INTELLIGENT TRANSPORTATION SYSTEMS

http://sites.ieee.org/itss/

IEEE ITS SOCIETY NEWSLETTER

Vol. 14, No. 2 April 2012 *Editor: Dr. Yaobin Chen,* yaobinchen@ieee.org

In This Issue

Web Archive and Electronic Newsletter Subscription

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: http://sites.ieee.org/itss/.

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.

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 yaobinchen@ieee.org.

SOCIETY NEWS

From the Editor

by Yaobin Chen

Most of us working in academic institutions have finished/will be finishing our spring semester (quarter). I hope you are ready for summer activities. Our ITS Society is sponsoring two major conferences this summer. The 2012 IEEE Intelligent Vehicles Symposium (IV12) will be held June 3-7, 2012, in Alcalá de Henares, Spain. The 2012 IEEE International Conference on Vehicular Electronics and Safety will be held in Istanbul, Turkey, July 24-27, 2012. I hope you will have the chance to attend these exciting events.

In this issue, we will start with "Message from the President" by Dr. Christoph Stiller, the current ITSS President. I hope Dr. Stiller will continue to communicate with ITS community through the Newsletter in the future. There is also a featured article contributed by Lee Stogner and Russell Lefevre, co-Chairs of the IEEE Transportation Electrification Initiative.

Have a safe and great summer!

Message from President:

On ITSS Society Benefits

By Dr. Christoph Stiller, President

The number of IEEE members has passed well beyond 400,000 and seems to keep growing. A question raised on last weekend's meeting of IEEE's Technical Activities Board was what the main benefits of IEEE and its Societies are to its members and whether IEEE benefits are well balanced for academic and industrial engineers.

IEEE lists many hard benefits that come with membership. But as IEEE is a multicultural professional association, the answer to those questions is multifaceted. When looking at my own membership career which lasts for 20 years by now, I remember that my PhD supervisor recommended entering the IEEE to become a member in a community of professional engineers. Honestly, at that time I did not really understand what that meant and looking back my main reason to actually join IEEE was receiving an own copy of the IEEE Transactions and thus avoiding to running to the library and photocopying its articles. Since long, internet access to publications in IEEE Xplore has rendered this reason obsolete but nevertheless I stayed with IEEE. Definitely, I very much like the idea of a non-profit engineering association that considers goals like fairness, non-discrimination, sustainability, and benefit to humanity. But beyond that, I have indeed experienced large personal benefit. In a nutshell, it is to be part in a network of the international engineering community. This community gave me a professional home at conferences and other meetings. In this community I meet with colleagues to discuss research and industrial trends and speculate what future directions technology and scientific structures may take. Fortunately, life including a professional career can never be planned precisely, but the community provided great inspirations and opportunities to me. Retrospectively, I met many professionals that later became important in my career and even friends through IEEE. These include the later advisor of my post-doctoral position overseas, several project partners, and colleagues visiting or accommodating me for a scientific exchange or a sabbatical. Just next month a scientist that I know for many years from IEEE Intelligent Vehicles Symposia joins my institute for his post-doctorate. This list is definitely not complete and hopefully it is not completed either.

Membership in a community is never a unidirectional matter. Asking both: "What does the IEEE ITS Society do for You?" and "What do You do for the IEEE ITS Society?" is not just an altruistic point of view, but only through active engagement in a society all sides really benefit the most from another. As a young and growing society, the IEEE Intelligent Transportation Systems Society offers excellent opportunities for participation to its members. We always seek volunteers in our society that are active as reviewers and editors for our conferences and journals, organizers of chapters, conferences, and meetings and as members in the society's self-organizing boards. Many volunteers experience that service in our active society is exciting and fosters valuable international contacts. We are permanently open to new individuals. Just contact me in case you are willing to volunteer in any position of our Society. Meanwhile I recommend not only to my PhD students to become a member in the IEEE ITS community of professional engineers.

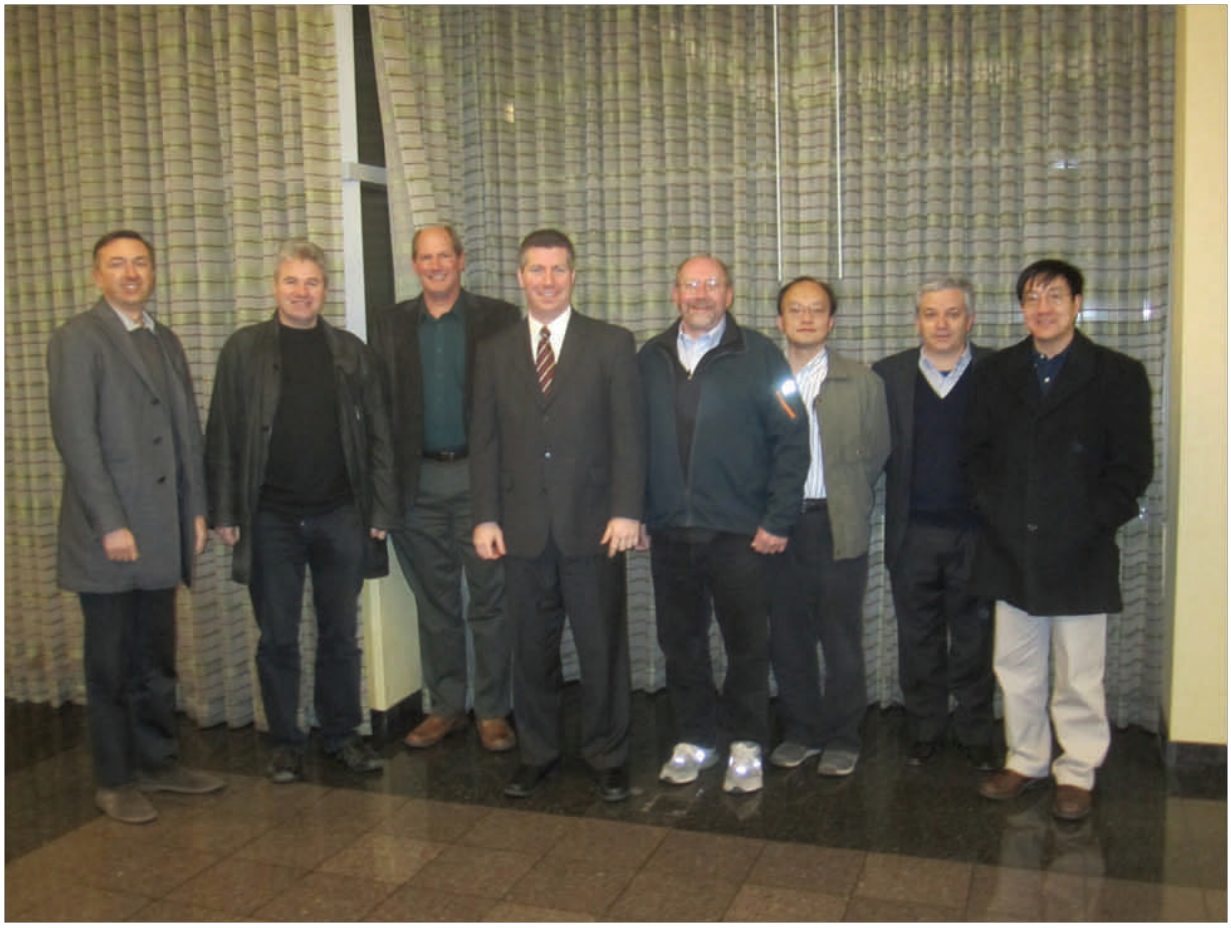
You might read this message just before one of our flagship conferences, the IEEE Intelligent Vehicles Symposium, takes place in Alcalá de Henares, Spain, from June 3-7, 2012. I am looking forward to this meeting in our community.

See you at IV2012 in Spain!

February 2012 ExCom Meeting Summary

By Jeffrey Miller, VP for Administration

The ITSS Executive Committee met on February 11, 2012 in Atlanta, Georgia, USA for its spring meeting. The ExCom will be meeting four times this year – once in winter, once via a teleconference with the Board of Governors in spring, once in summer in conjunction with IV (followed immediately by a BOG meeting), and once in fall in conjunction with ITSC (followed immediately by a BOG meeting). The meeting was attended by 9 of the 10 members of the ExCom, though all 10 members did prepare a report that was presented.



The ExCom members in attendance are shown in the image above. From left to right, Alberto Broggi (Past President), Christoph Stiller (President), Matt Barth (VP Conference Activities), Jeffrey Miller (VP Administrative Activities and Magazine Editor-in-Chief), Daniel Dailey (VP Financial Activities), Daniel Zeng (VP Publication Activities), Urbano Nunes (VP Technical Activities), and Yaobin Chen (Newsletter Editor-in-Chief). Fei-Yue Wang (Transactions Editor -in-Chief) was at the meeting but was not present for the picture. Jason Geng (VP Member Activities) had a conflict and was unable to attend. The facilities at the Hilton Atlanta Airport were adequate for the meeting and allowed the 10 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. Some of the main topics are summarized here.
All three of the ITSS publications (Transactions, Magazine, Newsletter) are doing well. Submissions are increasing and the page budgets for the Transactions need to be increased to keep up with the number of pages being published.

Thanks to Daniel Zeng and Jeff Miller, the ITSS web site has been revised and has a new look. It also has a new URL – http://sites.ieee.org/itss.

Conference activities are going well, and are by far the #1 revenue generator for the society. Christoph Stiller would like for the society to focus on consolidation of recent growth, specifically in publications, membership, and technical committees to continue with the momentum we currently have.
Here are the upcoming conferences with confirmed locations in ITSS:

ITSC 2012 – Anchorage, Alaska, USA
ITSC 2013 – The Hague, Netherlands
ITSC 2014 – perhaps in China, though not confirmed
ITSC 2015 – Las Palmas, Canary Islands
IV 2012 – Alcala de Henares, Spain
IV 2013 – Brisbane, Australia
VNC 2012 – Seoul, Korea

Financially the society is doing well and staying consistent. We currently have 1219 members in the ITSS, up 2.2% from 2011. We would like to strongly encourage more student members in the society through outreach programs at conferences.

