baseline algorithm presented, with examples based on Heathrow Airport, London, U.K., which contains up to 240 aircraft. The results show that average taxi times can be reduced by half, compared with the first-come–first-served approach. The main advantage is shown with the departure aircraft flow. Comparative testing demonstrates that iteration reduces the computational demand of the required separation constraints while introducing no loss in performance.

A Recursive Multiscale Correlation-Averaging Algorithm for an Automated Distributed Road-Condition-Monitoring System

Ndoye, M.; Barker, A. M.; Krogmeier, J. V.; Bullock, D. M.;

A signal processing approach is proposed to jointly filter and fuse spatially indexed measurements captured from many vehicles. It is assumed that these measurements are influenced by both sensor noise and measurement indexing uncertainties. Measurements from low-cost vehicle-mounted sensors (e.g., accelerometers and Global Positioning System (GPS) receivers) are properly combined to produce higher quality road roughness data for cost-effective road surface condition monitoring. The proposed algorithms are recursively implemented and thus require only moderate computational power and memory space. These algorithms are important for future road management systems, which will use on-road vehicles as a distributed network of sensing probes gathering spatially indexed measurements for condition monitoring, in addition to other applications, such as environmental sensing and/or traffic monitoring. Our method and the related signal processing algorithms have been successfully tested using field data.

Vehicle Re-Identification With Dynamic Time Windows for Vehicle Passage Time Estimation

Lin, W.-H.;

A simple method for vehicle re-identification to generate vehicle passage times with loop data is developed. The method departs from other existing methods for vehicle passage time estimation: 1) It handles vehicle signatures one at a time and evaluates each vehicle observed only once. 2) The commonly used prespecified time window is replaced by a dynamic list of vehicles to be matched. 3) Vehicle matching is based on a combined estimation model that integrates spot traffic data with spatial vehicle data. The performance of the algorithm was tested with field data. Furthermore, to examine the effect of some of the assumptions on the performance of the algorithm, we compared the result with that obtained from an offline optimization model based on a spatial constraint that considers as many vehicles as possible for matching. The proposed method is particularly suitable for real-time applications since it can be easily implemented with little calibration effort and is computationally efficient.
Background Foreground Segmentation for SLAM

Corcoran, P.; Winstanley, A.; Mooney, P.; Middleton, R.;

To perform simultaneous localization and mapping (SLAM) in dynamic environments, static background objects must first be determined. This condition can be achieved using a priori information in the form of a map of background objects. Such an approach exhibits a causality dilemma, because such a priori information is the ultimate goal of SLAM. In this paper, we propose a background foreground segmentation method that overcomes this issue. Localization is achieved using a robust iterative closest point implementation and vehicle odometry. Background objects are modeled as objects that are consistently located at a given spatial location. To improve robustness, classification is performed at the object level through the integration of a new segmentation method that is robust to partial object occlusion.

Modeling Evacuation of a Transport System: Application of a Multimodal Mesoscopic Dynamic Traffic Assignment Model

Di Gangi, M.;

In this paper, the analysis of a transportation system under emergency conditions due to hazardous events is considered. To assess the effects on the analyzed transport network, an extension to a mesoscopic dynamic traffic assignment (DTA) model was developed to determine quantitative indicators for estimating the exposure component of the total risk incurred by the transport networks in an area. In particular, a new version that is able to allow for multimodal networks and to consider network reliability was introduced. To give a practical example of the proposed model, it has been applied to two real networks, studying evacuation in the hypothesis that in the event of a calamity the population in the area follows the instructions proposed by the municipal civil protection plan. The work shows how adequate quantitative methodologies based on a dynamic approach can be a useful tool to support the process of evacuation planning at several scales.

Identification and Analysis of Queue Spillovers in City Street Networks

Geroliminis, N.; Skabardonis, A.;

We propose a methodology for identifying queue spillovers in city street networks with signalized intersections using data from conventional surveillance systems, such as counts and occupancy from loop detectors. The key idea of the proposed methodology is that when spillovers from a downstream link block vehicle departures from the upstream signal line, queues discharge at rates smaller than the saturation flow. The application of the methodology on an arterial site and the comparison with field data show that it consistently identifies spillovers in urban networks with signal-controlled intersections. The method is extended to account for the variations in vehicle lengths. We also investigate the significant effect of spillovers in congestion and show that a macroscopic diagram that connects spillovers with vehicle density exists in large-scale congested urban networks.
The Benefits of Dense Stereo for Pedestrian Detection

Keller, C. G.; Enzweiler, M.; Rohrbach, M.; Llorca, D. F.; Schnörr, C.; Gavrila, D. M.;

This paper presents a novel pedestrian detection system for intelligent vehicles. We propose the use of dense stereo for both the generation of regions of interest and pedestrian classification. Dense stereo allows the dynamic estimation of camera parameters and the road profile, which, in turn, provides strong scene constraints on possible pedestrian locations. For classification, we extract spatial features (gradient orientation histograms) directly from dense depth and intensity images. Both modalities are represented in terms of individual feature spaces, in which discriminative classifiers (linear support vector machines) are learned. We refrain from the construction of a joint feature space but instead employ a fusion of depth and intensity on the classifier level. Our experiments involve challenging image data captured in complex urban environments (i.e., undulating roads and speed bumps). Our results show a performance improvement by up to a factor of 7.5 at the classification level and up to a factor of 5 at the tracking level (reduction in false alarms at constant detection rates) over a system with static scene constraints and intensity-only classification.

