IEEE ITS SOCIETY NEWSLETTER

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The IEEE ITS Society Newsletter is published quarterly in January, April, July, and October. The current and all past issues of the Newsletter may be downloaded at no charge from the Society’s web site:

www.ewh.ieee.org/tc/its

You may subscribe to or unsubscribe from announcements at the same web site. Announcements are sent to approximately 10,000 ITS professionals from industry, academia, and government.

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Information for Contributors

Announcements, feature articles, book and meetings reviews, opinions, letters to the editor, professional activities, Abstracts of reports, and other material of interest to the ITS community are solicited. Please submit electronic material for consideration in any of the following formats: Microsoft Word, OpenOffice, plain ASCII, rich text format (rtf), or portable document format (pdf) to the Editor-in-Chief at yaobincheng@ieee.org.

SOCIETY NEWS

From the Editor

by Yaobin Chen

I would like to bring your attention to the following important announcements in the Society News section: (1) Nominations and applications for 2011 ITSS Awards and (2) the 2011 ITSS Best Ph.D. Dissertation Call for Application and Nomination. These annual awards will recognize our colleagues and Ph.D. students for their outstanding accomplishments in the field of ITS. I hope you will have the opportunity to nominate those who deserve such recognitions in our research community. We have also included a section of Transactions on ITS Abstracts that have been and will be published in the Transactions and IEEE Xplore (since December 2010). Thanks to Simona Berté, our Associate Editor for Transactions on ITS Report and Abstracts for putting them together. I am pleased to announce that the number of subscribers of our Newsletter has reached more than 16000. This number will continue to grow. I strongly encourage all of you to submit ITS related items to the Newsletter.
The ITSS Executive Committee met on February 5, 2011 in Orlando, Florida for its spring meeting. The ExCom typically meets three times a year – once in winter, once via a teleconference with the Board of Governors in spring, and once in fall in conjunction with ITSC (followed immediately by a BOG meeting). The meeting was attended by all 10 members of the ExCom – Alberto Broggi (President), Christoph Stiller (President-Elect and Magazine Editor-in-Chief), Jeffrey Miller (VP Administrative Activities), Reinhard Pfliegl (VP Conference Activities), Daniel Dailey (VP Financial Activities), Jason Geng (VP Member Activities), Daniel Zeng (VP Publication Activities), Urbano Nunes (VP Technical Activities), Fei-Yue Wang (Transactions Editor-in-Chief), and Yaobin Chen (Newsletter Editor-in-Chief). The facilities at the Hilton Orlando were tremendous and allowed the seven hour meeting to proceed uninterrupted.

Each of the members of the ExCom gave a detailed presentation about all of the activities that have been and will be conducted. The minutes from the meeting are included in the Administrative Activities section of the ITSS web site. Some of the main topics are summarized here.

- The Transactions continues to be a popular and highly-ranked publication. The review
times for papers are decreasing and will hopefully continue to decrease as more Associate Editors are invited to join the editorial board.

- The Magazine is beginning to gain more support with more papers being submitted. Since the magazine has only been in existence for just under 3 years, this is encouraging. We would like to see an even higher increase in the number of papers submitted to the Magazine.

- IVS 2011 will be in Baden-Baden, Germany in June 2011.
- FISTS 2011 will be in Vienna, Austria in June 2011.
- ITSC 2011 will be in Washington DC, USA in October 2011.
- VNC 2011 will be in the Netherlands in December 2011.
- ITSC 2012 will be in Anchorage, Alaska, USA in September 2012.
- Proposals have been received from Korea, Australia, the Netherlands, and Spain to host IVS or ITSC in the future, though nothing has been decided yet.
- Financially the society is doing well, though we would like to see more attendance at our conferences to ensure the financial stability.
- As of December 2010, we have 1,193 members in the ITSS.
- We only have 35 student members currently, so we would like to encourage students to join and possibly provide them with additional benefits to encourage membership.
- We now have three ITSS awards that became IEEE awards in 2010 – IEEE ITS Outstanding Research Award, IEEE ITS Outstanding Application Award, and IEEE ITS Institutional Lead Award.
- The Technical Committees have been revised based on interest and leadership abilities. They have been updated on the ITSS web site.
- We will have an online publication on different research topics called ITS Now. Stay posted on the ITSS web site for news on that initiative.

If you have any questions about anything covered at the meeting, feel free to contact the VP Administrative Activities, Jeffrey Miller, at jmiller@uaa.alaska.edu.
April 2011 Board of Governors Meeting

by Jeffrey Miller, VP Admin Activities

The ITSS Board of Governors (BOG) met via teleconference on April 6, 2011. The BOG typically meets twice a year – once in spring via a teleconference and once in fall in conjunction with ITSC. The meeting was attended by 14 of the 22 BOG members. The BOG consists of 15 members who are each elected for 3 year terms, with 5 members being elected each year. In addition, 9 of the ExCom positions are also on the BOG, including the President, President-Elect (or Past-President), VP Administrative Activities, VP Conference Activities, VP Financial Activities, VP Member Activities, VP Publication Activities, VP Technical Activities, and the Transactions Editor-in-Chief.

Each of the ExCom members that were present gave a short overview of all of the activities that have been completed and are expected to be completed in the near future in their respective areas. Much discussion ensued from the BOG members about topics presented by the ExCom members. The minutes from the meeting are included in the Administrative Activities section of the ITSS web site. Some of the main topics are summarized here.

- The ExCom and BOG pages on the ITSS web site have been updated.
- The ITSC 2011 submission deadline will be extended to May 15.
- FISTS 2011 is planning to have around 80 papers accepted with many plenary talks and project presentations.
- IVS 2011 will have 199 accepted papers with a vehicle demonstration on the last day of the conference.
- Financially the society is stable and the updated budget was due to the IEEE on April 15. Conferences need to be better attended since we break even on the periodicals.
- The Technical Committees have been updated on the ITSS web site based on which ones are active. A few committees were removed based on inactivity and lack of interest.
- The Transactions will have the page count increased in 2011 and again in 2012 to try to get more papers published that have already been accepted and are just pending publication.
- The Magazine currently received around 50 submissions per year, which is sufficient when coupled with special issues. We would like to have more submissions if possible. More than 50% of the papers submitted had decisions within 60 days of submission. Beginning in 2012, Jeffrey Miller will be the Editor-in-Chief as Christoph Stiller (the current EiC) will be assuming responsibility as the President of the society.
- The transition from the previous Newsletter EiC (Charles Herget) to the current Newsletter EiC (Yaobin Chen) went smoothly.

If you have any questions about anything covered at the meeting, feel free to contact the VP Administrative Activities, Jeffrey Miller, at jmiller@uaa.alaska.edu.
WELCOME to 2011, and Happy New Rabbit Year!

Thanks to everyone for their tremendous effort and hard work in serving our TRANSACTIONS this past year. I look forward to working together for an even better year ahead.

I would like to take this opportunity to announce the winners of the 2010 Outstanding Service Awards for the IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, which was established by the Board of Governors (BoG) of the IEEE ITS Society in October 2009.

The following recipients have been selected according to their unfailing dedication, high standards, and timely service in the past years:

- Miguel Ángel Sotelo Vázquez—University of Alcala, Madrid, Spain;
- Xiangwen Zhang—Guilin University of Electronic Technology, Guilin City, China;
- Li Li—Tsinghua University, Beijing, China;
- Mark Brackstone—Egis Mobilite, Southampton, U.K.

Plaques will be awarded to the winners during a ceremony at the 2011 IEEE International Intelligent Transportation Systems Conference, Washington, DC, October 5–7, 2011.

Congratulations to Dr. Sotelo Vázquez, Dr. Zhang, Dr. Li, and Dr. Brackstone, and thanks for your great service to our T-ITS and ITSS!

In 2009, the IEEE ITS BoG decided to establish the Best Paper and the Top 10 List Awards for the TRANSACTIONS and charged the Top 10 Committee with the task of selecting the best papers among all publications from 2000 to 2009. The winners of the Best Paper and the Top 10 List will be announced in our next issue.

I am also glad to inform you that, beginning this year, the Best Paper will be selected annually among all papers published within the previous two years. For example, the 2011 Best Paper Award will be chosen from papers published from 2009 to 2010.

This is a new and exciting award, which I hope will help promote ITS research around the world.
Intelligent Transportation Systems Society

Announcement of Awards

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

Purpose and Selection Criteria of Awards

The IEEE ITS Outstanding Research Award, IEEE ITS Outstanding Application Award, and IEEE ITS Institutional 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 by IEEE and administrated by IEEE Intelligent Transportation Systems Society to recognize, promote, and publicize major research contribution, application innovations with real-world impact, and ITS institutional leadership.

Winners of 2011 IEEE ITS Awards

IEEE ITS INSTITUTIONAL LEAD AWARD:
Dynamic Systems and Simulation Laboratory (DSSL)
TECHNICAL UNIVERSITY OF CRETE, GREECE
Citation: “For outstanding contributions and successful implementations in traffic flow modeling and control.”

IEEE ITS OUTSTANDING RESEARCH AWARD:
Professor Fei-Yue Wang
Chinese Academy of Sciences, Beijing, China
Citation: “For his pioneer work and outstanding contributions in developing parallel control and management for transportation operations and agent-based control for networked traffic systems.”

IEEE ITS OUTSTANDING APPLICATION AWARD:
Professor Moshe E. Ben-Akiva and MIT ITS Program
Massachusetts Institute of Technology, USA
Citation: “For outstanding contributions in development and deployment of DynaMIT.”
Purpose and Selection Criteria

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

Application materials

Each application must consist of the following materials:

1. A doctoral dissertation written by the applicant in any language no more than 18 months prior to the submission deadline and not previously submitted.
2. A summary of the dissertation in English of up to 3 pages in length written by the Ph.D. candidate highlighting the significance of the problem, the technical approach taken, application context and potential, and the scope of the dissertation.
3. A self-contained paper in English based on the dissertation written primarily by the Ph.D. candidate following the regular requirements of scientific journals such as the Transactions on ITS or the ITS Magazine.
4. A letter of recommendation from the applicant’s dissertation advisor that comments on the significance of the research, attests to the originality of the work, and comments on the engagement of the student in the field of ITS and the ITSS.

Applications and Selection Processes for Awards

- Please email single-package application before June 15, 2011 to ITSS Vice President of Membership: jason.geng@ieee.org.