The Transactions had 309 submissions in 2010 and 387 submissions in 2011, which is a 25% increase. The impact factor from 2010 is 2.257, making us the #1 journal in transportation and intelligent transportation. The Magazine is currently looking at a few special issues and has been delivered on time for the past three issues. This is important to maintain to get an impact factor as soon as possible.

The meeting concluded around 6:30p.m. If you have any questions about anything covered at the meeting, feel free to contact the VP Administrative Activities, Jeffrey Miller, at jeffrey.miller@ieee.org.

April 2012 BoG Meeting Summary

By Jeffrey Miller, VP for Administration

The ITSS Board of Governors (BOG) met via teleconference on April 23, 2012. The BOG has typically met twice a year – once in spring via a teleconference and once in fall in conjunction with ITSC. This year, the BOG will also meet in summer in conjunction with IV. The meeting was attended by 14 of the 24 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.

The purpose of the teleconference was to vote on matters that were time-sensitive. Here is a summary of the meeting.

The budget for 2012/2013 was unanimously approved. The budget provides us with a break-even if we use the old page budgets for the Transactions and Magazine. We may have some more revenue appearing from ITSC 2011 and the publications in the near future.
The Transactions page budget was unanimously approved to be increased to 1936 for the year 2012.

The BOG unanimously approved to hold IV 2013 in Brisbane, Australia, to hold the International Conference on Intelligent Rail Transportation (ICIRT) in China in May 2013, and to hold ITSC 2015 in the Canary Islands.
There are updated associate editors for both the Transactions and the Magazine that were unanimously approved.
The next BOG meeting will be on June 8, 2012 in Spain in conjunction with IV 2012.
If you have any questions about anything covered at the meeting, feel free to contact the VP Administrative Activities, Jeffrey Miller, at jeffrey.miller@ieee.org.

IEEE ITSS Best Ph.D. Dissertation Award

Call for Application of Award

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.

Eligibility of Applicant

Applicant should be a member or student member of IEEE ITSS by the date of application (June 15, 2012).

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 published paper (or submitted for publication) 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. All publication by the applicant in the related field.
5. 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, 2012** 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 1,000. The second place prize winner will receive USD 500. Award certificates will be given out at the ITSC 2012 conference in Anchorage, Alaska, 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.

Featured article:

The IEEE Transportation Electrification Initiative

By Lee Stogner and Russell Lefevre
Co-Chairs, IEEE Transportation Electrification Initiative

On March 4 - 8, in Greenville, South Carolina, we held the successful 2012 IEEE International Electric Vehicle Conference, IEVC. Attendees included over 646 very senior very international Registrants. I'm proud to say that this was a multi IEEE society conference that came together to firmly establish the IEEE as a force in the new world of transportation electrification. In addition, we had keynotes from the Presidents of other electric vehicle organizations that included SAE International and the Electric Drive Transportation Association, EDTA. To learn more about the IEVC, please view our overview video at,
http://www.youtube.com/watch?v=tANYyMzFkfU&feature=youtu.be.

Gordon Day's keynote video at,
http://www.youtube.com/watch?v=0ws05iYHboI&feature=youtu.be.

And other keynotes / panel discussions at,
http://ieeeusa.org/calendar/conferences/ievc/default.asp.

We would also like to thank IEEE TV, IEEE Conference Services, IEEE-USA, IEEE Future Directions Committee and the Clemson University International Center for Automotive Research, CU-ICAR, for their help in not only working to make the IEVC a success but to also help us launch the new IEEE Transportation Electrification Initiative.

The IEEE Transportation Electrification Initiative has been established to make it easy for those outside of the IEEE to connect with our large number of societies, councils, committees, standards and people that are actively involved in the electrification of transportation. Given that electric vehicle technology covers so much of the IEEE and that this technology will be a game changer for the world, the Initiative will help promote the concentration of discussion and rapid development of IEEE resources for this new mode of transportation.

Our first Initiative development is the creation of the IEEE Transportation Electrification Web Portal at: http://electricvehicle.ieee.org/.

This web portal will not only promote easy access to IEEE resources through a specially designed custom search and timely industry information, it will support on going discussions through Linkedin at,
http://www.linkedin.com/groups/IEEE-Clean-Transportation-3049403?trk=myg_ugrp_ovr.

Facebook at,
http://www.facebook.com/IeeeTransportationElectrification.

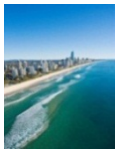
And Twitter at,
http://twitter.com/intent/follow?source=followbutton&variant=1.0&screen_name=IEEEEV.

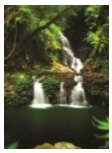
We encourage all of you to contribute articles, discussions and comments across all of these channels. We also need to know about your own electric vehicle events, meetings, conferences and developments. One of our main Initiative goals is to promote what you are doing and with your input, we will help connect you with the people and opportunities that you need to be successful.

Finally, we are actively reaching out to others that are involved in electric vehicles. To date we have exhibited and made presentations at the SAE World Congress and the EDTA EVS26. In June we will help lead a visit to Capital Hill to ensure that key Congressional Representatives know of the important electric vehicle work that the IEEE is doing. And, we are building a database of those outside of the IEEE that need to know about us. As it grows, this database will be important to the promotion of a growing percentage of our IEEE products and services.
Our next conference will be the 2012 IEEE Transportation Electrification Conference and Expo, ITEC, on June 18 - 20 in Dearborn, MI. I encourage all of you to participate and please invite people / companies outside of the usual IEEE crowd to register for ITEC. If we don't reach out to different people, we will not grow. More information on ITEC can be found at, http://itec-conf.com/.

Thank you for your support. Let's make the IEEE the "go to" organization for everything that will be needed for the electrification of transportation.






Call for Papers

THE INTELLIGENT VEHICLES SYMPOSIUM (IV'13) is the premier annual forum sponsored by the IEEE INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY (ITSS). Researchers, academics, practitioners, and students from universities, industry, and government agencies are invited to discuss research and applications for Intelligent Vehicles and Cooperative Vehicle Systems. The technical presentations are characterized by a single session format so that all attendees remain in a single room for multilateral communications in an informal atmosphere. Tutorials will be offered on the first day followed by three days of presentations. An exhibition area will be available for the presentation of products and projects.

The IFAC – INTELLIGENT AUTONOMOUS VEHICLES CONFERENCE IAV'13 will also be held at Gold Coast, from 26 June to 28 June 2013. It is the very first time, since their inception, that these two premier conferences will be held back-to-back. A special reduced conference fee will thus be on offer to intelligent autonomous vehicles researchers and practitioners towards encouraging them to attend both events and explore underpinning synergies. For details please visit www.iav2013.org

The IV'13 Program topics include but are not limited to:

Advanced Driver Assistance Systems
Automated Vehicles
Vehicular Safety, Active and Passive
Vehicle Environment Perception
Driver State and Intent Recognition
Eco-driving and Energy-Efficient Vehicles
Impact on Traffic Flows
Cooperative Vehicle – Infrastructure Systems
Collision Avoidance
Pedestrian Protection
V2I/V2V Communication
Proximity Detection Technology
Assistive Mobility Systems
Proximity Awareness Technology
Intelligent Ground, Air and Space Vehicles
Autonomous/Driverless Vehicles
Image, Radar and Lidar Signal Processing
Information Fusion
Vehicle Control
Telematics
Human Factors and HMI
Electric and Hybrid Vehicle Technologies
Novel Interfaces and Displays
Intelligent Vehicle Software Architecture

For detailed submission instructions visit the conference website at www.iv2013.org

Important Dates

Workshop, Special Session and Tutorial Proposals	01 November 2012
Paper Submission	01 November 2012
Notification of Acceptance	15 January 2013
Early Registration	15 February 2013
Final paper Submission	28 February 2013

Proposals

For special sessions, demonstrations, and exhibition proposals please contact respective chair.



AutomotiveUI'12

www.auto-ui.org

4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications
October 17-19, 2012
Portsmouth, New Hampshire, USA

AutomotiveUI, the International Conference on Automotive User Interfaces and Interactive Vehicular Applications, is the premier forum for UI research in the automotive domain. **AutomotiveUI** brings together researchers and practitioners interested in both the technical and the human aspects of in-vehicle user interfaces and applications. **AutomotiveUI'12** will investigate novel in-vehicle services, issues related to driver distraction, approaches to improving driver performance, and the varying needs of different user groups. Additionally, **AutomotiveUI'12** will explore the relationship between these topics and automotive user interface standards.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courtesy http://www.flickr.com/photos/drocpsu/728533952/in/photostream


courtesy http://visitwhitemountains.com

TOPICS

AutomotiveUI'12 invites you to submit original work in one or more of the following formats: full and short papers, workshops, posters, interactive demonstrations, and industrial show-cases. Topics include, but are not limited to:

- New concepts for in-car user interfaces *(multi modal, speech, audio, gestural, natural I/O)*
- Text input and output while driving
- Interfaces to control in-car entertainment
- Evaluation and benchmarking of in-car user interfaces
- Assistive technology in the vehicular context
- Methods and tools for automotive user interface research
- Automotive user interface frameworks and toolkits
- Detecting and estimating user intentions
- Emotional state recognition while driving
- Techniques for cognitive workload and/or visual demand estimation
- Biometrics and physiological sensors as a user interface component
- Detecting/measuring driver distraction
- Sensors and context for interactive experiences in the car
- User interfaces for information access (*search, browsing, etc.*) while driving
- User interfaces for navigation or route guidance
- Applications and user interfaces for inter-vehicle comm.
- In-car gaming and entertainment
- Different user groups and user group characteristics
- In-situ studies of automotive user interface approaches
- General automotive user experience research
- Topics associated with automotive user interface standards
- Vehicle based apps, web / cloud enabled connectivity
- The role of subliminal cues and feedback to augment driving behavior

IMPORTANT DATES

Please check the conference webpage at www.auto-ui.org for further information and/or any changes to submission deadlines.