Utilization of Fuel Consumption Data in an Ecodriving Incentive System for Heavy-Duty Vehicle Drivers

Liimatainen, H.;

Driver behavior is one of the greatest factors determining fuel consumption and, thus, carbon dioxide emissions from a heavy-duty vehicle. The difference in fuel consumption can be up to 30%, depending on the driver. Education, monitoring, and feedback are ways of guiding drivers toward more fuel-efficient driver behavior. An incentive system related to fuel consumption is one way of giving feedback. The greatest challenge facing transportation companies with such incentive systems is fair measurement of the driver's fuel consumption. This paper focuses on that challenge. As a result of this paper, a method for utilizing fuel consumption data in an incentive system has been developed for the case company Tampere City Transport. Measurement of fuel consumption is based on groups, which are formed by runs with similar vehicles, routes, and time of day. The individual driver's average fuel consumption in a specific group is then compared with the average fuel consumption of all drivers in that specific group.

Hidden-Markov-Model-Based Segmentation Confidence Applied to Container Code Character Extraction

Chen, M.; Wu, W.; Yang, X.; He, X.;

Automatic container code recognition (ACCR) has become an indispensable aspect of current intelligent container management systems. In real applications, an ACCR module sometimes
faces the problem of missing characters, i.e., not all the 11 container code characters (CCCs) appear in the input image. However, a few of the present methods can process container code images with missing characters. Therefore, a method is proposed to extract the CCCs for both the situation wherein all the 11 CCCs appear in an image and the situation wherein some CCCs are missing. In this method, hidden Markov model (HMM)-based segmentation confidence is proposed to describe the probability of the segmented characters belonging to the container code. Based on the segmentation confidence, the segmented characters are determined whether they belong to the container code or not, and if there are some characters missing, the positions of these characters can be estimated. Various container code images have been used to test the proposed method. The results of the tests show that the method is effective.

**Improving Propagation Modeling in Urban Environments for Vehicular Ad Hoc Networks**

*Hosseini Tabatabaei, S. A.; Fleury, M.; Qadri, N. N.; Ghanbari, M.*

Developing applications, particularly real-time applications, for wireless vehicular ad hoc networks (VANETs) requires a reasonable assurance of the likely performance of the network, at the least in terms of packet loss ratios and end-to-end delay. Because wireless propagation strongly influences performance, particularly in an urban environment, this paper improves on simpler propagation models for simulations by augmenting ray-tracing-derived models of propagation. In the non-line-of-sight (NLOS) component, the propagation distance is more closely calculated according to the reflection distance, the effect of roadside obstacles is included, and for the modeling of fast fading, a phase factor is introduced, all without necessarily overly increasing the computational load. In the line-of-sight (LOS) component, as well as the roadside obstacle modeling, single and double reflections from roadside buildings are added to the standard two-ray ground-propagation model, the distribution of vehicles within a street segment is used to more closely model the ground reflection ray, and the reflection coefficient is also accordingly adjusted to account for reflections from vehicles. The results have been compared with widely used measurement studies of city streets in the literature, which have confirmed the overall advantage of the improvements, particularly in the case of the NLOS component. A simulation case study shows that, in general, optimistic performance predictions of packet loss occur with the two-ray ground-propagation model when indiscriminately applied. This paper therefore represents a way forward for VANET wireless channel modeling in simulations.

**Metro Traffic Regulation by Adaptive Optimal Control**

*Lin, W.-S.; Sheu, J.-W.*

Automatic train regulation, which is a core function of the signaling system, concerns the headway/schedule adherence that dominates the transport capacity and punctuality of a metro line. The main difficulty in synthesizing a traffic regulator is that an accurate traffic model is inaccessible. This paper presents an adaptive optimal control (AOC) algorithm that can approximate the optimal traffic regulator by learning traffic data with artificial neural
networks. The AOC algorithm is derived from the discrete minimum principle and organized in the critic–actor architecture of reinforcement learning to carry out sequential optimization forward in time. The critic network receives no signal from the traffic model so that the prediction of the future cost and the optimization of the traffic regulator are not biased by modeling errors. The efficacy of the AOC algorithm in the traffic regulation is verified in a simulated system using traffic data acquired from a real metro line.

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**Discovering Traffic Bottlenecks in an Urban Network by Spatiotemporal Data Mining on Location-Based Services**


Discovering traffic bottlenecks and taking action to alleviate congestion to enhance the performance of a traffic network are the most important tasks for the advanced traffic management system in the intelligent transportation system. However, traffic bottlenecks are affected by several factors and vary with spatial and temporal environments, which makes them difficult to define and discover. This paper proposes a three-phase spatiotemporal traffic bottleneck mining (STBM) model, including several spatiotemporal traffic patterns and STBM algorithms that use the raw data of location-based services to discover urban network spatiotemporal traffic bottlenecks. This paper implements an STBM prototype system based on a taxi dispatching system in a Taipei, Taiwan, urban network. The experimental results show that the congestion prediction capability of the proposed heuristic methods (congestion-propagation heuristic) is up to 79.6% during workdays and 72.1% on weekends, which outperforms other methods (e.g., the congestion-converge heuristic, the congestion-drop heuristic, and congested object item), and the discovered spatiotemporal bottlenecks match the travelers' experience.

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**Optimization of transit priority in the transportation network using a genetic algorithm**

*Mesbah, M.; Sarvi, M.; Currie, G.;*

This paper proposes a detailed formulation to optimize transit road space priority at the network level and utilizes an efficient heuristic method to find the optimum solution. Previous approaches to transit priority have a localized focus in which only limited combinations of transit exclusive lanes could be assessed. The aim of this work is to reallocate the road space between private car and transit modes so that the system is optimized. A bilevel programming approach is adapted for this purpose. The upper level involves an objective function from the system managers' perspective, whereas at the lower level, a users' perspective is modeled. To take into account the major effects of a priority provision, three models are used: 1) a modal split; 2) a user equilibrium traffic assignment; and 3) a transit assignment. A genetic algorithm (GA) approach is used, which enables the method to be applied to large networks. Application of a parallel GA is also demonstrated in the solution method, which has a considerably shorter execution time. The methodology is applied to an example network, and results are discussed. It is found that the proposed methodology can successfully consider benefits of all stakeholders in the introduction of transit lanes.
Furthermore, using parallel GA enables the methodology to be used for real-world-network scale in a shorter computer processing time.