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

Award Prizes and Presentations:

The first place prize winners will receive awards of USD 1000. The second place prize winner will receive USD 500. Award certificates will be given out at the ITSC 2011 conference in Washington DC, where the recipients will be asked to give a brief presentation of their work. Awardees work will be featured in ITSS Transactions, ITS Magazine, and ITS Newsletter, when appropriate.
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).
Call for Papers

Original and innovative contributions in ITS research and advanced implementations and deployments are sought for technical sessions. Articles conveying new developments in theory, analytical and numerical simulation and modeling, experimentation, advanced deployment and case studies, results of laboratory or field operational tests, and other related creative endeavors as well as special educational development for ITS curriculum are sought. The conference theme is Safe, Secure, and Sustainable Transportation. The technical areas include but are not limited to the following:

- Traffic theory, modelling, simulation
- Intelligent algorithms
- Sensors and actuators
- Vision systems and processing
- Safety Systems
- Security Systems
- Evacuation Systems
- Traffic and Communications Networks
- Traffic Control Systems
- V2V and V2I Communications
- Technologies for ITS User services: ATMS, AVCS, etc.
- Intelligent Vehicles
- Driver Assistance
- Vehicle Collision Avoidance
- Integrated Safety Systems
- Commercial Vehicle Operations
- Multi-modal ITS
- ITS Implementation
- Pedestrian and Bicyclist Safety and Mobility systems
- ITS for Special Needs
- Emergency Services

In the tradition of successful IEEE ITS Conferences, only the highest quality papers will be accepted through an on-line peer review process. The final version of the accepted papers will be included in the Conference proceedings, only after at least one author’s official registration.

**Important Dates**

- Full-paper submission deadline: May 15, 2011
- Notification of acceptance: June 15, 2011
- Final paper submission deadline: July 15, 2011
- Special Session proposal submission deadline: May 15, 2011
- Workshop/Tutorial proposal submission deadline: May 15, 2011

**Best Student Paper Award**

Articles written and presented by a primary author who is a student will be specially selected for the Best Student Paper Award recognition during the Conference. This is arranged through the IEEE ITS Committee.

**Special Issue of IEEE Transactions on ITS**

Selected exceptional quality articles will be invited for submission to a special issue of the IEEE Transactions on Intelligent Transportation Systems; Authors will be asked to revise their papers according to the standards of the transactions, which will be subjected to the Transactions’ review process.

**Workshops**

Proposals are sought for Special Workshops and Tutorials related to the topics and themes of the conference.
THE INTELLIGENT VEHICLES SYMPOSIUM (IV’11) 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 Intelligent Infrastructures. 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. The symposium closes on the last day with a demonstration of latest intelligent vehicle functions on a test track.

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
- Smart Infrastructure
- Impact on Traffic Flows
- Cooperative Vehicle-Highway 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
- Human Machine Interaction
- Novel Interfaces and Displays
- Intelligent Vehicle Software Infrastructure

Registration and bookings are on first-come-first-serve basis
For further information and latest news visit the conference website www.mrt.kit.edu/iv2011
Symposium registration www.mrt.kit.edu/iv2011
Become a sponsor: iv2011@mrt.kit.edu
Propose a tutorial: iv2011@mrt.kit.edu
Book your demonstration ivDemo@mrt.uka.de
Book your exhibition site ivExhi@mrt.uka.de.
Call for Papers

2011 IEEE International Conference on Vehicular Electronics and Safety

Sponsored by the IEEE Intelligent Transportation Systems Society
Beijing, China, July 10-12, 2011
http://www.ieeeves.org

VENUE

The International Conference on Vehicular Electronics and Safety (ICVES’11) is an annual forum sponsored by the IEEE Intelligent Transportation Systems (ITS) Society. It brings together researchers and practitioners to discuss vehicle electronics, and safety systems research and practice. ICVES’11 welcomes papers dealing with any aspect of vehicle electronics and safety systems.

TOPICS OF INTEREST

The topics of interest include and but are not limited to the following:

- Active Safety Systems and Testing
- Battery Management and Vehicle System Control for Electric and Hybrid Vehicles
- Telematics
- Vehicular Power Networks
- X-By Wire Technology
- System-on-a-Chip
- Vehicular Sensor
- Vehicle Bus
- Sensor Network
- Embedded Operation System
- Electro Magnetic Compatibility
- Inter-Vehicular Network
- Vehicle Testing
- Navigation and Localization Systems
- Vehicular Measurement Technology
- Vehicular Signal Processing
- Micro-electromechanical Systems
- Image Sensor
- Vehicle/Engine Control
- Driver Assistance Driving Systems
- Adaptive Cruise Control Systems
- Pattern Recognition for Vehicles
- Human Machine Interaction
- Vehicle on Board Diagnostics
- Virtual/Digital System
- Vehicle Hardware /Software Systems
- (Semi-) Autonomous Driving Systems

CONFERENCE ORGANIZING COMMITTEE

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Glenn Widmann, Delphi Electronics and Safety, USA
Program Chair/Co-Chair
Lingxi Li, Purdue University-IUPUI, USA
Nigel Clarke, Jaguar & Land Rover Research, UK
Finance Chair
Yanqing Gao, University of Arizona, USA
Publication Chair
Guanpi Lai, University of Arizona, USA
Local Organizing Chair
Hongxia Zhao, Chinese Academy of Sciences, China

PAPER SUBMISSION

Regular paper submission: Complete manuscripts in PDF must be submitted electronically at the conference website: http://www.ieeeves.org. Manuscripts should be at most six (6) pages in the IEEE two-column format including figures, tables, and references.

Invited paper submission: Proposals for invited sessions should be submitted to the Program Chair. Full manuscripts should be submitted in the same manner as regular papers after the proposal has been accepted. The proposal should include a one-page summary of the proposed session with authors’ name, affiliation, title of the abstract with five (5) extended abstracts (no more than 1000 words) attached. Please contact us at: ieeeves2011@gmail.com if you have any questions. Please refer to the conference website for the most up-to-date information http://www.ieeeves.org.

IMPORTANT DATES

February 14, 2011
Proposal submission deadline for invited sessions

March 28, 2011
Full Paper submission deadline

May 9, 2011
Notification of acceptance

May 25, 2011
Camera-ready copy due
MESA11 - Call for Papers

The 7th ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications
August 29-31, 2011 Washington, DC, USA
http://iel.ucdavis.edu/mesa/MESA11

Objectives: Mechanical and electrical systems show an increasing integration of mechanics with electronics and information processing. This integration is between the components (hardware) and the information-driven functions (software), resulting in integrated systems called mechatronic systems. The development of mechatronic systems involves finding an optimal balance between the basic mechanical structure, sensor and actuators, automatic digital information processing and control in which embedded systems play a key role. The goal of the 7th ASME/IEEE MESA11, is to bring together experts from the fields of mechatronic and embedded systems, disseminate the recent advances made in the area, discuss future research directions, and exchange application experience. The conference is organized in a number of symposia under the umbrella of the ASME IDETC 2011.

Advisory Committee
D.M. Auslander, Univ. of California, Berkeley, USA
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Z. Dong, Univ. of Victoria, Canada

Symposia and Chairs

Autonomous Systems and Ambient Intelligence
H.S. Ahn, Gwangju Institute of Technology, Korea
Y. Zhou, State Univ. of New York at Stony Brook, USA

Bio-Mechatronics
S. Xie, University of Auckland, New Zealand
L. Zuo, State Univ. of New York at Stony Brook, USA

Cyber-Physical Systems and Cooperative Systems
S. Nestinger, Worcester Polytechnic Institute, USA

Diagnosis and Monitoring in Mechatronic Systems
W. Chen, Wayne State University, USA

Design & Verification Tools for Embedded Systems
P. Rössler, UAS Technikum Wien, Austria
J. Brauer, RWTH Aachen, Germany

Embedded Systems Infrastructure and Theory
J. Xu, York University, Canada

Fractional Derivatives and Their Applications
D. Baleanu, Cankaya University, Turkey

Mechatronic Control & Electrical Vehicular Systems
Ch. Ma, UM-SJTU Joint Institute, China

Mechatronic and Embedded Energy Systems
U.A. Rosa, University of California at Davis, USA

Mechatronics and Embedded Systems Applications
E. Frontoni, Polytechnic Univ. of Marche, Italy

Mechatronics and Embedded Systems Education
Y.C. Chou, Chung Yuan Christian University, Taiwan
Z. Wang, Zhejiang Sci-Tech University, China

Robotics & Mobile Machines
X. Kong, Heriot-Watt University, UK
M. Zoppi, Univ. of Genua, Italy

Sensors & Actuators
J.Ch. Koo, Sungkyunkwan University, Korea
J.Y. Chang, Massey University, New Zealand

Sensor Networks & Networked Embedded Systems
B. Chen, Michigan Technological University, USA

Small Unmanned Aerial Vehicle Technologies & Applications
Y.Q. Chen, Utah State University, USA
Y. Zhang, Concordia University, Canada

Virtual Prototyping in Mechatronics
M. Germani & M. Mengoni, Polytechnic Univ. of Marche, Italy

Paper Submission: Manuscripts shall be no longer than 10 pages and shall adhere to the ASME author guidelines. Word and LaTeX templates are available from ASME to assist authors in preparing their papers for publication. Final papers in PDF format must be electronically submitted to: https://www.asmeconferences.org/IDETC2011.

Important Dates:
Submission of Abstract 11-02-2011
Submission of Full-Length Paper 18-02-2011
Author Notification of Acceptance 20-05-2011
Submission of Final Paper 30-05-2011

Technical Co-Sponsors:
ASME Division of Design Engineering
IEEE Intelligent Transportation Systems Society
IEEE Control Systems Society
The Asian ITS market is flourishing with reports projecting it to reach nearly $28 billion by 2015. After extensive research with the Asian governments, IQPC understands the longing from them to benchmark their current intelligent transportation systems with their peers from the rest of the continent.

Growing population, ever increasing traffic congestion and increasing levels of pollution pressurizes the Asian governments to forge ahead with ITS. With the challenges aplenty, there is a serious dearth of time to effectively implement these systems. Realizing this, the key decision makers of leading economies across Asia are getting together to brainstorm the A to Z of their ITS systems, forge partnerships and benchmark on a regional scale at Intelligent Transport Asia 2011. (link to: http://www.intelligenttransportasia.com/Event.aspx?id=491150&MAC=IEEE)

Key Speakers at the event include those from:

- Malaysian Highway Authority
- National ICT Australia
- IEEE ITS Society
- Korea Expressway Corporation
- Ministry of Road, Transport and Highways, India
- Land Transport Authority Singapore
- Ministry of Transport, Vietnam
- Metro Manila Development Authority, Philippines
- Bangkok Metropolitan Authority and many more

Highlights from the event:

- Engrossing sessions and panel discussions on Asian plans for the future, tolling, parking management, smart cards and other hot off the fire technologies
- Case studies on ITS deployments in cities across Asia
- A purpose built workshop on Cooperative ITS & the developing paradigm for transport management
- An exclusive site visit to ITIS, Transport Management Centre in Kuala Lumpur

Download the latest agenda here (please link to: http://www.intelligenttransportasia.com/redForms.aspx?id=491146&pdf_form=1&MAC=IEEE) for full list of speakers and further details about the event.