Category	Submission Deadline	Acceptance Notification	Final Version
Full and Short Papers	June 1st, 2012	August 3rd, 2012	August 24th, 2012
Workshop Proposals	July 6th, 2012	July 20th, 2012	n/a
Work-in-progress, Demos, and Industrial Showcase	September 7th, 2012	September 21st, 2012	October 5th, 2012

ORGANIZING COMMITTEE

General Chair (*chair@auto-ui.org*)
- Andrew L. Kun, University of New Hampshire, USA

Paper Co-Chairs (*papers@auto-ui.org*)
- Linda Boyle, University of Washington, USA
- Bryan Reimer, MIT AgeLab, USA
- Andreas Riener, University of Linz, Austria

PUBLISHING

We plan to publish the AutomotiveUI'12 proceedings online via the ACM Digital Library. The adjunct proceedings of AutomotiveUI'12 will be published online at the conference website. Proceedings may be also considered for printing under a ISBN carrier.

Join us this October for stimulating discussions and for beautiful views of the New England fall foliage.


Conference Calendar

Massimo Bertozzi / Paolo Grisleri

Conference Calendar

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

2012

May 6-9 2012
IEEE Vehicular Technology Conference: VTC2012-Spring
Yokohama, Japan
http://www.ieeevtc.org/vtc2012spring/index.php

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

May 28-31, 2012
ISIE 2011 - 21th IEEE International Symposium on Industrial Electronics
Hangzhou, Zhejiang, China
http://www.isie2012.com/

May 30-31, 2012
16th International Forum on Advanced Microsystems for Automotive Applications (AMAA 2012)
Harnack House, Berlin (Germany)
http://www.amaa.de/

June 3-7, 2012
IEEE Intelligent Vehicle Symposium
Alcala de Hernares, Spain
http://www.robesafe.es/iv2012/

July 2-4, 2012
IEEE International Conference on Virtual Environments, Human Computer Interfaces and Measurement System (VECIMS2012)
Tianjin, China
http://vecims2012.ieee-ims.org/

July 17-19, 2013
International Symposium on Transportation and Traffic Theory
Noordwijk, the Netherlands
http://www.isttt.org/

June 18-20, 2012
Computer Vision and Pattern Recognition: CVPR 2011
Providence, Rhode Island, USA
http://www.cvpr2012.org/

July 14-16
12th Asia-Pacific ITS Forum & Exhibition
Kuala Lumpur, Malaysia
http://www.itsasiapacific2008.com/

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

September 3-6, 2012
IEEE Vehicular Technology Conference: VTC2012-Fall
Quebec City, Canada
http://www.ieeevtc.org/vtc2012fall/index.php

September 16-19, 2012
IEEE Intelligent Transportation Systems Conference
Anchorage, Alaska, USA
http://www.itsc2012.org

September 16-19, 2012
National Rural ITS Conference
Biloxi, Mississipi, USA
http://www.nritsconference.org

October 3-5, 2012
2012 IEEE Multi-Conference on Systems and Control
Dubrovnik, Croatia
http://www.msc2012.org/

October 7-12, 2012
2012 IEEE/RSJ International Conference on Intelligent Robots and Systems
Vilamoura-Algarve, Portugal
http://www.iros2012.org/site/

October 10-13, 2012

12th International Conference on Transport Systems Telematics
Katowice-Ustroń, Poland
http://www.tst-conference.org/index.php?page=home&lang=en

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

November 5-8, 2012
12th International Conference on ITS Telecommunications
Taipei, Taiwan
Submission due by: May 31,2012
http://www.itst2012.org

2013

June 2-5, 2013
IEEE Vehicular Technology Conference: VTC2013-Spring
Dresden, Germany
Submissions due by: September 30
http://www.ieeevtc.org/vtc2013spring/index.php

April 16-18, 2013
SAE 2013 World Congress
Detroit, Michigan, USA
Submissions due by: September 1st
http://www.sae.org/congress/techprogram/cfp.pdf

September 25-27, 2013
International Conference on Sustainable Automotive Technologies
Ingolstadt, Germany
Submissions due after: August 1st
http://www.icsat2013.com

October 14-18, 2013
20th World Congress on ITS
Tokyo, Japan
http://www.itsworldcongress.jp

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.
Prize: The award consists of a gold medal, bronze replica, certificate and honorarium.
Basis for Judging: In the evaluation process, the following criteria are considered: public benefits of the contribution; degree in improvement in important performance metrics; innovative design, development or application engineering; favorable influence on the contribution on technical professions.
Presentation: At the annual IEEE Honors Ceremony.
Nomination deadline: 1 July
For nomination guidelines and forms, visit http://www.ieee.org/about/awards/medals/envsaf.html
Questions? Contact IEEE Awards Activities, 445 Hoes Lane, Piscataway, NJ 08854 USA; tel.: +1 732 562 3844; fax: +1 732 981 9019; e-mail: awards@ieee.org.

Transactions on ITS Abstracts

EARLY ACCESS

Comparison of Broadcasting Schemes for Infrastructure to Vehicular Communications

Sikdar, B.

A large set of potential applications being designed for intelligent transportation systems (ITSs) depends on the broadcasting of information and control packets by roadside infrastructure points to vehicles in their vicinity. This paper considers the broadcast capacity of broadcast schemes and evaluates and compares the broadcast capacity of strategies based on time splitting, frequency splitting, and superposition coding. Frequency splitting is shown to always dominate time splitting, and the conditions under which superposition coding dominates the other two are derived. For these regimes, it is shown that the broadcast capacities associated with superposition coding are optimal. A proportionally fair algorithm for scheduling broadcast packets is then proposed, and its performance is compared against that of other schedulers.

Handoff Performance Improvements in MIMO-Enabled Communication-Based Train Control Systems

Zhu, L.; Yu, F. R.; Ning, B.; Tang, T.

Communication-based train control (CBTC) is an automated control system for railways using data communications. CBTC systems have stringent communication latency requirements. For rail transit systems, wireless local area network (WLAN)-based CBTC is a popular approach due to the wide availability of commercial-off-the-shelf WLAN equipment. However, WLANs were not originally designed for high-speed environments with frequent handoffs, which may result in communication interrupt and long latency. In this paper, we propose a handoff scheme in CBTC systems based on WLANs with multiple-input–multiple-output (MIMO) technologies to improve the handoff latency performance. In particular, we consider channel estimation errors and the tradeoff between MIMO multiplexing gain and diversity gain in making handoff decisions. The handoff problem is formulated as a partially observable Markov decision process (POMDP), and the optimal handoff policy can be derived to minimize the handoff latency. Simulations results based on real field channel measurements are presented to show the effectiveness of the proposed scheme.

Driver Behavior Classification at Intersections and Validation on Large Naturalistic Data Set

Aoude, G. S.; Desaraju, V. R.; Stephens, L. H.; How, J. P.

The ability to classify driver behavior lays the foundation for more advanced driver assistance systems. In particular, improving safety at intersections has been identified as a high priority due to the large number of intersection-related fatalities. This paper focuses on developing algorithms for estimating driver behavior at road intersections and validating them on real traffic data. It introduces two classes of algorithms that can classify drivers as compliant or violating. They are based on 1) support vector machines and 2) hidden Markov models, which are two very popular machine learning approaches that have been used successfully for classification in multiple disciplines. However, existing work has not explored the benefits of applying these techniques to the problem of driver behavior classification at intersections. The developed algorithms are successfully validated using naturalistic intersection data collected in Christiansburg, VA, through the U.S. Department of Transportation Cooperative Intersection Collision Avoidance System for Violations initiative. Their performances are also compared with those of three traditional methods, and the results show significant improvements with the new algorithms.

Integrating Appearance and Edge Features for Sedan Vehicle Detection in the Blind-Spot Area

Lin, B.-F.; Chan, Y.-M.; Fu, L.-C.; Hsiao, P.-Y.; Chuang, L.-A.; Huang, S.-S.; Lo, M.-F.

Changing lanes while having no information about the blind spot area can be dangerous. We propose a vision-based vehicle detection system for a lane changing assistance system to monitor the potential sedan vehicle in the blind-spot area. To serve our purpose, we select adequate features, which are directly obtained from vehicle images, to detect possible vehicles in the blind-spot area. This is challenging due to the significant change in the view angle of a vehicle along with its location throughout the blind-spot area. To cope with this problem, we propose a method to combine two kinds of part-based features that are related to the characteristics of the vehicle, and we build multiple models based on different viewpoints of a vehicle. The location information of each feature is incorporated to help construct the detector and estimate the reasonable position of the presence of the vehicle. The experiments show that our system is reliable in detecting various sedan vehicles in the blind-spot area.

On-Road Multivehicle Tracking Using Deformable Object Model and Particle Filter With Improved Likelihood Estimation

Tehrani Niknejad, H.; Takeuchi, A.; Mita, S.; McAllester, D.