**Petri Net Modeling of the Cooperation Behavior of a Driver and a Copilot in an Advanced Driving Assistance System**

*Wu, N.; Chu, F.; Mammar, S.; Zhou, M.*

As the traffic on roads becomes increasingly heavy, driving safety has widely become a concern. Thus, an advanced driving-assistance system (ADAS) becomes much more important, because it can improve driving safety. It is composed of a human driver and an automated system called a copilot. To make it effective, they should properly cooperate. Hence, it is very important to define and model their cooperation behavior such that an ADAS can effectively be designed and realized. This paper presents the colored hybrid Petri net (CHPN) model to describe their cooperation behavior. It shows how switch between the driver and the copilot should be done to control the vehicle. The model is shown to be deadlock-free and conflict-free. Therefore, it is useful for ADAS design, analysis, and simulation.

**A New Algorithm for Robust Pedestrian Tracking Based on Manifold Learning and Feature Selection**

*Wang, M.; Qiao, H.; Zhang, B.*

Manifold learning has been a popular method in many areas such as classification and recognition. In this paper, we propose a novel algorithm for pedestrian tracking based on our previous work on manifold learning. A new kind of manifold subspace is introduced, in which the intrinsic features of the target’s motion can be best preserved, and the dimensionality of feature is very low. In the proposed subspace, variations of continuous pedestrian postures can be represented well by these intrinsic features. This also validates our conjecture that the movement of pedestrians can be described by some intrinsic and low-dimensional features, which are significant for tracking. Although intrinsic features are useful for tracking, algorithms that directly apply intrinsic features could not guarantee stable performance due to the influence from a complicated background. To address this issue, a foreground extraction method is introduced to enhance tracking stability by selecting the most discriminative color features to automatically distinguish the foreground from the candidate image. This preprocessing stage is proven to promote the accuracy of low-dimensional feature representation in pedestrian tracking. The whole tracking procedure, particularly dimensionality reduction, is linear and fast without complicated calculations. The experimental results validate the effectiveness of our algorithm under challenging conditions, such as a complex background, various pedestrian postures, and even occlusion.

**Optimization-Based Feedback Control for Pedestrian Evacuation From an Exit Corridor**

*Vol.13 No.3 July 2011 55*
The evacuation of pedestrians is the most important task when a building is subjected to a significant level of threat that compromises occupant safety. However, very few studies have dealt with the problem of controlling pedestrian evacuation in real time. Due to modern developments in sensor technology and computational facilities, it now seems possible to attempt a real-time controlled evacuation by instructing pedestrians to adjust their velocities according to an algorithm to effect an efficient evacuation. This paper deals with the development of such a control algorithm for an exit corridor where high congestion can be expected during evacuation. To accommodate the possible variation in the pedestrian density along the length, the corridor is divided into several sections. Using the conservation of pedestrian mass, ordinary differential equations that define the pedestrian flow in all sections are developed. For the system of state-space equations that define the flow in all the sections of the corridor, an optimization-based feedback control scheme is developed, which ensures the maximum input discharge subject to tracking the critical state and boundedness of the control variables. Simulation results are obtained, which indicate the superior performance of the controlled flow over the uncontrolled flow. The proposed flow control is also applicable to the regulation of vehicular traffic on a long section of a freeway in urban areas that receives input at several ramps along its length.

**Practical String Stability of Platoon of Adaptive Cruise Control Vehicles**

*Xiao, L.; Gao, F.;*

In this paper, the practical string stability of both homogeneous and heterogeneous platoons of adaptive cruise control (ACC) vehicles, which apply the constant time headway spacing policy, is investigated by considering the parasitic time delays and lags of the actuators and sensors when building the vehicle longitudinal dynamics model. The proposed control law based on the sliding-mode controller can guarantee both homogeneous and heterogeneous string stability, if the control parameters and system parameters meet certain requirements. The analysis of the negative effect of the parasitic time delays and lags on the string stability indicates that the negative effect of the time delays is larger than that of the time lags. This paper provides a practical means to evaluate the ACC systems applying the sliding-mode controller and provides a reasonable proposal to design the ACC controller from the perspective of the practical string stability.

**Computationally Inexpensive Tracking Control of High-Speed Trains With Traction/Braking Saturation**

*Song, Q.; Song, Y.; Tang, T.; Ning, B.;*

The problem of the position and velocity tracking control of high-speed trains becomes interesting yet challenging when simultaneously considering inevitable factors such as the resistive friction and aerodynamic drag forces, the interactive impacts among the vehicles, and the nonlinear traction/braking notches inherent in train systems. In this paper, a multiple
point mass with a single-coordinate dynamic model that reflects resistive and transient impacts is derived, and based on this, computationally inexpensive robust adaptive control designs with optimal task distribution for speed and position tracking are proposed under traction/braking nonlinearities and saturation limitations. It is shown that the proposed method is not only robust to external disturbances, aerodynamic resistance, mechanical resistance, and transient impacts but adaptive to unknown system parameters as well. The effectiveness of the proposed approach is also confirmed through numerical simulations.