PS. Members of IEEE are entitled to 15% discount on the standard conference pricing. Call us +65 6722 9388 or e-mail enquiry@iqpc.com.sg to find out more.
Conference Calendar

Massimo Bertozzi / Paolo Grisleri

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

2011

May 9-13, 2011
IEEE International Conference on Robotics and Automation
Shanghai, China
http://www.icra2011.org/

15-18 May 2011
IEEE 73rd Vehicular Technology Conference: VTC2011-Spring
Budapest, Hungary

June 5-9
2011 IEEE Intelligent Vehicles Symposium
Baden-Baden, Germany
http://www.mrt.uni-karlsruhe.de/iv2011/

June 20-25
Computer Vision and Pattern Recognition: CVPR 2011
Colorado Springs, CO, USA

June 21-23, 2011
Computer Vision and Pattern Recognition: CVPR 2011
Colorado Springs, California
http://www.cvpr2011.org/

June 27-30, 2011
ISIE 2011 - 20th IEEE International Symposium on Industrial Electronics
Gdansk, Poland
http://www.isie2011.pl/
July 10-12
2011 IEEE International Conference on Vehicular Electronics and Safety (ICVES11)
Beijing, China
http://www.ieeeves.org/

August 23-25, 2011
11th International Conference on ITS Telecommunications
St. Petersburg, Russia
Submission due by: May 25, 2011

August 28-31, 2011
National Rural ITS Conference
Coeur d'Alene, ID, USA
http://www.nritsconference.org

August 29-31
7th ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications 2011 (MESA11)
Washington, D.C.
http://iel.ucdavis.edu/mesa/MESA11

September 5-8, 2011
IEEE 74nd Vehicular Technology Conference
San Francisco, CA, USA

September 19-21, 2011
IEEE International Conference on Virtual Environments, Human Computer Interfaces and Measurement System (VECIMS2010)
Ottawa, Canada
http://vecims2011.ieee-ims.org/

September 28-30, 2011
2010 IEEE Multi-Conference on Systems and Control
Denver, CO, USA
http://www.msc2011.org/

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

September 25-30, 2011
2010 IEEE/RSJ International Conference on Intelligent Robots and Systems
San Francisco, CA, USA
http://www.iros2011.org/
October 5-7
14th IEEE Intelligent Transportation Systems Conference 2011 (IEEE ITSC 2011)
Washington, D.C.
http://www.seas.gwu.edu/itsc2011/index.html

October 19-22, 2011
11th International Conference on Transport Systems Telematics
Katowice-Ustroń, Poland

2012

February 24-26, 2012
VISIGRAPP-2012 Conference
Rome, Italy
http://www.visigrapp.org/

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

October 22-26, 2012
19th World Congress on ITS
Vienna, Austria
http://2012.itsworldcongress.com/content/
Announcements

CALL FOR NOMINATIONS
2012 IEEE MEDAL FOR ENVIRONMENTAL AND SAFETY TECHNOLOGIES

The IEEE Medal for Environmental and Safety Technologies, established in 2008, is presented for outstanding accomplishments in the application of technology in the fields of interest of IEEE that improve the environment and/or public safety.

Sponsor: Toyota Motor Corp.
Presented to: An individual or team, up to three in number.
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Employment Opportunities Solicitation

The Intelligent Transportation Systems Magazine is soliciting any employment opportunities that may be of interest to our readers. Opportunities could be academic, professional, government, or otherwise. Since this is a new column we are adding to the ITS Magazine, there is no fee for posting an employment opportunity. Please send a description of the position and how to apply to Prof. Jeffrey Miller at jmiller@uaa.alaska.edu. Address any questions to the same address.
Transactions on ITS Abstracts

DEC 2010 ISSUE


Ji Hyoun Lim  Yili Liu  Tsimhoni, O.

This paper introduces a queueing network-based computational model to explain driver performance in a pedestrian-detection task assisted with night-vision-enhancement systems. The computational cognitive model simulated the pedestrian-detection task using images displayed by two night-vision systems as input stimuli. The system equipped with a far-infrared (FIR) sensor generated less-cluttered images than the system equipped with a near-infrared (NIR) sensor. Using a reinforcement learning process, the model developed eye-movement strategies for each night-vision system. The differences in eye-movement strategies generated different eye-movement behaviors, in accord with the empirical findings.

A Markov Model for Headway/Spacing Distribution of Road Traffic

Xiqun Chen; Li Li; Yi Zhang;

In this paper, we link two research directions of road traffic—the mesoscopic headway distribution model and the microscopic vehicle interaction model—together to account for the empirical headway/spacing distributions. A unified car-following model is proposed to simulate different driving scenarios, including traffic on highways and at intersections. Unlike our previous approaches, the parameters of this model are directly estimated from the Next Generation Simulation (NGSIM) Trajectory Data. In this model, empirical headway/spacing distributions are viewed as the outcomes of stochastic car-following behaviors and the reflections of the unconscious and inaccurate perceptions of space and/or time intervals that people may have. This explanation can be viewed as a natural extension of the well-known psychological car-following model (the action point model). Furthermore, the fast simulation speed of this model will benefit transportation planning and surrogate testing of traffic signals.

Creating Enhanced Maps for Lane-Level Vehicle Navigation.

Betaille, D.; Toledo-Moreo, R.;

The concept of enhanced maps (Emaps) was introduced with one main objective: It should characterize roads, first, with more completeness and, second, with more accuracy than standard maps to fulfill the requirements of new challenging road safety applications and advanced driver-assistance systems (ADAS). This paper introduces a paradigm for Emap definition and creation on which every road lane is represented and topologically connected to the rest of lanes. Following this approach, a number of Emaps have been created in France, Germany, and Sweden. The experiments carried out in these test sites with the Emaps show the capability of our Emap definition to assist with the determination of the vehicle position at the lane level. Details of the processes of extraction and connection of the road segments are given in the core of this paper, as well as a discussion of the elaboration process and future guidelines in the conclusion.

Matrix Tools for General Observability Analysis in Traffic Networks

Castillo, E.  Gallego, I.  Sánchez-Cambronero, S.  Rivas, A.

We deal with the problem of observability of a given subset \( V_1 \) of flows in terms of another subset \( V_2 \), no matter which type of flows [link, origin-destination (OD), route, node, plate scanned, etc.] they contain or whether they are mixed types. Two problems are stated: The first consists of determining which subsets of flows in \( V_1 \) can be
calculated in terms of the observed flows $V_2$. The second consists of determining which subset of flows $V_2$ needs to be observed to calculate a given subset $V_1$. A theorem providing necessary and sufficient conditions for observability is provided and used in the proposed methods to solve the two problems. Two theorems, one lemma, and one corollary provide the bases for optimizing the numerical procedures to solve these problems. Some examples of applications are used to illustrate the proposed methods.

Real-Time Measurement of Link Vehicle Count and Travel Time in a Road Network

Kwong, K. Kavaler, R. Rajagopal, R. Varaiya, P.

A system is described that measures the vehicle count and travel time in the links of a road network. The measurements require matching vehicle signatures recorded by a wireless magnetic sensor network. The matching algorithm is based on a statistical model of the signatures. The model itself is estimated from the data. The approach is first discussed for a single-lane road and extended to multiple-lane roads. The algorithm yields a correct matching rate of 75% for a false matching rate of 5% and reliably estimates the number of vehicles on each link and its travel-time distribution. The system is tested on a 0.9-mi-long segment of San Pablo Avenue, Albany, CA.

Near Real-Time Fuel-Optimal En Route Conflict Resolution

Vela, A.E. Solak, S. Clarke, J.B. Singhose, W.E. Barnes, E.R. Johnson, E.L.

In this paper, we consider the air-traffic conflict-resolution problem and develop an optimization model to identify the required heading and speed changes of aircraft to avoid conflict such that fuel costs are minimized. Nonconvex fuel functions in the optimization problem are modeled through tight linear approximations, which enable the formulation of the problem as a mixed-integer linear program. The significance of the developed model is that fuel-optimal conflict-resolution maneuvers can be identified in near real time, even for conflicts involving a large number of aircraft. Computational tests based on realistic air-traffic scenarios demonstrate that conflicts involving up to 15 aircraft can be solved in less than 10 s with an optimality gap of around 0.02%.

Enhancing Realism in Modeling Merge Junctions in Analytical Models for System-Optimal Dynamic Traffic Assignment

Wei-Hua Lin Hongchao Liu

The existing analytical system-optimal dynamic traffic assignment (SO-DTA) model formulated with the linear programming (LP) approach usually assumes system control over vehicles in the entire network. This property would give rise to unreasonable priorities at merge junctions that are sometimes physically impossible to realize for the given roadway configuration. In this paper, we demonstrate that models with and without considering the merge-priority ratio would exhibit very different traffic patterns and route-choice behavior. To realistically model traffic flow on a transportation network, one should properly distinguish the level of control by drivers, roadway geometry, and system providers. This paper also attempts to develop an LP module that explicitly considers the merge-priority ratio of a merge junction and can potentially be incorporated into the existing LP formulation of the SO-DTA problem based on the cell-transmission model. By more realistically modelling the behavior of vehicles at merge junctions, the obtained solution can be used as a benchmark to compare control strategies developed without explicitly considering the merge-priority ratio at merge junctions or strategies developed with heuristic approaches.
Robust Class Similarity Measure for Traffic Sign Recognition

Ruta, A. Yongmin Li Xiaohui Liu

Traffic sign recognition is an example of a hard multiclass classification problem. The existing approaches to that problem typically associate with each sign class a real-valued likelihood function and assign such a label to the unknown image that maximizes the value of this function. These template-matching techniques are usually based on arbitrary similarity metrics, such as normalized cross correlation, which do not capture the characteristics of the sign imagery. In this paper, we study the concept of a robust sign similarity measure that can be inferred from the domain-specific data. Two novel machine-learning techniques are proposed as a framework for automatic construction of such a measure from the pairs of images representing either the same or different classes. One is called SimBoost, which is a variation of the AdaBoost algorithm, and the other is based on the fuzzy regression tree framework. Through the experiments with low-quality images, we show that the proposed method admits efficient road sign recognition and outperforms the existing approaches in terms of the classification accuracy.

Modeling the Stochastic Drift of a MEMS-Based Gyroscope in Gyro/Odometer/GPS Integrated Navigation

Georgy, J. Noureldin, A. Korenberg, M.J. Bayoumi, M.M.