This paper proposes a novel method for multivehicle detection and tracking using a vehicle-mounted monocular camera. In the proposed method, the features of vehicles are learned as a deformable object model through the combination of a latent support vector machine (LSVM) and histograms of oriented gradients (HOGs). The detection algorithm combines both global and local features of the vehicle as a deformable object model. Detected vehicles are tracked through a particle filter, which estimates the particles' likelihood by using a detection scores map and template compatibility for both root and

parts of the vehicle while considering the deformation cost caused by the movement of vehicle parts. Tracking likelihoods are iteratively used as a priori probability to generate vehicle hypothesis regions and update the detection threshold to reduce false negatives of the algorithm presented before. Extensive experiments in urban scenarios showed that the proposed method can achieve an average vehicle detection rate of 97% and an average vehicle-tracking rate of 86% with a false positive rate of less than 0.26%.

Maximum-Likelihood Acceleration Estimation From Existing Roadway Vehicle Detectors

Ernst, J. M.; Krogmeier, J. V.; Bullock, D. M.XXX

Transportation agencies have invested in extensive infrastructure for vehicle detection and speed estimation. Although knowledge of vehicle speeds helps characterize traffic flow, vehicle accelerations can lead to better characterization. Vehicle accelerations are important in designing signal timings with respect to yellow intervals and green extensions for dilemma zone protection. Vehicle acceleration models are also used in studies of vehicle emissions. This paper develops an algorithm that uses existing inductive loops and magnetometers in speed trap configurations to measure acceleration. The algorithm chosen is the maximum-likelihood estimator, given an additive white Gaussian noise model for noise. The algorithm is found to have an error of about 0.02 g.

Simple Vehicle Powertrain Model for Modeling Intelligent Vehicle Applications

Rakha, H. A.; Ahn, K.; Faris, W.; Moran, K. S.

This research develops a simple vehicle powertrain model that can be incorporated within microscopic traffic simulation software for the modeling of intelligent vehicle applications. This simple model can be calibrated using vehicle parameters that are publically available without the need for field data collection. The model uses the driver throttle level input to compute the engine speed and, subsequently, the engine torque and power to finally compute the vehicle acceleration, speed, and position. The model is tested using field measurements and is demonstrated to produce vehicle power, fuel consumption, acceleration, speed, and position estimates that are consistent with field observations.

High-Altitude Wind Energy for Sustainable Marine Transportation

Fagiano, L.; Milanese, M.; Razza, V.; Bonansone, M..

This paper investigates the use of a controlled tethered wing, or kite, for naval transportation. Linked to a boat by light composite-fiber lines, the kite is able to fly

between 200 and 600 m above the sea and to generate high traction forces. A mechatronic system named Kite Steering Unit (KSU) that is installed on the boat controls the kite and converts the line speed and force into electricity. Different from previous works, the boat is also equipped with electric propellers so that naval propulsion can be achieved both directly, i.e., through the towing forces exerted by the lines, and indirectly, i.e., through the electricity generated by the KSU that is fed to the electric propellers via a battery pack. The optimal system operating conditions that maximize the boat speed for the given wind characteristics are computed. Then, a model predictive controller is designed, and numerical simulations with a realistic model are carried out to assess the performance of the control system against the optimal operating conditions. The results indicate that, with this system, a completely green naval transportation system can be obtained, regardless of the wind direction.

Integration of Physical and Cognitive Human Models to Simulate Driving With a Secondary In-Vehicle Task

Fuller, H. J. A.; Reed, M. P.; Liu, Y.

Human behavior models give insight into people's choices and actions and are tools for predicting performance and improving interface design. Most models focus on a task's cognitive aspects or its physical requirements. This research addresses the divide between cognitive and physical models by combining two models to produce an integrated cognitive–physical human model that enables studying of complex human–machine interactions. The capabilities of the integrated model are evaluated in a task scenario with both cognitive and physical components, i.e., driving while performing a secondary in-vehicle task. When applied in this way, the integrated model is called the Virtual Driver model and can replicate basic driving, in-vehicle tasks, and resource-sharing behaviors, providing a new way to study driver distraction. The model has applicability to interface design and predicting staffing requirements and performance.

Environment-Detection-and-Mapping Algorithm for Autonomous Driving in Rural or Off-Road Environment

Choi, J.; Lee, J.; Kim, D.; Soprani, G.; Cerri, P.; Broggi, A.; Yi, K.

This paper presents an environment-detection-and-mapping algorithm for autonomous driving that is provided in real time and for both rural and off-road environments. Environment-detection-and-mapping algorithms have been designed to consist of two parts: 1) lane, pedestrian-crossing, and speed-bump detection algorithms using cameras and 2) obstacle detection algorithm using LIDARs. The lane detection algorithm returns lane positions using one camera and the vision module “VisLab Embedded Lane Detector (VELD),” and the pedestrian-crossing and speed-bump detection algorithms return the position of pedestrian crossings and speed bumps. The obstacle detection algorithm organizes data from LIDARs and generates a local obstacle position map. The designed algorithms have been implemented on a passenger car using six LIDARs, three cameras,

and real-time devices, including personal computers (PCs). Vehicle tests have been conducted, and test results have shown that the vehicle can reach the desired goal with the proposed algorithm.

Signal Timing Estimation Using Sample Intersection Travel Times

Hao, P.; Ban, X.; Bennett, K. P.; Ji, Q.; Sun, Z.

Signal timing information is important in signal operations and signal/arterial performance measurement. Such information, however, may not be available for wide areas. This imposes difficulty, particularly for real-time signal/arterial performance measurement and traffic information provisions that have received much attention recently. We study, in this paper, the possibility of using intersection travel times, i.e., those collected between upstream and downstream locations of an intersection, to estimate signal timing parameters. The method contains three steps: 1) cycle breaking that determines whether a new cycle starts; 2) exact cycle boundary detection that determines when exactly a cycle starts or ends; and 3) effective red (or green) time estimation that estimates the actual duration of the red (or green) time. The proposed method is a combination of traffic flow theory and learning/estimation algorithms and can be used to estimate the cycle-by-cycle signal timing parameters for a specific movement of a signal. The method is tested using data from microscopic simulation, field experiments, and next-generation simulation with promising results.

Intersection Support System for Powered Two-Wheeled Vehicles: Threat Assessment Based on a Receding Horizon Approach

Biral, F.; Lot, R.; Rota, S.; Fontana, M.; Huth, V.

This paper reports a novel intersection support (IS) system for motorcycles developed through the SAFERIDER project (www.saferider-eu.org). The IS function described is built on a receding horizon approach that is designed for a set of predefined intersection scenarios. In the receding horizon scheme, a nonlinear optimal control problem is repetitively solved in real time, yielding a reference motion plan. The initial value of the longitudinal jerk (control input) of each plan is used as a measure of the correction that the rider has to apply to conform to an optimal-safe maneuver. This technique has the advantage of yielding a homogenous measure of the threat independent of the scenario, and it is directly linked with the control variable that the rider should use to accordingly change the vehicle's longitudinal dynamics. Additionally, the receding horizon approach naturally accommodates road geometry and constraint attributes, motorcycle dynamics, rider input, and riding styles. Warning feedback is given to the rider by an appropriate combination of human–machine interface elements, such as the haptic throttle, the vibrating glove, and the visual display. This paper explains the IS concept, discusses the

implementation aspects of the proposed receding horizon approach, and presents the results of pilot tests conducted on a top-of-the-range riding simulator.

Adaptive Vehicle Detector Approach for Complex Environments

Wu, B.-F.; Juang, J.-H.

In this paper, a vehicle detection approach for complex environments is presented. This paper proposes methods for solving problems of vehicle detection in traffic jams and complex weather conditions such as sunny days, rainy days, cloudy days, sunrise time, sunset time, or nighttime. In recent research, there have been many well-known vehicle detectors that utilize background extraction methods to recognize vehicles. In these studies, the background image needs to continuously be updated; otherwise, the luminance variation will impact the detection quality. The vehicle detection under various environments will have many difficulties such as illumination vibrations, shadow effects, and vehicle overlapping problems that appear in traffic jams. The main contribution of this paper is to propose an adaptive vehicle detection approach in complex environments to directly detect vehicles without extracting and updating a reference background image in complex environments. In the proposed approach, histogram extension addresses the removal of the effects of weather and light impact. The gray-level differential value method is utilized to directly extract moving objects from the images. Finally, tracking and error compensation are applied to refine the target tracking quality. In addition, many useful traffic parameters are evaluated. These useful traffic parameters, including traffic flows, velocity, and vehicle classifications, can help to control traffic and provide drivers with good guidance. Experimental results show that the proposed methods are robust, accurate, and powerful enough to overcome complex weather conditions and traffic jams.

An Interactive Web-Based Public Transport Enquiry System With Real-Time Optimal Route Computation

Pun-Cheng, L. S. C.

A comprehensive and presentable public transport information system is deemed invaluable for local residents and tourists all over the world. This is particularly necessary in view of the complex city structure and transportation system in Hong Kong. There are more than ten public transportation modes available, all with different operation schedules, fare structures, and routing characteristics. To assist commuters in making better use of public transport, the system needs to be not only user friendly and informative but intelligent enough to provide optimal route choices in terms of users' travelling behavior or preference as well. The web-map public transport enquiry system, as described in this paper, gives a good example of providing bilingual (English and Chinese) information on all public transports run in Hong Kong in the form of interactive maps and texts, as well as real-time derivation of optimal travelling routes for users in

terms of multiple criteria, i.e., preferred mode, least changes, shortest travelling time, or lowest fare.

A Generalized DAMRF Image Modeling for Superresolution of License Plates

Zeng W.; Lu, X.

In this paper, we propose a novel superresolution (SR) reconstruction algorithm to handle license plate texts in real traffic videos. To make license plate numbers more legible, a generalized discontinuity-adaptive Markov random field (DAMRF) model is proposed based on the recently reported bilateral filtering, which not only preserves edges but is robust to noise as well. Moreover, instead of looking for a fixed value for the regularization parameter, a method for automatically estimating it is applied to the proposed model based on the input images. Information needed to determine the regularization parameter is updated at each iteration step, which is based on the available reconstructed image. Finally, we use the graduated nonconvexity optimization procedure to minimize the cost function. Results on synthetic and real traffic sequences are presented, which show the effectiveness of the proposed method and demonstrate its superiority to the conventional DAMRF SR method.