A Probabilistic Analysis of Link Duration in Vehicular Ad Hoc Networks

Yan, G.;

The past decade has witnessed a phenomenal market penetration of wireless communications and a steady increase in the number of mobile users. Unlike wired networks, where communication links are inherently stable, in wireless networks, the lifetime of a link is a random variable whose probability distribution depends on mobility, transmission range, and various impairments of radio communications. Because of the very dynamic nature of Vehicular Ad hoc NETworks (VANETs) and the short transmission range mandated by the Federal Communications Commission (FCC), individual communication links come into existence and vanish unpredictably, making the task of establishing and maintaining routing paths between fast-moving vehicles very challenging. The main contribution of this work is to investigate the probability distribution of the lifetime of individual links in a VANET under the combined assumptions of a realistic radio transmission model and a realistic probability distribution model of intervehicle headway distance. Our analytical results were validated and confirmed by extensive simulation.

Local Feedback-Based Mainstream Traffic Flow Control on Motorways Using Variable Speed Limits

Carlson, R. C.; Papamichail, I.; Papageorgiou, M.;

Recent research has proposed mainstream traffic flow control (MTFC), enabled via variable speed limits (VSLs), as a novel motorway traffic management tool and has demonstrated its efficiency based on sophisticated optimal control methods that may face difficulties in practical field implementations. A simple local MTFC feedback controller is designed in this paper, taking into account a number of practical requirements and restrictions. The MTFC controller relies only on readily available real-time measurements (no online model usage and no demand predictions are needed) and is therefore robust and suitable for field implementations. The controller is evaluated in simulation and compared with optimal control results. Despite its simplicity, the new controller's performance is shown to approach the optimal control results while considering several practical and safety restrictions for a number of investigated scenarios.
Comparison of Markov Chain Abstraction and Monte Carlo Simulation for the Safety Assessment of Autonomous Cars

Althoff, M.; Mergel, A.;

The probabilistic prediction of road traffic scenarios is addressed. One result is a probabilistic occupancy of traffic participants, and the other result is the collision risk for autonomous vehicles when executing a planned maneuver. The probabilistic occupancy of surrounding traffic participants helps to plan the maneuver of an autonomous vehicle, whereas the computed collision risk helps to decide if a planned maneuver should be executed. Two methods for the probabilistic prediction are presented and compared: 1) Markov chain abstraction and 2) Monte Carlo simulation. The performance of both methods is evaluated with respect to the prediction of the probabilistic occupancy and the collision risk. For each comparison test, we use the same models that generate the probabilistic behavior of traffic participants, where the generation of these data is not compared with real-world data. However, the results independently show the behavior generation that Markov chains are preferred for the probabilistic occupancy, whereas Monte Carlo simulation is clearly preferred for determining the collision risk.

Cooperative Adaptive Cruise Control: A Reinforcement Learning Approach

Desjardins, C.; Chaib-draa, B.;

Recently, improvements in sensing, communicating, and computing technologies have led to the development of driver-assistance systems (DASs). Such systems aim at helping drivers by either providing a warning to reduce crashes or doing some of the control tasks to relieve a driver from repetitive and boring tasks. Thus, for example, adaptive cruise control (ACC) aims at relieving a driver from manually adjusting his/her speed to maintain a constant speed or a safe distance from the vehicle in front of him/her. Currently, ACC can be improved through vehicle-to-vehicle communication, where the current speed and acceleration of a vehicle can be transmitted to the following vehicles by intervehicle communication. This way, vehicle-to-vehicle communication with ACC can be combined in one single system called cooperative adaptive cruise control (CACC). This paper investigates CACC by proposing a novel approach for the design of autonomous vehicle controllers based on modern machine-learning techniques. More specifically, this paper shows how a reinforcement-learning approach can be used to develop controllers for the secure longitudinal following of a front vehicle. This approach uses function approximation techniques along with gradient-descent learning algorithms as a means of directly modifying a control policy to optimize its performance. The experimental results, through simulation, show that this design approach can result in efficient behavior for CACC.

Detection of Parked Vehicles Using Spatiotemporal Maps

Albiol, A.; Sanchis, L.; Albiol, A.; Mossi, J. M.;
This paper presents a video-based approach to detect the presence of parked vehicles in street lanes. Potential applications include the detection of illegally and double-parked vehicles in urban scenarios and incident detection on roads. The technique extracts information from low-level feature points (Harris corners) to create spatiotemporal maps that describe what is happening in the scene. The method neither relies on background subtraction nor performs any form of object tracking. The system has been evaluated using private and public data sets and has proven to be robust against common difficulties found in closed-circuit television video, such as varying illumination, camera vibration, the presence of momentary occlusion by other vehicles, and high noise levels.

### A Theoretical Framework for Traffic Speed Estimation by Fusing Low-Resolution Probe Vehicle Data

**Ou, Q.; Bertini, R. L.; Van Lint, J. W. C.; Hoogendoorn, S. P.;**

Probe vehicles with Global Positioning Systems (GPS) can provide accurate positions that enable spatial-average speed estimation. However, some probe vehicles cannot provide accurate positions but can provide location-specific information on when and where they are located at the segment or cell level. These topological position (TP) data with segment- or cell-level accuracy cannot provide the distance component that is necessary for traffic speed estimation. However, considering the wide availability of TP data in the existing telecommunications network, there is still hope and benefits to make use of the data for traffic state estimation. In this paper, an algorithm is proposed using low-resolution positioning data. The proposed method is capable of fusing low-resolution positioning data with other data sources, leading to more accurate and reliable speed estimation of relatively low bias. In addition, this method shows strong robustness and error tolerance and can reveal the magnitude of the estimation error, which is helpful for travel time prediction and traffic control.