To have a continuous navigation solution that does not suffer from interruption, GPS is integrated with relative positioning techniques such as odometry and inertial navigation. Targeting a low-cost navigation solution for land vehicles, this paper uses a reduced multisensor system consisting of one microelectromechanical-system (MEMS)-based single-axis gyroscope used together with the vehicle's odometer, and the whole system is integrated with GPS. This system provides a 2-D navigation solution, which is adequate for land vehicles. The traditional technique for this multisensor integration problem is Kalman filtering (KF). Due to the inherent errors of MEMS inertial sensors and their stochastic nature, which is difficult to model, the KF with its linearized models has limited capabilities in providing accurate positioning. Particle filtering (PF) has recently been suggested as a nonlinear filtering technique to accommodate arbitrary inertial sensor characteristics, motion dynamics, and noise distributions. An enhanced version of PF is utilized in this paper and is called the Mixture PF. Since PF can accommodate nonlinear models, this paper uses total-state nonlinear system and measurement models. In addition, sophisticated models are used to model the stochastic drift of the MEMS-based gyroscope. A nonlinear system identification technique based on parallel cascade identification (PCI) is used to model this stochastic gyroscope drift. In this paper, the performance of the PCI model is compared with that of higher order autoregressive (AR) stochastic models. Such higher order models are difficult to use with KF since the size of the dynamic matrix and the error-covariance matrix becomes very large and complicates the KF operation. The performance of the proposed 2-D navigation solution using Mixture PF with both PCI and higher order AR models is examined by road-test trajectories in a land vehicle. The two proposed combinations are compared with four other 2-D solutions: a Mixture PF with the Gauss-Markov (GM) model for the gyro drift, a Mixture PF with only white Gaussian noise (WGN) for stochastic gyro errors, and two different KF solutions with GM model for the gyro drift. The experimental results show that the two proposed solutions outperform all the compared counterparts.

An Efficient Optimization Approach to Real-Time Coordinated and Integrated Freeway Traffic Control

Ghods, A.H.; Liping Fu; Rahimi-Kian, A.;

This paper tackles the problem of real-time optimal control of traffic flow in a freeway network deployed with coordinated and integrated traffic controllers. One promising approach to this problem is casting the underlying dynamic control problem in a model predictive framework. The challenge is that the resulting optimization problem is computationally intractable for online applications in a network with a large number of controllers. In this paper, a game-theoretic approach with distributed controllers is proposed to address the foregoing issue. The efficiency of the proposed method is tested for a coordinated ramp metering and variable-speed limit control applied to a stretch of freeway network. The parallel nature of the optimization algorithm makes it suitable for solving large-scale problems with high accuracy. The speed and accuracy of the proposed solution approach are examined.
An Interval Fuzzy Controller for Vehicle Active Suspension Systems

Jiangtao Cao; Ping Li; Honghai Liu;

A novel interval type-2 fuzzy controller architecture is proposed to resolve nonlinear control problems of vehicle active suspension systems. It integrates the Takagi-Sugeno (T-S) fuzzy model, interval type-2 fuzzy reasoning, the Wu-Mendel uncertainty bound method, and selected optimization algorithms together to construct the switching routes between generated linear model control surfaces. The stability analysis of the proposed approach is presented. The proposed method is implemented into a numerical example and a case study on a nonlinear half-vehicle active suspension system. The simulation results demonstrate the effectiveness and efficiency of the proposed approach.

Crash Probability and Error Rates for Head-On Collisions Based on Stochastic Analyses

Taewung Kim  Hyun-Yong Jeong

Active safety systems are developed in the automotive industry to help avoid or mitigate collisions. To develop collision-avoidance or mitigation systems, an appropriate lead time must be determined to provide a warning or action with acceptable false positive and negative rates. There has been much research on the lead time for the rear-end collision, but the lead time for the head-on collision has not been studied much because of the complexity of the load case. In this paper, the crash probabilities of the head-on collision were estimated, and adaptive lead times were proposed. In addition, false positive and false negative rates were assessed for some precrash sensor errors. For the assessment, an analytical vehicle model was validated against static and dynamic test data, and the driver's behaviors in normal and evasive maneuvers were surveyed and modeled. Using the analytical vehicle model and the driver models, stochastic analyses were conducted to assess the crash probability, the adaptive lead times, and the error rates.

A Pattern-Recognition Approach for Driving Skill Characterization

Yilu Zhang  Lin, W.C.  Chin, Y.-K.S.

Information about a driver's driving skill can be used to adapt vehicle control parameters to facilitate the specific driver's needs in terms of vehicle performance and safety. This paper presents an approach to driving skill characterization from a pattern-recognition perspective. The basic idea is to extract patterns that reflect the driver's driving skill level from the measurements of the driver's behavior and the vehicle response. The experimental results demonstrate the feasibility of using a pattern-recognition approach to characterize a driver's handling skill. This paper concludes with the discussions of the challenges and future works to bring the proposed technique to practical use.

Goal Evaluation of Segmentation Algorithms for Traffic Sign Recognition

Gomez-Moreno, H. ; Maldonado-Bascon, S. ; Gil-Jimenez, P. ; Llafuente-Arroyo, S.

This paper presents a quantitative comparison of several segmentation methods (including new ones) that have successfully been used in traffic sign recognition. The methods presented can be classified into color-space thresholding, edge detection, and chromatic/achromatic decomposition. Our support vector machine (SVM) segmentation method and speed enhancement using a lookup table (LUT) have also been tested. The best algorithm will be the one that yields the best global results throughout the whole recognition process, which comprises three stages:
1) segmentation; 2) detection; and 3) recognition. Thus, an evaluation method, which consists of applying the entire recognition system to a set of images with at least one traffic sign, is attempted while changing the segmentation method used. This way, it is possible to observe modifications in performance due to the kind of segmentation used. The results lead us to conclude that the best methods are those that are normalized with respect to illumination, such as RGB or Ohta Normalized, and there is no improvement in the use of Hue Saturation Intensity (HSI)-like spaces. In addition, an LUT with a reduction in the less-significant bits, such as that proposed here, improves speed while maintaining quality. SVMs used in color segmentation give good results, but some improvements are needed when applied to achromatic colors.

Designing On-Demand Four-Wheel-Drive Vehicles via Active Control of the Central Transfer Case

Panzani, G. Corno, M. Tanelli, M. Zappavigna, A. Savaresi, S.M. Fortina, A. Campo, S.

New driveline architectures equipped with torque-biasing devices such as active differentials and active transfer cases have yielded a new generation of on-demand four-wheel-drive vehicles, where the torque distribution between left and right and between front and rear axles can actively be modulated online. This allows one to design active vehicle-control systems that are capable of altering, via electronic control, the behavior of a car dictated from its mechanical layout, e.g., understeering and oversteering characteristics. This paper proposes a control strategy that optimizes vehicle performance while guaranteeing vehicle stability and drivability by actively controlling the transfer case. The performance of the overall control strategy is assessed on both a multibody simulator and an instrumented test vehicle.

Light-Stripe-Projection-Based Target Position Designation for Intelligent Parking-Assist System

Ho Gi Jung Dong Seok Kim Jaihie Kim

This paper proposes a novel light-stripe-projection-based target position-designation method for an intelligent parking assist system, providing an economical free-space-based target position-designation method for poorly lit indoor parking spaces without degradation of the external appearance when integrated into a vehicle's body. The proposed method can be applied by adding a low-cost light plane projector to existing backward-parking cameras. Light stripe features are detected by the difference between an image with the light plane projector on and off. Three-dimensional information of the parking area is reconstructed using the light-stripe-projection theory. By orientation normalization and depth-map construction, free spaces are detected, and the nearest is selected as the target position. Experimental results show that the proposed method can successfully designate the target position, in spite of poor lighting conditions and the black reflective surface of adjacently parked vehicles.

On the Use of Q2 Abstractions to Lower the Computational Cost of Derivation of Conflict Resolution Advisories in Air Traffic Control

Mei Li Kokar, M.M.

This paper addresses the high computational complexity of generating multistep conflict resolution advisories (RAs) in air traffic control. Because this problem is known to be NP-hard, one cannot expect algorithms that will solve every instance of the problem independent of its size. Thus, the goal is to develop more efficient algorithms that can analyze a wider space of possible RAs, for instance, horizontal maneuvers. This paper presents a study of the use of abstraction to such a problem. However, abstractions can lead to wrong decisions, e.g., to maneuvers that result in unsafe states. Such abstractions are referred to as inconsistent. To avoid these kinds of problems, we use the so-called Q2 abstractions, which are derived from the specifications of a problem and are guaranteed to be consistent. To assess the usability of the Q2 approach to computing horizontal RAs, we analyze the impact of such abstractions on the computational cost of an exhaustive search algorithm and on the quality of RAs found. The results show that the use of the Q2 approach lowers the conflict-resolution computation time without losing much of the quality of solutions.
Critical Scenarios and Their Identification in Parallel Railroad Level Crossing Traffic Control Systems.

Yi-Sheng Huang ; Yi-Shun Weng ; MengChu Zhou ;

Deterministic and stochastic Petri nets (DSPNs) are well utilized as a visual and mathematical formalism to model discrete event systems. This paper proposes to use them to model parallel railroad level crossing (LC) control systems. Their applications to both single- and double-track railroad lines are illustrated. The resulting models allow one to identify and thus avoid critical scenarios in such systems by conditions and events of the model that control the phase of traffic light alternations. Their analysis is performed to demonstrate how the models enforce the phase of traffic transitions by a reachability graph method. Their important properties are verified. To our knowledge, this is the first work that employs DSPNs to model a parallel railroad LC system and identify its critical scenarios for the purpose of their complete avoidance. This helps advance the state of the art in traffic safety related to the intersection of railroads and roadways.

MARCH 2011 ISSUE

Polynomial-Time Feasibility Condition for Multiclass Aircraft Sequencing on a Single-Runway Airport

Harikiopoulo, D. Neogi, N.

In this paper, we consider the airport-landing problem of scheduling different types of aircraft on a single runway. Since the minimum allowable landing separation time between two consecutive aircraft depends on the relative weight of both aircraft, this is a state-dependent scheduling problem, which, in the general case, is NP-hard. We attempt to modify the aircraft landing sequence from the traditionally used “first-come-first-served” (FCFS) order to be able to land more aircraft in a given period of time. Given a set of planes, the goal is to find a sequence such that no plane can land before it is actually available for landing, the minimum safety separation between two consecutive planes is always satisfied, and the total landing time (makespan) is minimized. Based on the Federal Aviation Administration (FAA) partition of aircraft into weight categories, our algorithm provides a polynomial-time feasibility condition for scheduling a set of planes in a given time interval. It ensures that the Aircraft Scheduling Problem (ASP) presented earlier is not NP-complete and allows us to develop possible practical real-time air traffic control (ATC) execution policies.

Cooperative Maneuvering in Close Environments Among Cybercars and Dual-Mode Cars

Milanés, V. Alonso, J. Bouraoui, L. Ploeg, J.