Design and Experimental Validation of a Cooperative Driving System in the Grand Cooperative Driving Challenge

Kianfar, R.; Augusto, B.; Ebadighajari, A.; Hakeem, U.; Nilsson, J.; Raza, A.; Tabar, R. S.; Irukulapati, N. V.; Englund, C.; Falcone, P.; Papanastasiou, S.; Svensson, L.; Wymeersch, H.

In this paper, we present the Cooperative Adaptive Cruise Control (CACC) architecture, which was proposed and implemented by the team from Chalmers University of Technology, Göteborg, Sweden, that joined the Grand Cooperative Driving Challenge (GCDC) in 2011. The proposed CACC architecture consists of the following three main components, which are described in detail: 1) communication; 2) sensor fusion; and 3) control. Both simulation and experimental results are provided, demonstrating that the proposed CACC system can drive within a vehicle platoon while minimizing the inter-vehicle spacing within the allowed range of safety distances, tracking a desired speed profile, and attenuating acceleration shockwaves.

Traffic Management for Automated Highway Systems Using Model-Based Predictive Control

Baskar, L. D.; De Schutter, B.; Hellendoorn, H.

We present an integrated traffic management and control approach for automated highway systems (AHS). The AHS consist of interacting roadside controllers and intelligent vehicles that are organized in platoons with short intraplatoon distances and larger distances between platoons. All vehicles are assumed to be fully automated, i.e., throttle, braking, and steering commands are determined by an automated onboard controller. The proposed control approach is based on a hierarchical traffic control architecture for AHS, and it also takes the connection and transition between the nonautomated part of the road network and the AHS into account. In particular, we combine dynamic speed limits and lane allocation for the platoons on the AHS highways with access control for the on-ramps using ramp metering, and we propose a model-based predictive control approach to determine optimal speed limits and lane allocations, as well as optimal release times for the platoons at the on-ramps. To illustrate the potential of the proposed traffic control method, we apply it to a simple simulation example.

Map-Aided Integrity Monitoring of a Land Vehicle Navigation System

Velaga, N. R.; Quddus, M. A.; Bristow, A. L.; Zheng, Y.

The concept of user-level integrity monitoring has been successfully applied to air transport navigation systems, where the main focus is on the errors associated with the Global Positioning System (GPS)-data-processing chain. Little research effort has been devoted to the study of integrity monitoring for the case of land vehicle navigation systems. The primary difference is that it is also necessary to consider errors associated with a spatial map and a map-matching (MM) process when monitoring the integrity of a land vehicle navigation system. This is because these two components play a vital role in land vehicle navigation. To date, research has focused on either the integrity of raw positioning data obtained from GPS or the integrity of the MM process and digital map errors. In this paper, these sources of error are simultaneously considered. Therefore, the main contribution of this paper is to report the development of a user-level integrity-monitoring system that concurrently takes into account all the potential error sources associated with a navigation system and considers the operational environment to further improve performance. Errors associated with a spatial road map are given special attention. Two knowledge-based fuzzy inference systems were developed to measure the integrity scale. The performance of the integrity method was assessed using field data collected in Nottingham and London, U.K. The results indicate that the integrity method provides valid warnings 98.2% and 99.4% of the time for positioning data in a mixed operational environment in Nottingham and suburban areas of London, respectively.

Efficient Resource Allocation for Attentive Automotive Vision Systems

Matzka, S.; Wallace, A. M.; Petillot, Y. R.

We describe a novel architecture for automotive vision organized on five levels of abstraction, i.e., sensor, data, semantic, reasoning, and resource allocation levels, respectively. Although we implement and evaluate processes to detect and classify other participants within the immediate environment of a moving vehicle, our main emphasis is on the allocation of computational resource and attentive processing by the sensor suite. To that end, an efficient multiobjective resource allocation method is formalized and implemented. This includes a decision-making process dependent upon the environment, the current goal, the available sensors and computational resource, and the time available to make a decision. We evaluate our approach on road traffic test sequences acquired by a test vehicle provided by Audi. This vehicle includes lidar, video, radar, and sonar sensors, in addition to conventional global positioning system (GPS) navigation, but our evaluation is confined to lidar and video data alone.

Analytical Study of the IEEE 802.11p MAC Sublayer in Vehicular Networks

Han, C.; Dianati, M.; Tafazolli, R.; Kernchen, R.; Shen, X.

This paper proposes an analytical model for the throughput of the enhanced distributed channel access (EDCA) mechanism in the IEEE 802.11p medium-access control (MAC) sublayer. Features in EDCA such as different contention windows (CW) and arbitration interframe space (AIFS) for each access category (AC) and internal collisions are taken into account. The analytical model is suitable for both basic access and the request-to-send/clear-to-send (RTS/CTS) access mode. Different from most of existing 3-D or 4-D Markov-chain-based analytical models for IEEE 802.11e EDCA, without computation complexity, the proposed analytical model is explicitly solvable and applies to four access categories of traffic in the IEEE 802.11p. The proposed model can be used for large-scale network analysis and validation of network simulators under saturated traffic conditions. Simulation results are given to demonstrate the accuracy of the analytical model. In addition, we investigate service differentiation capabilities of the IEEE 802.11p MAC sublayer.

Matching Raw GPS Measurements on a Navigable Map Without Computing a Global Position

Fouque, C.; Bonnifait, P.

Map matching means determining the location of a mobile with respect to a road network description stored in a digital map. This problem is usually addressed using Global Positioning System (GPS)-like fixes. Unfortunately, there are many situations in urban areas where few satellites are visible because of outages due to tall buildings. In this paper, map matching is solved using raw GPS measurements (pseudoranges and Doppler measurements), avoiding the necessity to compute a global position. The problem is formalized in a general Bayesian framework to handle noise, which can perform multihypothesis map matching when there is not enough information to make

unambiguous decisions. This tightly coupled GPS–map fusion has to simultaneously cope with identifying the road and estimating the mobile's position on that road. A marginalized particle filter is proposed to efficiently solve this hybrid estimation problem. Real experimental results are reported to show that this approach can be initialized with fewer than four satellites. It can also track the location with only two satellites once the road selection has been solved.

Real-Time Computer Vision/DGPS-Aided Inertial Navigation System for Lane-Level Vehicle Navigation

Vu, A.; Ramanandan, A.; Chen, A.; Farrell, J. A.; Barth, M.

Many intelligent transportation system (ITS) applications will increasingly rely on lane-level vehicle positioning that requires high accuracy, bandwidth, availability, and integrity. Lane-level positioning methods must reliably work in real time in a wide range of environments, spanning rural to urban areas. Traditional positioning sensors such as the Global Navigation Satellite Systems may have poor performance in dense urban areas, where obstacles block satellite signals. This paper presents a sensor fusion technique that uses computer vision and differential pseudorange Global Positioning System (DGPS) measurements to aid an inertial navigation system (INS) in challenging environments where GPS signals are limited and/or unreliable. To supplement limited DGPS measurements, this method uses mapped landmarks that were measured through a priori observations (e.g., traffic light location data), taking advantage of existing infrastructure that is abundant within suburban/urban environments. For example, traffic lights are easily detected by color vision sensors in both day and night conditions. A tightly coupled estimation process is employed to use observables from satellite signals and known feature observables from a camera to correct an INS that is formulated as an extended Kalman filter. A traffic light detection method is also outlined, where the projected feature uncertainty ellipse is utilized to perform data association between a predicted feature and a set of detected features. Real-time experimental results from real-world settings are presented to validate the proposed localization method.

A Learning Approach Towards Detection and Tracking of Lane Markings

Gopalan, R.; Hong, T.; Shneier, M.; Chellappa, R.

Road scene analysis is a challenging problem that has applications in autonomous navigation of vehicles. An integral component of this system is the robust detection and tracking of lane markings. It is a hard problem primarily due to large appearance variations in lane markings caused by factors such as occlusion (traffic on the road), shadows (from objects like trees), and changing lighting conditions of the scene (transition from day to night). In this paper, we address these issues through a learning-based approach using visual inputs from a camera mounted in front of a vehicle. We propose the following: 1) a pixel-hierarchy feature descriptor to model the contextual

information shared by lane markings with the surrounding road region; 2) a robust boosting algorithm to select relevant contextual features for detecting lane markings; and 3) particle filters to track the lane markings, without knowledge of vehicle speed, by assuming the lane markings to be static through the video sequence and then learning the possible road scene variations from the statistics of tracked model parameters. We investigate the effectiveness of our algorithm on challenging daylight and night-time road video sequences.

We Can Deliver Messages to Far Vehicles

Mershad, K.; Artail, H.; Gerla, M.

Vehicular ad hoc networks (VANETs) enable vehicles to communicate with each other but require efficient and robust routing protocols for their success. In this paper, we exploit the infrastructure of roadside units (RSUs) to efficiently and reliably route packets in VANETs. Our system operates by using vehicles to carry and forward messages from a source vehicle to a nearby RSU and, if needed, route these messages through the RSU network and, finally send them from an RSU to the destination vehicle. Our system is mostly critical for users who are far apart and want to communicate using their vehicles' onboard units. Many recent paradigms, like social networks, will greatly benefit from a system like ours to enable users on the road to exchange different types of data. We evaluate the performance of our system using the ns2 simulation platform and compare our scheme to existing solutions. The results prove the feasibility and efficiency of our scheme.

Routing Protocols for GeoNet: A Survey

Taysi, Z. C.; Yavuz, A. G.