### OPQ: OT-Based Private Querying in VANETs

**Chim, T. W.; Yiu, S. M.; Hui, L. C. K.; Li, V. O. K.;**

We consider the querying service (e.g., location-based query service) in vehicular ad hoc networks (VANETs). Querying service has been studied in various kinds of networks such as traditional mobile phone networks and other mobile ad hoc networks. However, existing schemes are either not suitable for VANETs due to their highly dynamic environment or do not provide a privacy-preserving solution. In this paper, we first discuss the security concerns of providing a querying service that ensures that a query will not be linkable to the querier. Then, we briefly highlight the characteristics of VANETs, which make the problem different from other types of networks. Finally, we propose a solution for solving the problem by using techniques of pseudoidentity, indistinguishable credentials, and oblivious transfer. We show that, although all infrastructure units collude, it is still impossible to link the real identity of the user to a query. Based on our simulation study, we show that our scheme is effective in terms of processing delay, message overhead, and success rate.
A Complementary Modularized Ramp Metering Approach Based on Iterative Learning Control and ALINEA

Hou, Z.; Xu, X.; Yan, J.; Xu, J.-X.; Xiong, G.;

Ramp metering is an effective tool for traffic management on freeway networks. In this paper, we apply iterative learning control (ILC) to address ramp metering in a macroscopic-level freeway environment. By formulating the original ramp metering problem as an output regulating and disturbance rejection problem, ILC has been applied to control the traffic response. The learning mechanism is further combined with Asservissement Linéaire d'Entrée Autoroutière (ALINEA) in a complementary manner to achieve the desired control performance. The ILC-based ramp metering strategy and the modified modularized ramp metering approach based on ILC and ALINEA in the presence of input constraints are also analyzed to highlight the advantages and the robustness of the proposed methods. Extensive simulations are given to verify the effectiveness of the proposed approaches.

The Driving School System: Learning Basic Driving Skills From a Teacher in a Real Car


To offer increased security and comfort, advanced driver-assistance systems (ADASs) should consider individual driving styles. Here, we present a system that learns a human's basic driving behavior and demonstrate its use as ADAS by issuing alerts when detecting inconsistent driving behavior. In contrast to much other work in this area, which is based on or obtained from simulation, our system is implemented as a multithreaded parallel central processing unit (CPU)/graphics processing unit (GPU) architecture in a real car and trained with real driving data to generate steering and acceleration control for road following. It also implements a method for detecting independently moving objects (IMOs) for spotting obstacles. Both learning and IMO detection algorithms are data driven and thus improve above the limitations of model-based approaches. The system's ability to imitate the teacher's behavior is analyzed on known and unknown streets, and results suggest its use for steering assistance but limit the use of the acceleration signal to curve negotiation. We propose that this ability to adapt to the driver can lead to better acceptance of ADAS, which is an important sales argument.

Using Cellular Automata to Form Car Society in Vehicular Ad Hoc Networks

Cheng, S.-T.; Horng, G.-J.; Chou, C.-L.;
This paper proposes a novel approach to clustering the interests of car drivers, increasing the lifetime of interest groups, and increasing the throughput in vehicle-to-vehicle environments. It develops an interest ontology of cellular automata (CA) clustering using the zone of interest (ZOI) for mobicast communications in vehicular ad hoc network (VANET) environments. The key to the proposed method is to integrate CA clustering with the ontology of users' interests. This paper argues for the use of both an interest profile (ontology) of drivers and information about vehicles to form a group of VANET-related interests. The current study evaluates the performance of the approach by conducting computer simulations. Simulation results reveal the strengths of the proposed CA clustering algorithm in terms of increased group lifetime and increased ZOI throughput for VANETs.

A Decision Fusion and Reasoning Module for a Traffic Sign Recognition System


A novel approach for a decision fusion and reasoning system for vision-based traffic sign recognition is presented. This module consists of several steps. In the first stage, a track-based Bayesian fusion scheme is used to fuse the classification results from each frame to obtain a fusion result for each track to decide whether a sign is present, as well as to determine the sign type. In order to determine the sign type, the temporal fusion scheme has been combined with a decision tree. In the second stage, the system combines and fuses probable identical objects which help to further reduce failures in the recognition process. The decision is based on the fusion results, as well as a position cue. Finally, a reasoning module is used to decide which of the passed signs should be shown to the driver. In addition to these modules, a general evaluation method for multi-class tracking systems is shown. While some failures are observed from the evaluation on object level, the additional post processing steps improve the system in such a way that the finally presented signs are almost always correct on the test set.

Detection and Classification of Traffic Anomalies Using Microscopic Traffic Variables

Barria, J. A.; Thajchayapong, S.;

This paper proposes a novel anomaly detection and classification algorithm that combines the spatiotemporal changes in the variability of microscopic traffic variables, namely, relative speed, intervehicle time gap, and lane changing. When applied to real-world scenarios, the proposed algorithm can use the variances of statistics of microscopic traffic variables to detect and classify traffic anomalies. Based on a simulation environment, it is shown that, with minimum prior knowledge and partial availability of microscopic traffic information from as few as 20% of the vehicle population, the proposed algorithm can still achieve 100% detection rates and very low false alarm rates, which outperforms previous algorithms monitoring loop detectors that are ideally placed at locations where anomalies originate.
A Model With a Heuristic Algorithm for Solving the Long-Term Many-to-Many Car Pooling Problem

Yan, S.; Chen, C.-Y.; Lin, Y.-F.;

Long-term car pooling is defined as the sharing of a private vehicle by more than one user who need to reach a destination following a semicommon route between the individuals' points of origin and destination in a specific period. In this paper, we employ a network flow technique to systematically develop a long-term many-to-many car pooling model. The model is formulated as a special integer multiple-commodity network flow problem. A Lagrangian relaxation-based algorithm is also developed to solve the model. The performance of the heuristic algorithm is evaluated by carrying out a case study using real data and suitable assumptions. The test results confirm the usefulness of the model and the heuristic algorithm and that they could be useful in practice.