This paper describes the results of vehicle-to-vehicle (V2V) and infrastructure-to-vehicle (I2V) experiments implementing cooperative maneuvering for three different vehicles driving automatically. The cars used were cybercars from the Institut National de Recherche en Informatique et Automatique (INRIA), (France), which are fully automated road vehicles, and two mass-produced cars—one a Smart Fortwo car from TNO (Netherlands) equipped with additional actuators and sensors and the other a convertible Citroën C3 from IAI (Spain) that uses sensorial information to manage the actuators. The cars communicate by a wireless mesh network over Wi-Fi using the optimized link state routing (OLSR) ad-hoc protocol. The entire communication task is embedded in a small MIPS Linux Box (4G System Cube) that is transparent for the cars. A standard framework was defined with the parameters needed to perform adaptive cruise control (ACC) and intersection maneuvers among the cars, as well as emergency stops via a signal sent by the infrastructure. The experiments were carried out in La Rochelle (France) during the final demonstration of the European Union (EU) Cybercars-2 Project.
Design of Infrared Electronic-Toll-Collection Systems With Extended Communication Areas and Performance of Data Transmission

Wern-Yarng Shieh  Chen-Chien Hsu  Shen-Lung Tung  Po-Wen Lu  Ti-Ho Wang  Shyang-Lih Chang

Based on our previous works in the design of an infrared emitter for electronic-toll-collection (ETC) applications, we use the unidirectional cosines functions to approximate the irregular radiation pattern for typical infrared low-cost commercial light-emitting diodes (LEDs) with a half-intensity angle $\Phi_{1/2} = 10^\circ$. With the aid of this approximation, the main characteristics of the performance of an infrared ETC system utilizing this type of LED as the emitter can be investigated based on the received signal strength of the system. For on-off keying, a simple model connecting the received signal strength and the bit error rate (BER) of the system is further established. From the calculated or the measured received signal strength of the system, it is not difficult to estimate the system performance in terms of the BER by this simple model. Roughly speaking, for a typical setting of the circuit parameters and a typical uplink and downlink data-transmission protocol, the data transmission can be very successful in terms of a very low BER if the received signal strength is 1.3 times stronger than the signal strength received at the communication boundary. The emitter presented in this paper is able to produce a relatively extended communication area in the vehicle-traveling direction, resulting in longer communication time interval for the data transmission between the onboard unit (OBU) and the roadside unit (RSU) than conventional emitters. Furthermore, the design presented in this paper is validated by experimental measurement to demonstrate its effectiveness.

Agent-Based Cooperative Decentralized Airplane-Collision Avoidance

Šišlák, D.  Volf, P.  Pěchouček, M.

The efficiency of the current centralized air-traffic management is limited. A next-generation air transportation system should allow airplanes (manned and unmanned) to change their flight paths during the flight without approval from a centralized en route control. Such a scheme requires decentralized peer-to-peer conflict detection and collision-avoidance processes. In this paper, two cooperative (negotiation-based) conflict-resolution algorithms are presented: iterative peer-to-peer and multiparty algorithms. They are based on high-level flight-plan variations using evasion maneuvers. The algorithms work with a different level of coordination autonomy, respect realistic assumptions of imprecise flight execution (integrating required navigation performance), and work in real time, where the planning and plan-execution phases interleave. Both algorithms provide a resolution in a 4-D domain (3-D space and time). The proposed algorithms are evaluated experimentally, and their quality is studied in comparison with a state-of-the-art agent-based method—the satisficing game theory algorithm.

Collision Avoidance in Air Traffic Management: A Mixed-Integer Linear Optimization Approach

Alonso-Ayuso, A.  Escudero, L.F.  Martín-Campo, F.J.

This paper tackles the collision-avoidance problem in air traffic management. The problem consists of deciding the best strategy for new aircraft configurations (velocity and altitude changes) such that all conflicts in the airspace, i.e., the loss of the minimum safety distance that has to be kept between two aircraft, are avoided. A mixed 0-1 linear optimization model based on geometric transformations for collision avoidance between an arbitrary number of aircraft in the airspace is developed. Knowing the initial coordinates, angle direction, and level flight, the new configuration for each aircraft is established by minimizing several objective functions, e.g., velocity variation and total number of changes (velocity and altitude), and forcing to return to the original flight configuration when no aircraft are in conflict. Due to the small computational time for the execution, the new configuration approach can be used in real time by using optimization software.
Patrol Routing Expression, Execution, Evaluation, and Engagement

Steil, D.A.  Pate, J.R.  Kraft, N.A.  Smith, R.K.  Dixon, B.  Li Ding  Parrish, A.

Recommended patrol routes can be used by organizations such as police agencies, emergency medical responders, and taxi services whose agents patrol roadway segments at proper times to assist or deter their target events. The creation of optimal complementary patrol routes for multiple agents targeting temporal event hotspots and minimizing travel distance is an NP-hard combinatorial problem that belongs to a class of problems known as the vehicle routing problem with time windows (VRPTW). Traffic safety patrol routing problems share many characteristics of VRPTW problems but differ in ways that prevent the application of existing solutions. In our approach, nondeterministic patrol routing algorithms are used to specify the movements of simulated mobile agents on a roadway system. Nondeterminism is critical in the traffic safety patrol routing domain, as rigidity and predictability can negatively impact the effectiveness of law enforcement agents' efforts. This paper addresses the problem of expressing, executing, evaluating, and engaging patrol routing algorithms that target event hotspots on roadways. The patrol algorithms are first expressed using Turn, which is our extensible domain-specific language (DSL) created for this purpose. Algorithms specified using Turn syntax are then executed in a custom simulation environment. Utilizing predefined metrics, users evaluate the resulting patrol routes to ensure that the criteria of interest in a given patrol context are met. Acceptable patrol routes are then engaged by end users via a web-based geographic information system (GIS) portal. To demonstrate the applicability and efficacy of our approach, we present two illustrative case studies.

Cascade Architecture for Lateral Control in Autonomous Vehicles

Pérez, J.  Milanés, V.  Onieva, E.

Research on intelligent transport systems (ITSs) is steadily leading to safer and more comfortable control for vehicles. Systems that permit longitudinal control have already been implemented in commercial vehicles, acting on throttle and brake. Nevertheless, lateral control applications are less common in the market. Since a too-sudden turn of the steering wheel can cause an accident in a few seconds, good speed and position control of the steering wheel is essential. We present here a new cascade control architecture based on fuzzy logic controllers that emulate a human driver's behavior. The control architecture was tested on a real vehicle at different vehicle speeds. The results showed the use of a straightforward and intuitive fuzzy controller to give good performance.

Image Segmentation and Shape Analysis for Road-Sign Detection

Khan, J.F.  Bhuiyan, S.M.A.  Adhami, R.R.

This paper proposes an automatic road-sign recognition method based on image segmentation and joint transform correlation (JTC) with the integration of shape analysis. The presented system is universal, which is able to detect traffic signs of any countries with any color and any of the existing shapes (e.g., circular, rectangular, triangular, pentagonal, and octagonal) and is invariant to transformation (e.g., translation, rotation, scale, and occlusion). The main contributions of this paper are: 1) the formulation of two new criteria for analyzing different shapes using two basic geometric properties, 2) the recategorization of the rectangular signs into diamond or nondiamond shapes based on the inclination of the four sides with the ground and 3) the employment of the distortion-invariant fringe-adjusted JTC (FJTC) technique for recognition. There are three main stages in the proposed algorithm: 1) segmentation by clustering the pixels based on the color features to find the regions of interest (ROIs); 2) traffic-sign detection by using two novel shape classification criteria, i.e., the relationship between area and perimeter and the number of sides of a given shape; and 3) recognition of the road sign using FJTC to match the unknown signs with the known reference road signs stored in the database. Experimental results on real-life images show a high success rate and a very low false hit rate and demonstrate that the proposed framework is invariant to translation, rotation, scale, and partial occlusions.
Detecting Driver Sleepiness Using Optimized Nonlinear Combinations of Sleepiness Indicators

Sandberg, D. Akerstedt, T. Anund, A. Kecklund, G. Wahde, M.

This paper addresses the problem of detecting sleepiness in car drivers. First, a variety of sleepiness indicators (based on driving behavior) proposed in the literature were evaluated. These indicators were then subjected to parametric optimization using stochastic optimization methods. To improve performance, the functional form of some of the indicators was generalized before optimization. Next, using a neural network, the best performing sleepiness indicators were combined with a mathematical model of sleepiness, i.e., the sleep/wake predictor (SWP). The analyses were based on data obtained from a study that involved 12 test subjects at the moving-base driving simulator at the Swedish National Road and Transportation Research Institute (VTI), Linköping, Sweden. The data were derived from 12 1-h driving sessions for each test subject, with varying degrees of sleepiness. The performance measure (range [0,1]) for indicators was taken as the average of sensitivity and specificity. Starting with indicators proposed in the literature, the best such indicator, i.e., the standard deviation of the yaw angle, reached a performance score of 0.72 on previously unseen test data. It was found that indicators based on a given signal gave essentially equal performance after parametric optimization, but in no case was it better than 0.72. The best generalized indicator (the generic variability indicator) obtained a performance score of 0.74. SWP achieved a score of 0.78. However, by nonlinearly combining SWP with the generic variability indicator, a score of 0.83 was obtained. Thus, the results imply that a nonlinear combination of a measure based on driving behavior with a model of sleepiness significantly improves driver sleepiness detection.

Analysis of Real-World Driver's Frustration

Malta, L. Miyajima, C. Kitaoka, N. Takeda, K.

This paper investigates a method for estimating a driver's spontaneous frustration in the real world. In line with a specific definition of emotion, the proposed method integrates information about the environment, the driver's emotional state, and the driver's responses in a single model. Driving data are recorded using an instrumented vehicle on which multiple sensors are mounted. While driving, drivers also interact with an automatic speech recognition (ASR) system to retrieve and play music. Using a Bayesian network, we combine knowledge on the driving environment assessed through data annotation, speech recognition errors, the driver's emotional state (frustration), and the driver's responses measured through facial expressions, physiological condition, and gas- and brake-pedal actuation. Experiments are performed with data from 20 drivers. We discuss the relevance of the proposed model and features of frustration estimation. When all of the available information is used, the overall estimation achieves a true positive rate of 80% and a false positive rate of 9% (i.e., the system correctly estimates 80% of the frustration and, when drivers are not frustrated, makes mistakes 9% of the time).

Sensing and Signal Processing for Vehicle Reidentification and Travel Time Estimation

Ndoye, M. Totten, V.F. Krogmeier, J.V. Bullock, D.M.

Link travel times are crucial for advanced traveler information systems and traffic management applications. However, current systems for estimating them still have shortcomings that need to be addressed. In this paper, we propose a novel framework for vehicle reidentification via signature matching using signal processing techniques and a travel time estimation algorithm that is robust to potential (and often inevitable) vehicle misidentifications. Individual vehicles are matched between well-separated stations in a road transportation network using signatures captured by embedded roadway sensors. Statistical and multirate signal processing methods are used to develop data-postprocessing algorithms that are critical to the subsequent signature-matching problem, which is formulated using optimal techniques from communication theory. A probabilistic modeling of the generated matching assignments and an unsupervised data-clustering technique are then used to devise a travel time estimation algorithm. The proposed method is tested under a real traffic scenario, and accurate link travel time measures are reported.
Efficient Routing on Large Road Networks Using Hierarchical Communities

Qing Song  Xiaofan Wang

Efficient routing is essential in everyday life. Although various hierarchical algorithms exist for computing shortest paths, their heavy precomputation/storage costs and/or query costs hinder their application to large road networks. By detecting a hierarchical community structure in road networks, we develop a community-based hierarchical graph model that supports efficient route computation on large road networks. We then propose a new hierarchical routing algorithm that can significantly reduce the search space over the conventional algorithms with acceptable loss of accuracy. Experimental results on a New York road network demonstrate the performance of the algorithm.