The last decade has witnessed the rapid development of intelligent transportation systems (ITS), which aim to improve transportation activities in terms of safety and efficiency. Intervehicle communication (IVC) is an important component of the ITS architecture that enables vehicles to communicate with other vehicles and roadside infrastructure. The GeoNet Project will bring IVC one step further by enabling transparent Internet Protocol connectivity between vehicles and the infrastructure. Integrating the IVC with existing infrastructure over Internet Protocol version 6 (IPv6) will also enable the use of multimedia services. Although GeoNet concluded its activity, several topics in the final specification were left open ended, including the definition of the car-to-car transport layer, multiradio support, congestion control, IPv6 encoding of GeoDestination, mapping of IPv6 addresses to GeoNet addresses, and GeoRouting protocol. This paper provides a survey of the existing GeoRouting protocols and evaluates the compatibility of these protocols with the GeoNet architecture.

Adaptive Metering Algorithm for Electronic Commercial Vehicle Preclearance Systems

Lee, J.; Chow, G.

This paper presents an adaptive metering algorithm for enhancing the electronic screening (e-screening) operation at truck weight stations. This algorithm uses a feedback control mechanism to control the level of truck vehicles entering the weight station. The basic operation of the algorithm allows more trucks to be inspected when the weight station is underutilized by adjusting the weight threshold lower. Alternatively, the algorithm restricts the number of trucks to inspect when the station is overutilized to prevent queue spillover. The proposed control concept is demonstrated and evaluated in a simulation environment. The simulation results demonstrate the considerable benefits of the proposed algorithm in improving overweight enforcement with minimal negative impacts on nonoverweighed trucks. The test results also reveal that the effectiveness of the algorithm improves with higher truck participation rates in the e-screening program.

A Queueing Model Based Intelligent Human–Machine Task Allocator

Wu, C.; Liu, Y.; Lin, B.

Automatic machines are increasingly being used to help drivers automatically complete tasks; however, the high error rate of automatic machines limits how they might reduce driver task load. Therefore, allocating tasks between human and machine becomes an important question in system design. Existing methods of task allocation do not consider several natural characteristics of human–machine systems simultaneously, including speed–error tradeoff, cognitive modeling of workload, multicriteria decision modeling, dynamic allocation, and global optimum. In this paper, a queueing model-based intelligent task allocator (QM-ITA) that covers the criteria above and optimally allocates tasks between a human operator and an automatic machine is developed. The optimal task allocation algorithm is described in four scenarios that demonstrate how QM-ITA is able to minimize the workload of human operator, minimize system error rate, propose a maximum acceptable error rate of an automatic machine, determine if an automatic machine is necessary for a system, and suggest a maximum acceptable task arrival rate. Further development of the model and the prospects for future research are also discussed.

Dynamic Modeling of Driver Control Strategy of Lane-Change Behavior and Trajectory Planning for Collision Prediction

Xu, G.; Liu, L.; Ou, Y.; Song, Z.

This paper introduces a dynamic model of the driver control strategy of lane-change behavior and applies it to trajectory planning in driver-assistance systems. The proposed model reflects the driver control strategies of adjusting longitudinal and latitudinal acceleration during the lane-change process and can represent different driving styles (such as slow and careful, as well as sudden and aggressive) by using different model parameters. We also analyze the features of the dynamic model and present the methods for computing the maximum latitudinal position and arrival time. Furthermore, we put forward an extended dynamic model to represent evasive lane-change behavior. Compared with the fifth-order polynomial lane-change model, the dynamic models fit actual lane-change trajectories better and can generate more accurate lane-change trajectories. We apply the dynamic models in emulating different lane-change strategies and planning lane-change trajectories for collision prediction. In the simulation, we use the models to compute the percentage of safe trajectories in different scenarios. The simulation shows that the maximum latitudinal position and arrival time of the generated lane-change trajectories can be good indicators of safe lane-change trajectories. In the field test, the dynamic models can generate the feasible lane-change trajectories and efficiently obtain the percentage of safe trajectories by computing the minimum gap and time to collision. The proposed dynamic model and module can be combined with the human–machine interface to help the driver easily identify safe lane-change trajectories and area.

Vehicular Traffic Density State Estimation Based on Cumulative Road Acoustics

Tyagi, V.; Kalyanaraman, S.; Krishnapuram, R.

This paper considers the problem of vehicular traffic density estimation, utilizing the information cues present in the cumulative acoustic signal acquired from a roadside-installed single microphone. This cumulative signal comprises several noise signals such as tire noise, engine noise, engine-idling noise, occasional honks, and air turbulence noise of multiple vehicles. The occurrence and mixture weightings of these noise signals are determined by the prevalent traffic density conditions on the road segment. For instance, under a free-flowing traffic condition, the vehicles typically move with medium to high speeds and thereby produce mainly tire noise and air turbulence noise and less engine-idling noise and honks. For slow-moving congested traffic, the cumulative signal will largely be dominated by engine-idling noise and honks; air turbulence and tire noises will be inconspicuous. Furthermore, these various noise signals have spectral content that are very different from each other and, hence, can be used to discriminate between the different traffic density states that lead to them. Therefore, in this work, we extract the short-term spectral envelope features of the cumulative acoustic signals and model their class-conditional probability distributions, conditioned on one of the three broad traffic density states, i.e., Jammed (0–10 km/h), Medium-Flow (10–40 km/h), and Free-Flow (40 km/h and above) traffic. While these states are coarse measures of the average traffic speed, they nevertheless can provide useful traffic density information in the often-chaotic and nonlane-driven traffic conditions of the developing geographies, where other techniques (magnetic loop detectors) are inapplicable. Based on these learned distributions, we use a Bayes' classifier to classify the acoustic signal segments spanning a

duration of 5–30 s, which results in a high classification accuracy of sim95%. Using a discr- minative classifier such as a support vector machine (SVM) results in further classification accuracy gains over the Bayes' classifier.

Safe Driving Using Mobile Phones

Fazeen, M.; Gozick, B.; Dantu, R.; Bhukhiya, M.; González, M. C.

As vehicle manufacturers continue to increase their emphasis on safety with advanced driver-assistance systems (ADASs), we propose a device that is not only already in abundance but portable enough as well to be one of the most effective multipurpose devices that are able to analyze and advise on safety conditions. Mobile smartphones today are equipped with numerous sensors that can help to aid in safety enhancements for drivers on the road. In this paper, we use the three-axis accelerometer of an Android-based smartphone to record and analyze various driver behaviors and external road conditions that could potentially be hazardous to the health of the driver, the neighboring public, and the automobile. Effective use of these data can educate a potentially dangerous driver on how to safely and efficiently operate a vehicle. With real-time analysis and auditory alerts of these factors, we can increase a driver's overall awareness to maximize safety.

Gaze Fixation System for the Evaluation of Driver Distractions Induced by IVIS

Jiménez, P.; Bergasa, L. M.; Nuevo, J.; Hernández, N.; Daza, I. G.

We present a method to monitor driver distraction based on a stereo camera to estimate the face pose and gaze of a driver in real time. A coarse eye direction is composed of face pose estimation to obtain the gaze and driver's fixation area in the scene, which is a parameter that gives much information about the distraction pattern of the driver. The system does not require any subject-specific calibration; it is robust to fast and wide head rotations and works under low-lighting conditions. The system provides some consistent statistics, which help psychologists to assess the driver distraction patterns under influence of different in-vehicle information systems (IVISs). These statistics are objective, as the drivers are not required to report their own distraction states. The proposed gaze fixation system has been tested on a set of challenging driving experiments directed by a team of psychologists in a naturalistic driving simulator. This simulator mimics conditions present in real driving, including weather changes, maneuvering, and distractions due to IVISs. Professional drivers participated in the tests.

A Cooperative Approach to Traffic Congestion Detection With Complex Event Processing and VANET

Terroso-Sáenz, F.; Valdés-Vela, M.; Sotomayor-Martínez, C.; Toledo-Moreo, R.; Gómez-Skarmeta, A. F.

Currently, distributed traffic information systems have come up as one of the most important approaches for detecting traffic flow problems on a road. For that purpose, they usually make use of the location information that vehicles share among them through periodical messages that are transmitted across a vehicular ad hoc network (VANET). This paper puts forward an event-driven architecture (EDA) as a novel mechanism to get insight into VANET messages to detect different levels of traffic jams; furthermore, it also takes into account environmental data that come from external data sources, such as weather conditions. The proposed EDA has been developed through the complex-event-processing technology. Simulation tests show that the proposed mechanism can detect traffic congestions, which involve different numbers of lanes and lengths with short delay.

Integrity and Continuity for Automated Surface Conflict-Detection Monitoring

Mario, C.; Rife, J.

This paper discusses how surface surveillance technologies impact the design of automated conflict-detection capability for a next-generation air transportation system dubbed NextGen. In NextGen, automated conflict detection and resolution (CD&R) algorithms will be necessary to assist air traffic controllers in identifying and mitigating potential hazards posed by nonconforming aircraft. Given this high reliance on automation, rigorous specifications for conflict detection (CD) algorithm continuity and integrity risk will be required. Continuity risk refers to the probability that a CD alert interrupts an ongoing operation; integrity risk refers to the probability that the CD algorithm fails to provide an alert rapidly enough to resolve the conflict. The continuity and integrity of CD algorithms strongly depend on the quality of surface surveillance sensor measurements; as such, we propose mechanisms for modifying the CD&R algorithm design to rigorously account for the capabilities and limitations of surveillance sensors.

Maritime Traffic Monitoring Based on Vessel Detection, Tracking, State Estimation, and Trajectory Prediction

Perera, L. P.; Oliveira, P.; Guedes Soares, C.