Virtual-Point-Based Fault-Tolerant Lateral and Longitudinal Control of 4W-Steering Vehicles

Song, Y.-D.; Chen, H.-N.; Li, D.-Y.;

This paper studies the lateral and longitudinal path tracking control of four-wheel steering autonomous vehicles. A robust and adaptive fault-tolerant tracking control strategy is proposed to simultaneously counteract modeling uncertainties, unexpected disturbances, coupling effects, as well as actuator failures. By introducing the virtual points along the longitudinal centerline of the vehicle and utilizing a state transformation, a special feature of the control gain matrix is revealed, which allows for the development of structurally simple and computationally inexpensive robust adaptive and fault-tolerant control algorithms. The closed-loop stability issues of the control scheme are analyzed using a Lyapunov-based method. A nonlinear dynamic model of a passenger vehicle is developed to simulate the performance of control design. The controller is tested and validated via computer simulations in the presence of parametric uncertainties and varying driving conditions.

Active Pedestrian Safety by Automatic Braking and Evasive Steering


Active safety systems hold great potential for reducing accident frequency and severity by warning the driver and/or exerting automatic vehicle control ahead of crashes. This paper presents a novel active pedestrian safety system that combines sensing, situation analysis, decision making, and vehicle control. The sensing component is based on stereo vision, and it fuses the following two complementary approaches for added robustness: 1) motion-based object detection and 2) pedestrian recognition. The highlight of the system is its ability to decide, within a split second, whether it will perform automatic braking or evasive steering.
and reliably execute this maneuver at relatively high vehicle speed (up to 50 km/h). We performed extensive precrash experiments with the system on the test track (22 scenarios with real pedestrians and a dummy). We obtained a significant benefit in detection performance and improved lateral velocity estimation by the fusion of motion-based object detection and pedestrian recognition. On a fully reproducible scenario subset, involving the dummy that laterally enters into the vehicle path from behind an occlusion, the system executed, in more than 40 trials, the intended vehicle action, i.e., automatic braking (if a full stop is still possible) or automatic evasive steering.

Adaptive Performance Optimization for Large-Scale Traffic Control Systems

Kouvelas, A.; Aboudolas, K.; Kosmatopoulos, E. B.; Papageorgiou, M.;

In this paper, we study the problem of optimizing (fine-tuning) the design parameters of large-scale traffic control systems that are composed of distinct and mutually interacting modules. This problem usually requires a considerable amount of human effort and time to devote to the successful deployment and operation of traffic control systems due to the lack of an automated well-established systematic approach. We investigate the adaptive fine-tuning algorithm for determining the set of design parameters of two distinct mutually interacting modules of the traffic-responsive urban control (TUC) strategy, i.e., split and cycle, for the large-scale urban road network of the city of Chania, Greece. Simulation results are presented, demonstrating that the network performance in terms of the daily mean speed, which is attained by the proposed adaptive optimization methodology, is significantly better than the original TUC system in the case in which the aforementioned design parameters are manually fine-tuned to virtual perfection by the system operators.

Modeling and Tracking the Driving Environment With a Particle-Based Occupancy Grid

Danescu, R.; Oniga, F.; Nedevschi, S.;

Modeling and tracking the driving environment is a complex problem due to the heterogeneous nature of the real world. In many situations, modeling the obstacles and the driving surfaces can be achieved by the use of geometrical objects, and tracking becomes the problem of estimating the parameters of these objects. In the more complex cases, the scene can be modeled and tracked as an occupancy grid. This paper presents a novel occupancy grid tracking solution based on particles for tracking the dynamic driving environment. The particles will have a dual nature—they will denote hypotheses, as in the particle filtering algorithms, but they will also be the building blocks of our modeled world. The particles have position and speed, and they can migrate in the grid from cell to cell, depending on their motion model and motion parameters, but they will be also created and destroyed using a weighting-resampling mechanism that is specific to particle filtering algorithms. The tracking algorithm will be centered on particles, instead of cells. An obstacle grid derived from
processing a stereovision-generated elevation map is used as measurement information, and the measurement model takes into account the uncertainties of the stereo reconstruction. The resulting system is a flexible real-time tracking solution for dynamic unstructured driving environments.

**Cognitive Cars: A New Frontier for ADAS Research**


This paper provides a survey of recent works on cognitive cars with a focus on driver-oriented intelligent vehicle motion control. The main objective here is to clarify the goals and guidelines for future development in the area of advanced driver-assistance systems (ADASs). Two major research directions are investigated and discussed in detail: 1) stimuli–decisions–actions, which focuses on the driver side, and 2) perception enhancement–action-suggestion–function-delegation, which emphasizes the ADAS side. This paper addresses the important achievements and major difficulties of each direction and discusses how to combine the two directions into a single integrated system to obtain safety and comfort while driving. Other related topics, including driver training and infrastructure design, are also studied.