Real-Time Urban Monitoring Using Cell Phones: A Case Study in Rome

Calabrese, F.  Colonna, M.  Lovisolo, P.  Parata, D.  Ratti, C.

This paper describes a new real-time urban monitoring system. The system uses the Localizing and Handling Network Event Systems (LocHNESs) platform developed by Telecom Italia for the real-time evaluation of urban dynamics based on the anonymous monitoring of mobile cellular networks. In addition, data are supplemented based on the instantaneous positioning of buses and taxis to provide information about urban mobility in real time, ranging from traffic conditions to the movements of pedestrians throughout the city. This system was exhibited at the Tenth International Architecture Exhibition of the Venice Biennale. It marks the unprecedented monitoring of a large urban area, which covered most of the city of Rome, in real time using a variety of sensing systems and will hopefully open the way to a new paradigm of understanding and optimizing urban dynamics.

A Problem of Infrared Electronic-Toll-Collection Systems: The Irregularity of LED Radiation Pattern and Emitter Design

Wern-Yarng Shieh  Hsu, C.-C.J.  Ti-Ho Wang

According to our measurements, the radiation pattern of many low-cost commercial light-emitting diodes (LEDs) is not smooth. Some LEDs even have serious irregularities that affect the performance of infrared communication systems. For systems where a definite communication area is required, such as electronic-toll-collection (ETC) applications, this problem is particularly serious. In this paper, we first present our measured results for the radiation pattern of several typical low-cost commercial LEDs, showing that almost all of them are irregular to some extent. We then use the most acceptable model with a suitable half-intensity angle to construct the emitter of an ETC system. The design was calculated with the aid of an optimization algorithm to determine the mounting angle for each LED such that the system has an extended communication area in the longitudinal direction, i.e., in the vehicle traveling direction, and can withstand high signal attenuation. For a typical LED with half-intensity angle $\Phi_{1/2} = 13^\circ$, a very simple two-group structure for the emitter is obtained, and the analysis results are verified by experimental measurements.

Optimizing Minimum and Maximum Green Time Settings for Traffic Actuated Control at Isolated Intersections

Guohui Zhang  Yinhai Wang

Optimization of signal control at isolated intersections has been an important research focus in traffic engineering over the past few years. Due to its flexibility and practicality, fully actuated control has been extensively deployed. In the conventional actuated control scheme, two important parameters, i.e., minimum and maximum green times, are arbitrarily prespecified, although it is widely recognized that they can significantly impact system operations. Previous studies have concentrated on computing these parameters using deterministic models. Due to the stochastic features of traffic arrival, such statically designated green time boundaries cannot sufficiently handle various traffic demands. To solve this problem, a stochastic model is established to dynamically optimize the minimum
and maximum green times using real-time queue lengths and traffic arrival characteristics for each phase. Multiple criteria are fused and exploited as control objectives, such as avoiding cycle failures, minimizing control delays, and maximizing total traffic throughputs. Performance of the proposed algorithms is examined using a microscopic traffic simulation program, i.e., VISSIM 4.30, under various scenarios. The results show that the control system operated by the proposed algorithm produces promising improvements in system operation efficiency and fairness under various traffic demands.

On the Use of Stochastic Driver Behavior Model in Lane Departure Warning

Angkititrakul, P. Terashima, R. Wakita, T.

In this paper, we propose a new framework for discriminating the initial maneuver of a lane-crossing event from a driver correction event, which is the primary reason for false warnings of lane departure prediction systems (LDPSs). The proposed algorithm validates the beginning episode of the trajectory of driving signals, i.e., whether it will cause a lane-crossing event, by employing driver behavior models of the directional sequence of piecewise lateral slopes (DSPLS) representing lane-crossing and driver correction events. The framework utilizes only common driving signals and allows the adaptation scheme of driver behavior models to better represent individual driving characteristics. The experimental evaluation shows that the proposed DSPLS framework has a detection error with as low as a 17% equal error rate. Furthermore, the proposed algorithm reduces the false-warning rate of the original lane departure prediction system with less tradeoff for the correct prediction.

Road Detection Based on Illuminant Invariance

Alvarez, J.M.A. Lopez, A.M.

By using an onboard camera, it is possible to detect the free road surface ahead of the ego-vehicle. Road detection is of high relevance for autonomous driving, road departure warning, and supporting driver-assistance systems such as vehicle and pedestrian detection. The key for vision-based road detection is the ability to classify image pixels as belonging or not to the road surface. Identifying road pixels is a major challenge due to the intraclass variability caused by lighting conditions. A particularly difficult scenario appears when the road surface has both shadowed and nonshadowed areas. Accordingly, we propose a novel approach to vision-based road detection that is robust to shadows. The novelty of our approach relies on using a shadow-invariant feature space combined with a model-based classifier. The model is built online to improve the adaptability of the algorithm to the current lighting and the presence of other vehicles in the scene. The proposed algorithm works in still images and does not depend on either road shape or temporal restrictions. Quantitative and qualitative experiments on real-world road sequences with heavy traffic and shadows show that the method is robust to shadows and lighting variations. Moreover, the proposed method provides the highest performance when compared with hue-saturation-intensity (HSI)-based algorithms.

Online Spatio-Temporal Risk Assessment for Intelligent Transportation Systems

Linda, O. Manic, M.

Due to modern pervasive wireless technologies and high-performance monitoring systems, spatio-temporal information plays an important role in areas such as intelligent transportation systems (ITS), surveillance, scheduling, planning, or industrial automation. Security or criminal/terrorist threat prevention in modern ITS is one of today's most relevant concerns. This paper presents an algorithm for online spatio-temporal risk assessment in urban environments. In its first phase, the algorithm uses the online nearest neighbor clustering (NNC) algorithm to identify a set of significant places. In the second phase, a fuzzy inference engine is employed to quantify the level of risk that each significant place poses to the place of interest (e.g., vehicle, person, building, or an object of high assets). The contributions of the presented algorithm are given as follows: 1) recognition and extraction of the set of the most significant places; 2) dynamic adaptation of the solution to time-dependent traffic distributions; 3) parametric con-
Induced Voltage Calculation in Electric Traction Systems: Simplified Methods, Screening Factors, and Accuracy

Mariscotti, A.

In modern electric traction systems, the calculation of induced voltage on internal and external conductors is always required for both interference and people and equipment safety. The International Telegraph and Telephone Consultative Committee (CCITT) method is based on simplified relationships, which are integrated by suitable screening factors (representing and hiding the traction system complexity). Focus is on the determination of these factors and the accuracy, which are evaluated with simulation and experimental data. The considered systems are rail return, return conductor, and autotransformer (AT) 2 × 25-kV traction systems with victim cables of various lengths; the influence of the most relevant electric parameters (soil resistivity and conductance to earth of the return circuit conductors) is considered. The results confirm the relevance of the conductance to earth and of the position of the current injection point. The induced voltage is approximately proportional to the length, with a slight increase for shorter victim cables. The calculated AT screening factor is always smaller than the values suggested by the standards by a factor of 2 in the worst case. For the influence of separation of the inducing and victim circuits, the adopted methods agree in finding a critical distance around 6-8 m; at larger distances, CCITT values are slightly optimistic. Measured results confirm that the CCITT coefficients are all conservative by a factor of 2-4 (except the AT coefficient for total length exposure), whereas the multiconductor transmission line (MTL) results agree with a worst-case margin of 13%.

Development and Application of an Integrated Evaluation Framework for Preventive Safety Applications


Preventive safety functions help drivers avoid or mitigate accidents. No quantitative methods have been available to evaluate the safety impact of these systems. This paper describes a framework for the assessment of preventive and active safety functions, which integrates procedures for technical performance, human factors, and safety assessments in one holistic approach. The concept of situational control, which is defined as the degree of control that a joint driver-vehicle system exerts over a traffic situation, has been introduced. Assessment involves technical evaluation, which assesses that the system and all subsystems work according to the functional and technical specifications, human factors evaluation, which assesses the behavioral situational control parameters, and safety potential evaluation, which performs a detailed assessment of internal and external impact mechanisms that change the situational control at the traffic level. The methodology has been applied to the INSAFES project, which integrates lateral and longitudinal control functions.


Bin Wu  Changxu Lin

With the increasing usage of in-vehicle systems, drivers have to frequently perceive and respond to messages from these in-vehicle systems. In addition, previous studies have found that the interval between the messages (arrival rate) presented to a driver becomes one of the factors affecting driver workload. To reduce driver workload, researchers on adaptive workload-management systems have found that adding extra delay time into the interval of messages can significantly reduce driver workload. However, it is unknown whether this extra delay time added by an adaptive workload-management system will increase the performance time of drivers or not. To answer this important question, using closed-form mathematical equations, the current work quantifies human performance...
time (total task completion time and reaction time of each task) when there are two serial processing stages in the human cognitive system. The mathematical model developed in this work provides solutions of the optimal interval of messages that generate the lowest workload without deteriorating drivers' performance time to respond to multiple messages from in-vehicle systems. This is one of a few closed-form deterministic mathematical models with analytic solutions that can predict average reaction time when there are two multiple serial stages in the cognitive system in dual tasks. With relatively simple equations, the mathematical model can still capture the major patterns of simulation results with stochastic properties and human behavioral experimental results. The mathematical equations developed in this study can be used in the design of adaptive workload-management systems and other driver assistance systems.

Easy Calibration of a Blind-Spot-Free Fisheye Camera System Using a Scene of a Parking Space

Shigang Li  Ying Hai

Mounting three fisheye cameras, on the sides and rear of a vehicle, can help a driver maneuver his/her vehicle in restricted environments by providing a top view that is generated from these three fisheye cameras. To generate the top view, the pose of each fisheye camera must first be calibrated. In this paper, we propose an easy method of calibrating such a fisheye camera system by observing the scene of a parking space. First, each camera pose relative to the ground is estimated from the typical line pattern of a parking space. Then, the relative pose among the three cameras is refined using the overlapping region of the ground between the neighboring cameras. Finally, if necessary, any small deviation of the pose of the camera system can manually be adjusted by an interactive interface. Since the calibration of the fisheye camera system can be performed without preparing a specific calibration pattern for this particular purpose beforehand, the proposed method can reduce the workload on the user. Experimental results reveal the effectiveness of the proposed method.

Travel Time Prediction Using Floating Car Data Applied to Logistics Planning

Simroth, A.  Zähle, H.