Maneuvering vessel detection and tracking (VDT), incorporated with state estimation and trajectory prediction, are important tasks for vessel navigational systems (VNSs), as well as vessel traffic monitoring and information systems (VTMISs) to improve maritime safety and security in ocean navigation. Although conventional VNSs and VTMISs are equipped with maritime surveillance systems for the same purpose, intelligent capabilities for vessel detection, tracking, state estimation, and navigational trajectory prediction are underdeveloped. Therefore, the integration of intelligent features into VTMISs is proposed

in this paper. The first part of this paper is focused on detecting and tracking of a multiple-vessel situation. An artificial neural network (ANN) is proposed as the mechanism for detecting and tracking multiple vessels. In the second part of this paper, vessel state estimation and navigational trajectory prediction of a single-vessel situation are considered. An extended Kalman filter (EKF) is proposed for the estimation of vessel states and further used for the prediction of vessel trajectories. Finally, the proposed VTMIS is simulated, and successful simulation results are presented in this paper.

Assessing the Mobility and Environmental Benefits of Reservation-Based Intelligent Intersections Using an Integrated Simulator

Huang, S.; Sadek, A. W.; Zhao, Y.

The connected vehicle research program is a multimodal research initiative in the U.S. that envisions a fully connected transportation system with wireless communications linking vehicles, the infrastructure, and handheld smart devices. This paper designs and evaluates a reservation-based approach to intersection control that is designed to take full advantage of the unprecedented connectivity that the connected vehicle initiative promises to provide. The control approach, which is referred to herein as the “intelligent intersection” approach, builds on the previous work by Dresner and Stone by introducing new features to better account for several aspects of the real-world driving environment. To design and evaluate the “intelligent intersection,” a novel simulation test bed for connected vehicle applications is developed. The test bed integrates a microscopic traffic simulator with a network simulator and an emission analyzer. Using the integrated simulator, the mobility and environmental benefits of the intelligent intersection approach, compared with those of traditional control methods, are evaluated on two case studies: 1) an isolated intersection and 2) a real-world transportation network with multiple intersections. Results show that the proposed control approach offers significant mobility and environmental benefits. For example, for the second test case and using observed traffic volumes, the intelligent intersection reduced the average vehicle delay by 85%, fuel consumption by 50%, and emissions by 39%–50%. The study also demonstrates the utility of using the simulator test bed in the design and evaluation of connected vehicle applications.

Detection and Classification of Vehicles From Video Using Multiple Time-Spatial Images

Mithun, N. C.; Rashid, N. U.; Rahman, S. M. M.

Detection and classification of vehicles are two of the most challenging tasks of a video-based intelligent transportation system. Traditional detection and classification methods are computationally highly expensive and become unsuccessful in many cases such as occlusion among the vehicles and when differences between pixel intensities of vehicles

and backgrounds are small. In this paper, a novel detection and classification method is proposed using multiple time-spatial images (TSIs), each obtained from a virtual detection line on the frames of a video. Such a use of multiple TSIs provides the opportunity to identify the latent occlusions among the vehicles and to reduce the dependencies of the pixel intensities between the still and moving objects to increase the accuracy of detection performance as well as to achieve an improved classification performance. In order to identify the class of a particular vehicle, a two-step k nearest neighborhood classification scheme is proposed by utilizing the shape-based, shape-invariant, and texture-based features of the segmented regions corresponding to the vehicle appeared in appropriate frames that are determined from the TSIs of the video. Extensive experimentations are carried out in vehicular traffics of varying environments to evaluate the detection and classification performance of the proposed method, as compared with the existing methods. Experimental results demonstrate that the proposed method provides a significant improvement in counting and classifying the vehicles in terms of accuracy and robustness alongside a substantial reduction of execution time, as compared with that of the other methods..

Travel Information: Time to Drop the Labels?

Chorus, C. G.

This paper argues that the literature on travel information and its potential as a travel demand management tool suffers from confusing use of terminology. It shows how labels such as “advanced,” “personalized,” and “dynamic”—when referring to travel information services—have been either implicitly or explicitly assigned a variety of often quite different meanings in various contexts. As a result, these labels, and similar labels such as “predictive” and “intelligent,” often obfuscate rather than explain what kind of travel information is actually being discussed. Several options for avoiding this confusion in future research are presented. For example, one option is to entirely forego the use of labels and instead describe travel information services in terms of their relevant characteristics and functionalities. Another option is to start using recently proposed definitions and International Standards Organization standards, with the aim of achieving a more formal building ground for travel-information-related research than is currently available.

Vision-Based Vehicle Detection System With Consideration of the Detecting Location

Cheon, M.; Lee, W.; Yoon, C.; Park, M.

In this paper, we propose a vision-based vehicle detection system. We use a method composed of a hypothesis generation (HG) step and a hypothesis verification (HV) step, following the general approach to vision-based vehicle detection systems. In the HG step, the system extracts hypotheses using shadow regions that appear under vehicles. In the HV step, the system classifies feature vectors extracted from hypotheses to determine

whether those hypotheses are vehicles. Along with the histogram of oriented gradients (HOG), we propose and implement a new type of feature vector, i.e., HOG symmetry vectors, in this paper. We also propose a new classification method that uses data importance in the HV step. The data importance value is based on the locations of hypotheses to prioritize hypotheses that have greater risks of accident. Experimental results show the strong performance of our proposed system.

A Two-Phase Method of Detecting Abnormalities in Aircraft Flight Data and Ranking Their Impact on Individual Flights

Smart, E.; Brown, D.; Denman, J.

A two-phase novelty detection approach to locating abnormalities in the descent phase of aircraft flight data is presented. It has the ability to model normal time series data by analyzing snapshots at chosen heights in the descent, weight individual abnormalities, and quantitatively assess the overall level of abnormality of a flight during the descent to a given runway. The method models normal approaches to a given runway (as determined by the airline's standard operating procedures) and detects and ranks deviations from that model. The approach expands on a recommendation by the UK Air Accident Investigation Branch to the UK Civil Aviation Authority. The first phase quantifies abnormalities at certain heights in a flight. The second phase ranks all flights to identify the most abnormal, each phase using a one-class classifier. For both the first and second phases, i.e., the support vector machine (SVM), the mixture of Gaussians and the K-means one-class classifiers are compared. The method is tested using a data set containing manually labeled abnormal flights. The results show that the SVM provides the best detection rates and that the approach identifies unseen abnormalities with a high rate of accuracy. The feature selection tool F-score is used to identify differences between the abnormal and normal data sets. It identifies the heights where the discrimination between the two sets is largest and the aircraft parameters most responsible for these variations. The method presented adds much value to the existing event-based approach.

Flow Equilibrium Under Dynamic Traffic Assignment and Signal Control—An Illustration of Pretimed and Actuated Signal Control Policies

Chen, L.-W.; Hu, T.-Y.

Under intelligent transportation systems, the interaction between signal setting and traffic assignment is an important issue in designing efficient advanced traffic management systems. Most of the studies only describe the interaction under static assumptions, which do not consider possible temporal flow distribution. These assumptions limit the applicability in real-time management and control. This paper focuses on finding equilibrium under the interaction of signal setting and traffic assignment. The problem is

constructed and solved through a bi-level framework. The upper level solves for signal setting parameters based on flow distributions, including cycle length and green splits. The lower level solves for user equilibrium dynamic traffic assignment (UEDTA) flows in a traffic network. The signal setting parameters are adjusted through pretimed and actuated signal controls. UEDTA flow patterns are generated through a simulation-based dynamic traffic assignment (DTA) model, DynaTAIWAN. Numerical experiments based on a real network in Kaohsiung City, Taiwan, are conducted to study the dynamic equilibrium. The numerical results indicate the existence of equilibrium flow under signal control and route assignment in a dynamic aspect. The results show that the average travel times under the pretimed signal policy are, in general, better than the times under the actuated signal policy.

Simulation-Assignment-Based Travel Time Prediction Model for Traffic Corridors

Hu, T.-Y.; Tong, C.-C.; Liao, T.-Y.; Ho, W.-M.

Travel time prediction in Advanced Traveler Information Systems is an important issue, because travel time is a major factor in motorists' decisions to avoid congestion and incidents. A simulation-assignment-based travel time prediction model for traffic corridors is constructed in this paper. Based on the concept of simulation-assignment models, two algorithms—the flow- and the vehicle-based models—are proposed for travel time prediction. One of the critical issues in simulation-assignment models is how reliable time-dependent origin–destination (O–D) trip tables are generated. A dynamic O–D estimation and prediction procedure is developed to generate time-dependent O–D demand data for simulating vehicle movements using DynaTAIWAN: a simulation-assignment model. The empirical travel time data that were collected from electronic toll stations are used to validate the travel times that were predicted by the proposed models. The mean absolute percentage errors (RMSPEs) and root-mean-square percentage errors are less than 20% and 26% for the vehicle-based model and less than 10% and 12% for the flow-based model, respectively. The results show that the proposed algorithms predict reasonable travel times for traffic corridors.

Performance Degradation Monitoring for Onboard Speed Sensors of Trains

Xu, Z.; Wang, W.; Sun, Y.

Photoelectric speed sensors (PSSs), which are used for velocity measuring and positioning, are key components of train control systems. In real applications, the performance of PSSs may degrade, such as the decrease in the number of the output pulses, which is caused by the existence of jammed code tracks on the shading plates of PSSs. Considering this kind of performance degradation, this paper proposes an online performance-degradation-monitoring approach that can detect the existence of the jammed code tracks and estimate the number of them. Based on the results from the

performance-degradation-monitoring approach, this paper also provides a compensation algorithm for the distorted speed readings resulting from the existence of the performance degradation. The results from the mathematical analysis and numerical examples verify the effectiveness of the proposed performance-degradation-monitoring approach for PSSs.

Modeling Strategic Route Choice and Real-Time Information Impacts in Stochastic and Time-Dependent Networks

Gao, S.