**P2P Multiuser Low-Cost Universal Solution for On-Demand GPS Positioning and Tracking in Large Environments**

Godino-Llorente, J. I.; Cruz-Roldán, F.; Blanco-Velasco, M.; Fraile, R.; Osma-Ruiz, V.; Sáenz-Lechón, N.;

This paper presents the design and development of an on-demand low-cost positioning and tracking (P&T) system for large environments based on standard mobile phones and Global Positioning System (GPS)-enabled devices, which allows the position of a terminal to be tracked by exchanging text or multimedia messages using short message service (SMS) and/or multimedia message service (MMS). In contrast with other works in the state of the art, the presented method and system do not require an intermediate server or an intermediation center (location-based service (LBS) providers) since communication is performed, following a peer-to-peer (P2P) paradigm. The P2P communication established between two devices with means of access to the mobile network is carried out, guaranteeing the privacy, security, and anonymity in their use and avoiding third-party intervention. Moreover, the proposed procedure protects the user from unwanted tracking through exchange of specific information, following a predefined protocol. In addition, the confidentiality of the information exchanged is guaranteed, in part, by the underlying wireless communication protocols that encrypt the messages swapped. The presented method and system represent an improvement with respect to the state-of-the-art P&T devices since it runs on standard mobile platforms, avoiding the need for a specific hardware and guaranteeing the universalization of the service. Another major advantage with respect to existing devices is that one peer can track multiple users, and each user can be tracked by multiple peers with no third-party intervention.
Adaptive Background Modeling Integrated With Luminosity Sensors and Occlusion Processing for Reliable Vehicle Detection

Faro Giordano, A.; Giordano, D.; Spampinato, C.

This paper presents a novel vehicle detection and tracking system with stationary camera that relies on a recursive background-modeling approach, i.e., the adaptive Poisson mixture model, which is integrated with a hardware module consisting of luminosity sensors. The luminosity information side channel allows the system to effectively handle rapid changes in illumination, which is typical of outdoor applications and bottleneck of the existing background pixel classification methods. A novel algorithm for detecting and removing partial and full occlusions among blobs is also proposed. Partial occlusions are detected by evaluating the ratio between the area of the vehicle and the area of the vehicle's convex hull and are suppressed by identifying a cutting line using curvature analysis. A predictive model of the shape and motion features of the vehicles over consecutive frames instead corrects the error of the previous levels when full occlusions or background–vehicle occlusions occur in the scene. Quantitative evaluation and comparisons on some real-world scenarios demonstrate that the proposed approach outperforms state-of-the-art methods in terms of both vehicle detection and processing time, particularly due to the robustness and the efficiency of the background-modeling algorithm.

A Content-Based Dissemination Protocol for VANETs: Exploiting the Encounter Probability

Cenerario, N.; Delot, T.; Ilarri, S.

This paper focuses on intelligent transportation systems and, more precisely, on intervehicle ad hoc networks. A vehicular ad hoc network (VANET) is a highly dynamic network as the vehicles communicate using short-range wireless communications and can move very quickly. Thus, for example, we can only rely on short interactions between vehicles to exchange information about relevant events. In this paper, we describe in detail a dissemination protocol that vehicles can use to share information by using vehicle-to-vehicle communications. The dissemination approach considers the relevance of the data, represented by what we call encounter probability, to decide when a rediffusion is needed. The protocol is able to disseminate data about any type of event in the network (e.g., available parking spaces, accidents or obstacles in the road, information about moving objects such as emergency vehicles that should get the right of way, etc.) by setting appropriate weights for the different factors that affect the computation of the encounter probability. An extensive experimental evaluation with different types of events shows the interest of the proposal: The vehicles receive the relevant messages in time, and the network overload is limited.

Data Modeling and Optimization for Wireless Drive-Through Applications
Xu, Z.; Zhu, Q.; Guo, Y.; Giuli, T.; Prasad, K. V.; Huang, H.

The increasing capabilities and decreasing cost of information and communication technologies (ICTs) are enabling new categories of vehicular telematics applications, such as wireless drive-through (WDT) services, in which an external service provider provides services to in-vehicle occupants via a wireless connection. Most telematics systems rely on proprietary protocols for data exchange between an in-vehicle client and its external counterpart in individual applications, making it difficult to share data-exchange methods among applications. Sharing data-exchange methods is important because it allows a rapid return on ICT investments. In this paper, we study the data-modeling issues for data exchange between an in-vehicle client and its service provider for WDT services. We present a novel data model that captures the main characteristics of data exchange for the WDT application family, using a formal mathematical representation and an intuitive graphical representation. We show that the proposed data model provides generality for such data exchange. In addition, we propose several optimization techniques based on the data model to minimize user interaction so that a good usability can be achieved. Our simulations and analysis demonstrate that the proposed data model and relevant optimization techniques are promising in supporting efficient WDT applications.

Design and Evaluation of Context-Aware and Location-Based Service Discovery Protocols for Vehicular Networks

Abrougui, K.; Boukerche, A.; Pazzi, R. W. N.;

The increasing number of potential applications related to intelligent transportation systems (ITSs) have attracted researchers to the area of vehicular networks (VNs). Two main classes of applications have lately gained popularity, i.e., security and safety, and traffic information and service location applications. However, several open research challenges are delaying the efficient and widespread deployment and management of such applications in VNs. One of these challenges comprises how vehicles and service providers could discover each other in VNs, which are well known for their large scale and high mobility. Most service discovery strategies available present high overhead and poor performance in a VN environment. Existing context-aware and location-based service discovery protocols (LocVSDPs) are either designed without considering the particularities of VNs or are not scalable with the increase in network density and the number of requests. In this paper, we propose a new context-aware and LocVSDP (EB-LocVSDP) for VNs and its variant (Naive-LocVSDP). Our protocols offer a scalable framework for the discovery of time-sensitive and location-based services in VNs. They rely on a cluster-based infrastructure. Furthermore, LocVSDPs are integrated into the network layer and use channel diversity to improve service discovery efficiency. We discuss the implementation of our protocols and techniques, report on performance evaluation experiments, and offer a comparison against an existing location-based discovery protocol [the Vehicular Information Transfer Protocol (VITP)]. Our simulation results indicate that our proposed LocVSDPs show a gain of 20% in terms of success rate. LocVSDPs use at least 90% less bandwidth than VITP, and their average response time is at least 10% lower than VITP for successful query transactions.
Influence of Aircraft Maneuver Preference Variability on Airspace Usage