Travel time information plays an important role in transportation and logistics. Much research has been done in the field of travel time prediction in local areas, aiming at accurate short-term predictions based on the current traffic situation and historical data of the area. In contrast, literature on prediction methods for long-range trips in large areas is rare, although it is highly relevant for logistics companies to manage their fleet of vehicles. In this paper, we present a new algorithm for predicting the remaining travel times of long-range trips. It makes use of nonparametric distribution-free regression models, which are applicable only in the presence of a sufficiently large database. Since, in contrast to local areas, such a base is visionary for large areas, we bring into play a dynamic data preparation to artificially enlarge the database. The algorithm also takes into account that routes of long-range trips are not completely given in advance but are rather unknown and subject to change. We illustrate our algorithm by means of simulations and a real-life case study at a German logistics company. The latter shows that, by our algorithm, the average relative error can be halved compared with conventional methods.

Real-Time Gaze Estimator Based on Driver's Head Orientation for Forward Collision Warning System

Sung Joo Lee  Jaeik Jo  Ho Gi Jung  Kang Ryoung Park  Jaihie Kim

This paper presents a vision-based real-time gaze zone estimator based on a driver's head orientation composed of yaw and pitch. Generally, vision-based methods are vulnerable to the wearing of eyeglasses and image variations between day and night. The proposed method is novel in the following four ways: First, the proposed method can work under both day and night conditions and is robust to facial image variation caused by eyeglasses because it only requires simple facial features and not specific features such as eyes, lip corners, and facial contours. Second, an ellipsoidal face model is proposed instead of a cylindrical face model to exactly determine a driver's yaw. Third, we propose new features-the normalized mean and the standard deviation of the horizontal edge projection histo-
gram-to reliably and rapidly estimate a driver's pitch. Fourth, the proposed method obtains an accurate gaze zone by using a support vector machine. Experimental results from 200 000 images showed that the root mean square errors of the estimated yaw and pitch angles are below 7 under both daylight and nighttime conditions. Equivalent results were obtained for drivers with glasses or sunglasses, and 18 gaze zones were accurately estimated using the proposed gaze estimation method.

Design of a Haptic Gas Pedal for Active Car-Following Support

Mulder, M. Abbink, D. A. van Paassen, M. M. Mulder, M.

The research presented in this paper focuses on the design of a driver support system for the manual longitudinal control of a car during car-following. The aim of the design was to develop a system that would cooperate with the driver in comfortably maintaining (safe) separation with a lead vehicle. Three important design issues for a haptic gas pedal feedback system can be distinguished: 1) quantification of intervehicle separation parameters; 2) the type of haptic feedback; and 3) the relation between haptic feedback and intervehicle separation. Because of the inverse relationship between time-to-contact (TTC) and time-headway (THW)—the smaller the THW, the more important the avoidance of high TTC—THW should act as an amplifier for the haptic gas pedal feedback based on TTC. Using gas pedal stiffness feedback is expected to better facilitate the manual control of intervehicle separation changes, quantified by THW and TTC, because stiffness feedback allows perception of force and force-slope changes. The force changes inform drivers of instantaneous changes in the environment. Force-slope changes prevent drivers from input to the car that would continue to reduce the following gap in situations where this would be undesirable. A review of fixed-base simulator and field tests confirms that haptic gas pedal feedback improves driver vigilance during car-following without increasing the workload.

A Fast Signal Timing Algorithm for Individual Oversaturated Intersections

Lei Zhao Xiaoshan Peng Li Li Zhenjiang Li

In this paper, we propose a fast greedy search algorithm for optimal single-cycle signal timing at individual oversaturated intersections. We illustrate the efficiency of the algorithm with a numerical example in the literature.

Scale-Adaptive Spatial Appearance Feature Density Approximation for Object Tracking

Liu, C.Y. Yung, N.H.C.

Object tracking is an essential task in visual traffic surveillance. Ideally, a tracker should be able to accurately capture an object's natural motion such as translation, rotation, and scaling. However, it is well known that object appearance varies due to changes in viewing angle, scale, and illumination. They introduce ambiguity to the image cue on which a visual tracker usually relies and which affects the tracking performance. Thus, a robust image appearance cue is required. This paper proposes scale-adaptive spatial appearance feature density approximation to represent objects and construct the image cue. It is found that the appearance representation improves the sensitivity on both the object's rotation and scale. The image cue is then constructed by both the appearance representation of the object and its surrounding background such that distinguishable parts of an object can be tracked under poor imaging conditions. Moreover, tracking dynamics is integrated with the image cue so that objects are efficiently localized in a gradient-based process. Comparative experiments show that the proposed method is effective in capturing the natural motion of objects and generating better tracking accuracy under different image conditions.

Requiem for Freeway Travel Time Estimation Methods Based on Blind Speed Interpolations Between Point Measurements

Soriguera, F. Robuste, F.

Travel time estimation from loop measurements has attracted extensive research in the last decade, resulting in numerous methodologies. Among these, those that rely on spot speed measurements at detector sites to obtain travel time estimation on the target stretch are the most intuitive. The key issue concerning these methods is the spatial generalization of point measurements over a freeway link. This paper shows that all speed interpolation
methods that omit traffic dynamics and queue evolution do not contribute to better travel time estimations. All methods are inaccurate in congested and transition conditions, and the claimed relative benefits using various speed interpolation methods result from context-specific experiments. Therefore, these methods should be carefully used and not taken as perfect. Lacking a better approach, it is recommended to avoid overcomplicated mathematical interpolations and focus efforts on intelligent smoothing of the noisy loop detector data, reducing the fluctuations of short time interval aggregations while maintaining the immediacy of the measurements.

Robust Inference of Principal Road Paths for Intelligent Transportation Systems

Agamennoni, G.  Nieto, J.I.  Nebot, E.M.

Over the last few years, electronic vehicle guidance systems have become increasingly more popular. However, despite their ubiquity, performance will always be subject to availability of detailed digital road maps. Most current digital maps are still inadequate for advanced applications in unstructured environments. Lack of up-to-date information and insufficient refinement of the road geometry are among the most important shortcomings. The massive use of inexpensive Global Positioning System (GPS) receivers, combined with the rapidly increasing availability of wireless communication infrastructure, suggests that large amounts of data combining both modalities will be available in the near future. The approach presented here draws on machine-learning techniques and processes logs of position traces to consistently build a detailed and fine-grained representation of the road network by extracting the principal paths followed by the vehicles. Although this work addresses the road-building problem in dynamic environments such as open-pit mines, it is also applicable to urban environments. New contributions include a fully unsupervised segmentation method for sampling roads and inferring the network topology, which is a general technique for extracting detailed information about road splits, merges, and intersections, as well as a robust algorithm that articulates these two. Experimental results with data from large mining operations are presented to validate the new algorithm.

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Virtual Testbed for Assessing Probe Vehicle Data in IntelliDrive Systems

Dion, F.  Oh, J.-S.  Robinson, R.

This paper presents an effort to develop a virtual testbed for assessing probe vehicle data generation by IntelliDrive vehicles within a microscopic traffic-simulation environment. Simulation capabilities are implemented through the development of a portable plug-in module using the application programming interface of the Paramics microscopic traffic simulation. This module simulates the generation of snapshots by individual vehicles, the uploading of these snapshots to roadside units, and some probe vehicle data postprocessing. While some temporary simplifying assumptions are made, the simulation generally follows operational concepts described in the Society of Automotive Engineers (SAE) J2735 Surface Vehicle Standard. Application of the model is demonstrated by simulating IntelliDrive probe data collection over the U.S. Department of Transportation (USDOT)'s Michigan Proof-of-Concept testbed. Simulation results show the sensitivity of probe data collection to communication range, market penetration, number of active roadside communication units (RSEs), interval between snapshots, and snapshot buffer size. Impacts on link travel time estimates are also presented. These results clearly demonstrate the utility of the simulator in conducting evaluations and sensitivity analyses for scenarios that would be difficult to execute in existing testbeds.

Urban Transit Coordination Using an Artificial Transportation System

Li, L.  Zhang, H.  Wang, X.  Lu, W.  Mu, Z.

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. Tradi-
tional 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.

Intervehicle Transmission Rate Control for Cooperative Active Safety System

Huang, C.-L.  Fallah, Y. P.  Sengupta, R.  Krishnan, H.

We propose an intervenicle communication framework for the cooperative active safety system (CASS) whose operation is based on the dissemination of each vehicle's state information through a wireless network. Such a CASS requires each subject vehicle to be aware of its surroundings, particularly of the motion and position of other vehicles in its proximity. In this paper, we assume that all vehicles are equipped with onboard communication devices. In such situations, the wireless channel is simultaneously shared by a large number of vehicles, and one of the most difficult challenges in designing CASS is to maintain real-time tracking accuracy of neighboring vehicles while avoiding network congestion and failure. To address this issue, we analyze the problem that multiple scalar linear time-invariant dynamical systems track each other over a multiaccess channel, and then, we propose a rate adaptation algorithm to distributively control the self-information broadcast behavior of each vehicle. The proposed algorithm uses a closed-loop control concept and accounts for the lossy channel. Simulation results show that, if the message generation rate is dynamically adjusted in an on-demand fashion, more accurate and robust tracking performance can be achieved under various traffic conditions.

Reinforcement Learning With Function Approximation for Traffic Signal Control

L. A., Prashanth  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 et al., 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 et al. and Cools et al., 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 et al. We observe that our algorithm outperforms all the other algorithms on all the road network settings that we consider.

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.

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

Sun, S.  Xu, X.

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.

Driver Inattention Monitoring System for Intelligent Vehicles: A Review

Dong, Y.  Hu, Z.  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.

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

Ji, Z.  Luciw, M.  Weng, J.  Zeng, S.

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 uncoded 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.

Automatic Road Environment Classification

Tang, I. Breckon, T. P.

The ongoing development 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 $\sim 90\%$ correct classification is achieved for the {off-road, on-road} problem at a near real-time classification rate of 1 Hz.

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.

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

Huang, X. Tan, Y. He, X.

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.

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 sys-
tems (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.

Automated On-Ramp Merging System for Congested Traffic Situations
Milanés, V. Godoy, J. Villagrá, J. Pérez, 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.

EasiTia: A Pervasive Traffic Information Acquisition System Based on Wireless Sensor Networks
Wang, R. Zhang, L. Sun, R. Gong, J. Cui, L.

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.
Automatic Traffic Signs and Panels Inspection System Using Computer Vision


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.

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


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.

A Model of Risk-Sensitive Route-Choice Behavior and the Potential Benefit of Route Guidance

Illenberger, J. Flötteröd, G. Nagel, K.

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.

An Efficient Computational Architecture for a Collision Early-Warning System for Vehicles, Pedestrians, and Bicyclists

Greene, D. Liu, J. Reich, J. Hirokawa, Y. Shinagawa, A. Ito, H. Mikami, T.

We describe a computational architecture of a collision early-warning system for vehicles and other principals. Early-warnings allow drivers to make good judgments and to avoid emergency stopping or dangerous maneuvering. With many principals (vehicles, pedestrians, bicyclists, etc.) coexisting in a dense intersection, it is difficult to predict, even a few seconds in advance, since there are many possible scenarios. It is a major challenge to manage computational resources and human attention resources so that only the more plausible collisions are tracked, and of those, only the most critical collisions prompt warnings to drivers. In this paper, we propose a two-stage collis-
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.

Impact of Ambulance Dispatch Policies on Performance of Emergency Medical Services

Lim, C. S.  Mamat, R.  Bräunl, 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.

Prediction Intervals to Account for Uncertainties in Travel Time Prediction

Khosravi, A.  Mazloumi, E.  Nahavandi, S.  Creighton, D.  van Lint, J.W.C.

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.
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.

A Multiagent Approach to the Dynamic Enactment of Semantic Transportation Services

Fernández, 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.

Decoupled Conflict-Resolution Procedures for Decentralized Air Traffic Control

Devasia, S.  Iamratanakul, 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.

Autonomous Pedestrian Collision Avoidance Using a Fuzzy Steering Controller


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 colli-
tion. 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.

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

Wang, Y.  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.

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.

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

Li, J.  Tang, S.  Wang, X.  Duan, W.  Wang, F.-Y.

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.

Ecological Vehicle Control on Roads With Up-Down Slopes

Kamal, M. A. S.  Mukai, M.  Murata, J.  Kawabe, T.

This paper presents a novel development of an ecological (eco) driving system for running a vehicle on roads with up–down slopes. Fuel consumed in a vehicle is greatly influenced by road gradients, aside from its velocity and acceleration characteristics. Therefore, optimum control inputs can only be computed through anticipated rigorous
reasoning using information concerning road terrain, model of the vehicle dynamics, and fuel consumption characteristics. In this development, a nonlinear model predictive control method with a fast optimization algorithm is implemented to derive the vehicle control inputs based on road gradient conditions obtained from digital road maps. The fuel consumption model of a typical vehicle is formulated using engine efficiency characteristics and used in the objective function to ensure fuel economy driving. The proposed eco-driving system is simulated on a typical road with various shapes of up–down slopes. Simulation results reveal the ability of the eco-driving system in significantly reducing fuel consumption of a vehicle. The fuel saving behavior is graphically illustrated, compared, and analyzed to focus on the significance of this development.

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.

An Algorithm for License Plate Recognition Applied to Intelligent Transportation System

Wen, Y. Lu, Y. Yan, J. Zhou, Z. von Deneen, K. M. Shi, P.

An algorithm for license plate recognition (LPR) applied to the intelligent transportation system is proposed on the basis of a novel shadow removal technique and character recognition algorithms. This paper has two major contributions. One contribution is a new binary method, i.e., the shadow removal method, which is based on the improved Bernsen algorithm combined with the Gaussian filter. Our second contribution is a character recognition algorithm known as support vector machine (SVM) integration. In SVM integration, character features are extracted from the elastic mesh, and the entire address character string is taken as the object of study, as opposed to a single character. This paper also presents improved techniques for image tilt correction and image gray enhancement. Our algorithm is robust to the variance of illumination, view angle, position, size, and color of the license plates when working in a complex environment. The algorithm was tested with 9026 images, such as natural-scene vehicle images using different backgrounds and ambient illumination particularly for low-resolution images. The license plates were properly located and segmented as 97.16% and 98.34%, respectively. The optical character recognition system is the SVM integration with different character features, whose performance for numerals, Kana, and address recognition reached 99.5%, 98.6%, and 97.8%, respectively. Combining the preceding tests, the overall performance of success for the license plate achieves 93.54% when the system is used for LPR in various complex conditions.

Fast Model Predictive Control for Urban Road Networks via MILP

Lin, S. De Schutter, B. Xi, Y. Hellendoorn, H.

In this paper, an advanced control strategy, i.e., model predictive control (MPC), is applied to control and coordinate urban traffic networks. However, due to the nonlinearity of the prediction model, the optimization of MPC is a nonlinear nonconvex optimization problem. In this case, the online computational complexity becomes a big chal-
The challenge for the MPC controller if it is implemented in a real-life traffic network. To overcome this problem, the online optimization problem is reformulated into a mixed-integer linear programming (MILP) optimization problem to increase the real-time feasibility of the MPC control strategy. The new optimization problem can be very efficiently solved by existing MILP solvers, and the global optimum of the problem is guaranteed. Moreover, we propose an approach to reduce the complexity of the MILP optimization problem even further. The simulation results show that the MILP-based MPC controllers can reach the same performance, but the time taken to solve the optimization becomes only a few seconds, which is a significant reduction, compared with the time required by the original MPC controller.

Toward Air Traffic Complexity Assessment in New Generation Air Traffic Management Systems

Prandini, M.  Piroddi, L.  Puechmorel, S.  Brázdilová, S. L.

The characterization of complex air traffic situations is an important issue in air traffic management (ATM). Within the current ground-based ATM system, complexity metrics have been introduced with the goal of evaluating the difficulty experienced by air traffic controllers in guaranteeing the appropriate aircraft separation in a sector. The rapid increase in air travel demand calls for new generation ATM systems that can safely and efficiently handle higher levels of traffic. To this purpose, part of the responsibility for separation maintenance will be delegated to the aircraft, and trajectory management functions will be further automated and distributed. The evolution toward an autonomous aircraft framework envisages new tasks where assessing complexity may be valuable and requires a whole new perspective in the definition of suitable complexity metrics. This paper presents a critical analysis of the existing approaches for modeling and predicting air traffic complexity, examining their portability to autonomous ATM systems. Possible applications and related requirements will be discussed.

Vehicle Detection and Tracking in Car Video Based on Motion Model

Jazayeri, A.  Cai, H.  Zheng, J. Y.  Tuceryan, M.

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.

A Hybrid Strategy for Real-Time Traffic Signal Control of Urban Road Networks

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

The recently developed traffic signal control strategy known as traffic-responsive urban control (TUC) requires availability of a fixed signal plan that is sufficiently efficient under undersaturated traffic conditions. To drop this requirement, the well-known Webster procedure for fixed-signal control derivation at isolated junctions is appropriately employed for real-time operation based on measured flows. It is demonstrated via simulation experiments and field application that the following hold: 1) The developed real-time demand-based approach is a viable real-time signal control strategy for undersaturated traffic conditions. 2) It can indeed be used within TUC to drop the requirement for a prespecified fixed signal plan. 3) It may, under certain conditions, contribute to more efficient results, compared with the original TUC method.
A New Framework for Stereo Sensor Pose Through Road Segmentation and Registration

Dornaika, F. Álvarez, J. M. Sappa, A. D. López, A. M.

This paper proposes a new framework for real-time estimation of the onboard stereo head's position and orientation relative to the road surface, which is required for any advanced driver-assistance application. This framework can be used with all road types: highways, urban, etc. Unlike existing works that rely on feature extraction in either the image domain or 3-D space, we propose a framework that directly estimates the unknown parameters from the stream of stereo pairs' brightness. The proposed approach consists of two stages that are invoked for every stereo frame. The first stage segments the road region in one monocular view. The second stage estimates the camera pose using a featureless registration between the segmented monocular road region and the other view in the stereo pair. This paper has two main contributions. The first contribution combines a road segmentation algorithm with a registration technique to estimate the online stereo camera pose. The second contribution solves the registration using a featureless method, which is carried out using two different optimization techniques: 1) the differential evolution algorithm and 2) the Levenberg–Marquardt (LM) algorithm. We provide experiments and evaluations of performance. The results presented show the validity of our proposed framework.

A Decentralized Approach for Anticipatory Vehicle Routing Using Delegate Multiagent Systems

Claes, R. Holvoet, T. Weyns, D.

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.

Asphalt Concrete Surfaces Macrotexure Determination From Still Images

Elunai, R. Chandran, V. Gallagher, E.

Road surface macrotexure is identified as one of the factors contributing to the surface's skid resistance. Existing methods of quantifying the surface macrotexure, such as the sand patch test and the laser profilometer test, are either expensive or intrusive, requiring traffic control. High-resolution cameras have made it possible to acquire good quality images from roads for the automated analysis of texture depth. In this paper, a granulometric method based on image processing is proposed to estimate road surface texture coarseness distribution from their edge profiles. More than 1300 images were acquired from two different sites, extending to a total of 2.96 km. The images were acquired using camera orientations of $60^\circ$ and $90^\circ$. The road surface is modeled as a texture of particles, and the size distribution of these particles is obtained from chord lengths across edge boundaries. The mean size from each distribution is compared with the sensor measured texture depth obtained using a laser profilometer. By tuning the edge detector parameters, a coefficient of determination of up to $R^2 = 0.94$ between the proposed method and the laser profilometer method was obtained. The high correlation is also confirmed by robust calibration parameters that enable the method to be used for unseen data after the method has been calibrated over road surface data with similar surface characteristics and under similar imaging conditions.
Online Driver Distraction Detection Using Long Short-Term Memory

Wöllmer, M. Blaschke, C. Schindl, T. Schuller, B. Färber, B. Mayer, S. Trefflich, B.

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).

Energy-Efficient Cooperative Techniques for Infrastructure-to-Vehicle Communications

Nguyen, T.-D. Berder, O. Sentieys, O.

In wireless distributed networks, cooperative relay and cooperative multiple-input–multiple-output (MIMO) techniques can be used to exploit the spatial and temporal diversity gains to increase the performance or reduce the transmission energy consumption. The energy efficiency of cooperative MIMO and relay techniques is then very useful for the infrastructure-to-vehicle (I2V) and infrastructure-to-infrastructure (I2I) communications in intelligent transport system (ITS) networks, where the energy consumption of wireless nodes embedded on road infrastructure is constrained. In this paper, applications of cooperation between nodes to ITS networks are proposed, and the performance and the energy consumption of cooperative relay and cooperative MIMO are investigated and compared with the traditional multihop technique. The comparison between these cooperative techniques helps us choose the optimal cooperative strategy in terms of energy consumption for energy-constrained road infrastructure networks in ITS applications.

A Review of Computer Vision Techniques for the Analysis of Urban Traffic

Buch, N. Velastin, S. A. Orwell, J.

Automatic video analysis from urban surveillance cameras is a fast-emerging field based on computer vision techniques. We present here a comprehensive review of the state-of-the-art computer vision for traffic video with a critical analysis and an outlook to future research directions. This field is of increasing relevance for intelligent transport systems (ITSS). The decreasing hardware cost and, therefore, the increasing deployment of cameras have opened a wide application field for video analytics. Several monitoring objectives such as congestion, traffic rule violation, and vehicle interaction can be targeted using cameras that were typically originally installed for human operators. Systems for the detection and classification of vehicles on highways have successfully been using classical visual surveillance techniques such as background estimation and motion tracking for some time. The urban domain is more challenging with respect to traffic density, lower camera angles that lead to a high degree of occlusion, and the variety of road users. Methods from object categorization and 3-D modeling have inspired more advanced techniques to tackle these challenges. There is no commonly used data set or benchmark challenge, which makes the direct comparison of the proposed algorithms difficult. In addition, evaluation under challenging weather conditions (e.g., rain, fog, and darkness) would be desirable but is rarely performed. Future work should be directed toward robust combined detectors and classifiers for all road users, with a focus on realistic conditions during evaluation.
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