Lupu, M. F.; Feron, E.; Mao, Z.-H.;

Human factors constitute a core aspect of air traffic control concepts and must be addressed when dealing with traffic flow stability problems. This paper aims to evaluate how the usage of airspace depends on the degree of flexibility in pilot decision-making. Specifically, we study the airspace usage of two intersecting flows of aircraft when pilot maneuver preferences vary. The amount of airspace required for the two flows to cross without conflict can reveal certain aspects of traffic complexity of this specific traffic pattern. To simplify the analysis, we use models of instantaneous lateral and longitudinal position changes to approximate the heading-change and speed-change maneuvers of the aircraft, respectively. Pilot preferences, which are expressed as preferred heading or speed changes, are reflected by different penalty functions of position displacements that the pilots attempt to minimize during conflict resolution. Under the same pilot preferences, the aircraft flow stability is preserved using a decentralized conflict-resolution scheme. However, when the pilot preferences are allowed to vary so that individual aircraft have more control freedom in conflict resolution, the intersecting flows require a much larger fraction of airspace to ensure conflict-free and stable flows of aircraft.

Greenhouse Gas Emission Impacts of Carsharing in North America

Martin, E. W.;

This paper evaluates the greenhouse gas (GHG) emission impacts that result from individuals participating in carsharing organizations within North America. The authors conducted an online survey with members of major carsharing organizations and evaluated the change in annual household emissions (e.g., impact) of respondents that joined carsharing. The results show that a majority of households joining carsharing are increasing their emissions by gaining access to automobiles. However, individually, these increases are small. In contrast, the remaining households are decreasing their emissions by shedding vehicles and driving less. The collective emission reductions outweigh the collective emission increases, which implies that carsharing reduces GHG emissions as a whole. The results are reported in the form of an observed impact, which strictly evaluates the changes in emissions that physically occur, and a full impact, which also considers emissions that would have happened but were avoided due to carsharing. The mean observed impact is $-\$0.58$ t GHG/year per household, whereas the mean full impact is $-\$0.84$ t GHG/year per household. Both means are statistically significant. We present a sensitivity analysis to evaluate the robustness of the results and find that the overall results hold across a variety of assumptions. The average observed vehicle kilometers traveled (VKT) per year was found to decline by 27%. We conclude with an evaluation of the annual aggregate impacts of carsharing based on current knowledge of the industry membership population.
Efficient Data Propagation in Traffic-Monitoring Vehicular Networks

Skordylis, A.;

Road congestion and traffic-related pollution have a large negative social and economic impact on several economies worldwide. We believe that investment in the monitoring, distribution, and processing of traffic information should enable better strategic planning and encourage better use of public transport, both of which would help cut pollution and congestion. This paper investigates the problem of efficiently collecting and disseminating traffic information in an urban setting. We formulate the traffic data acquisition problem and explore solutions in the mobile sensor network domain while considering realistic application requirements. By leveraging existing infrastructure such as traveling vehicles in the city, we propose traffic data dissemination schemes that operate on both the routing and the application layer; our schemes are frugal in the use of the wireless medium, rendering our system interoperable with the proliferation of competing applications. We introduce the following two routing algorithms for vehicular networks that aim at minimizing communication and, at the same time, adhering to a delay threshold set by the application: 1) delay-bounded greedy forwarding and 2) delay-bounded minimum-cost forwarding. We propose a framework that jointly optimizes the two key processes associated with monitoring traffic, i.e., data acquisition and data delivery, and provide a thorough experimental evaluation based on realistic vehicular traces on a real city map.

Application of the LP-ELM Model on Transportation System Lifetime Optimization

Sun, Z.-L.; Ng, K. M.; Soszyńska-Budny, J.; Habibullah, M. S.;

Considering factors such as economic costs and lives, an unreliable transportation system is more likely to cause severe consequences. Therefore, reliability optimization of transportation systems has attracted much attention over the past several decades. The traditional reliability optimization design is usually focused on redundancy allocation or reliability redundancy allocation. In practice, the operation process usually has a significant influence on the transportation system lifetime. By combining linear programming (LP) and extreme learning machine (ELM), a two-stage approach is proposed to optimize the transportation system lifetime, in which a semi-Markov model (SMM) is used to model the operation process. In the proposed method, we first formulate the optimization problem as an LP model, and the LP algorithm is utilized to search for the approximate optimal state probabilities. After data production and sample selection, ELM is trained with the produced training data and used to predict the optimal sojourn time distribution parameters. Applications on three different cases demonstrate that a higher lifetime can be ensured for the transportation system by using the proposed method.
# Officers and Committee Chairs

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<td>VP Member Activities: Jason Geng, Galax LLC, Rockville, MD, USA</td>
<td>William T. Scherer</td>
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<td>VP Publication Activities: Daniel Zeng, U. of Arizona, Tucson, AZ, USA</td>
<td>Jason Geng</td>
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<td>VP Technical Activities: Urbano Nunes, University of Coimbra, Gabinete, Portugal</td>
<td>William T. Scherer</td>
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<td>Transactions Editor: Fei-Yue Wang, CAS, China, and U. of Arizona, Tucson, AZ, USA</td>
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<td>Magazine Editor: Christoph Stiller, Universität Karlsruhe, Karlsruhe, Germany</td>
<td>Jason Geng</td>
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<td>Newsletter Editor: Yaobin Chen, Purdue U. Indianapolis, Indiana, USA</td>
<td>Jason Geng</td>
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