This paper establishes a general framework to study the impacts of real-time information on the users' routing decisions and the system cost in a stochastic time-dependent traffic network under a generalized equilibrium condition. Users are assumed to make strategic routing decisions, and the rule that maps a user's current state, including node, time, and information, to a decision on the next node to take, is defined as a routing policy. This definition allows for a wide variety of information accessibility situations, thus excluding the usually simplified assumptions, such as either no information or full information. A user's choice set contains routing policies rather than simple paths. A fixed-point problem formulation of the user equilibrium is given, and a method of successive average heuristic is designed. Computational tests are carried out in a hypothetical network, where random incidents are the source of stochasticity. System costs derived from three models with different information accessibility situations are compared. The strategic route choices lead to shorter expected travel times at equilibrium. Smaller travel time variances are obtained as a byproduct. The value of real-time information is an increasing function of the incident probability. However, it is not a monotonic function of the market penetration of information, which suggests that in designing a traveler information system or route guidance system, the information penetration needs to be chosen carefully to maximize benefits.

A Simple Free-Flow Traffic Model for Vehicular Intermittently Connected Networks

Khabbaz, M. J.; Fawaz, W. F.; Assi, C. M..

The performance of vehicular data networks (VDNs) is highly dependent on vehicular traffic. Existing studies on VDNs consider custom-developed traffic models that mimic real-life vehicular traffic behavior and prepare the ground for accurate VDN performance evaluation. Traffic evolution is affected by numerous random events. Some developed models are microscopic. They independently consider some possible factors (e.g., weather, road geometry, and drivers' skills). These microscopic models are complex, and their implementations may be costly. Other models are macroscopic. They revolve around only the following three major traffic parameters: 1) density; 2) flow; and 3) speed. The majority of such existing models are unrealistic, because they are based on restrictive assumptions tailored to their enclosing study. Comparing the performance of VDN

protocols becomes adequate if and only if these protocols are all developed on top of the same traffic model. Unfortunately, the opposite is true. Hence, the design of a generic traffic model that serves as a basis for future studies on VDNs is equally urgent and important. This paper presents a comprehensive and traffic-theory-inspired macroscopic description of vehicular traffic behavior over roadway facilities that operate under free-flow traffic conditions. Accordingly, a simple and tractable macroscopic traffic model is proposed. Extensive simulations are conducted to verify the validity of the proposed model and its high accuracy.

Multiscale Path Optimization for the Reduced Environmental Impact of Air Transportation

Campbell, S. E.

Recent research has stressed the importance of understanding the impact of air transportation on the environment. The environmental impact of aviation comes from many different sources, which occur on different spatial and temporal scales. The objective of this work is to develop a path-planning strategy that generates an optimal trajectory in a multiscale environment such that fuel consumption and persistent contrail formation are minimized. A receding-horizon controller is constructed to adapt to diverse and evolving obstacles while maintaining tractability in an onboard operation. The multiscale control strategy is shown to perform better than a controller designed with respect to a single scale..

Robust Road Detection and Tracking in Challenging Scenarios Based on Markov Random Fields With Unsupervised Learning

Guo, C.; Mita, S.; McAllester, D.

This paper presents a robust stereo-vision-based drivable road detection and tracking system that was designed to navigate an intelligent vehicle through challenging traffic scenarios and increment road safety in such scenarios with advanced driver-assistance systems (ADAS). This system is based on a formulation of stereo with homography as a maximum a posteriori (MAP) problem in a Markov random field (MRF). Under this formulation, we develop an alternating optimization algorithm that alternates between computing the binary labeling for road/nonroad classification and learning the optimal parameters from the current input stereo pair itself. Furthermore, online extrinsic camera parameter reestimation and automatic MRF parameter tuning are performed to enhance the robustness and accuracy of the proposed system. In the experiments, the system was tested on our experimental intelligent vehicles under various real challenging scenarios. The results have substantiated the effectiveness and the robustness of the proposed system with respect to various challenging road scenarios such as heterogeneous road materials/textures, heavy shadows, changing illumination and weather conditions, and dynamic vehicle movements.

Differentiating Alcohol-Induced Driving Behavior Using Steering Wheel Signals

Das, D.; Zhou, S.; Lee, J. D.

Detection of alcohol-induced driving impairment through vehicle-based sensor signals is of paramount importance for road safety. To differentiate the driving conditions with and without alcohol-induced impairment, data were collected from 108 drivers under both conditions in a high-fidelity driving simulator. With this data set, various quantitative measures of steering wheel movement, including not only simple statistics such as the mean and the standard deviation but nonlinear dynamic invariant measures such as sample entropy and Lyapunov exponent as well, are compared in terms of their differentiating capabilities. Nonlinear invariant measures are more robust and consistent than the simple measures in differentiating the impairment. Furthermore, people respond to alcohol-induced impairment quite differently, and for a certain group of people, the alcohol-induced impairment can be well detected using these nonlinear invariant measures. Many interesting insights into characterizing the effect of alcohol on driving behavior are obtained in this paper. This paper lays a foundation for the future development of a real-time detection method for alcohol-induced impairment.

Making Vehicles Transparent Through V2V Video Streaming

Gomes, P.; Olaverri-Monreal, C.; Ferreira, M.

The advent of infrastructureless vehicle-to-vehicle (V2V) communication has opened the opportunity to design driver-assistance systems that collect information from sensors residing in neighboring vehicles. Windshield-installed cameras are one example of a sensor that is becoming common in modern vehicles. Remotely accessing real-time images of these cameras using V2V communication enables a significant increase in the visual awareness of each driver. In this paper, we propose and evaluate the performance of a driver-assistance system that leverages on V2V communication and windshield-installed cameras to transform vision-obstructing vehicles into transparent tubular objects. This cooperative system is able to increase the visibility of drivers intending to overtake, thus making such critical maneuvers safer. Our system uses an augmented reality human–machine interface that is able to convey the increased visibility perspective in a straightforward fashion. We also show that the required latency for this intervehicle communication can be obtained using the Dedicated Short-Range Communications (DSRC) proposed for vehicular environments.

A Visibility-Based Approach for Occupancy Grid Computation in Disparity Space

Perrollaz, M.; Yoder, J.-D.; Nègre, A.; Spalanzani, A.; Laugier, C.

Occupancy grids are a very convenient tool for environment representation in robotics. This paper will detail a novel approach for computing occupancy grids from stereo vision and show its application to intelligent vehicles. In the proposed approach, occupancy is initially computed directly in the stereoscopic sensor's disparity space. The calculation formally accounts for the detection of obstacles and road pixels in disparity space, as well as partial occlusions in the scene. In the second stage, this disparity-space occupancy grid is transformed into a Cartesian space occupancy grid to be used by subsequent applications. This transformation includes spatial and temporal filtering. The proposed method is designed to easily be processed in parallel. Consequently, we chose to implement it on a graphics processing unit, which allows real-time processing for demanding applications. In this paper, we present this method, and we propose an application to the problem of perception in a road environment. Results are presented with real road data, qualitatively comparing this approach with other methods.

Bus-Stop Control Strategies Based on Fuzzy Rules for the Operation of a Public Transport System

Milla, F.; Sáez, D.; Cortés, C. E.; Cipriano, A.

In the daily operation of a bus system, the movement of vehicles is affected by uncertain conditions as the day progresses, such as traffic congestion, unexpected delays, randomness in passenger demand, irregular vehicle dispatching times, and incidents. In a real-time setting, researchers have devoted significant effort to developing flexible control strategies, depending on the specific features of public transport systems. In this paper, we propose a control scheme for the operation of a bus system running along a linear corridor, based on expert rules and fuzzy logic. The parameters of the fuzzy controllers were tuned through a particle swarm optimization (PSO) algorithm. That is, the control strategies aim at keeping regular headways between consecutive buses, with the objective of reducing the total waiting time of passengers. The proposed control systems rely on measures of the position of each bus, which are easy to obtain and implement by means of emerging automatic vehicle location devices through Global Positioning System (GPS) technology. The utilized strategies are holding, stop-skipping, and the integration of both. After tuning the controller parameters, we conducted several simulation tests, obtaining promising results in terms of savings in waiting times with the implementation of the proposed rules, noting that the best performance occurred when fuzzy rules are included. The methodology has great impact, and it is easy to implement due to its simplicity.

An Integer Linear Programming Approach for Radio-Based Localization of Shipping Containers in the Presence of Incomplete Proximity Information

Abbate, S.; Avvenuti, M.; Corsini, P.; Panicucci, B.; Passacantando, M.; Vecchio, A.

The most advanced solutions that are currently adopted in ports and terminals use technologies based on radio frequency identification (RFID) and the Global Positioning System (GPS) to identify and localize shipping containers in the yard. Nevertheless, because of the limitations of these solutions, the position of containers is still affected by errors, and it cannot be determined in real time. In this paper, a nonconventional approach is presented: Each container is equipped with nodes that use wireless communication to detect neighbor containers and to send proximity information to a base station. At the base station, geometrical constraints and proximity data are combined to determine the positions of containers. Missing information due to faulty nodes is tolerated by modeling geometrical constraints as an integer linear programming problem. Numerical simulations show that most of the containers can be localized, even when the number of nodes that are affected by faults is on the order of 30%.

Traffic Flow Estimation Models Using Cellular Phone Data

Caceres, N.; Romero, L. M.; Benitez, F. G.; del Castillo, J. M.

Traffic volume is a parameter used to quantify demand in transportation studies, and it is commonly collected by using on-road (fixed) sensors such as inductive loops, cameras, etc. The installation of fixed sensors to cover all roads is neither practical nor economically feasible; therefore, they are only installed on a subset of links. Cellular phone tracking has been an emerging topic developed and investigated during the last few years to extract traffic information. Cellular systems provide alternative methods to detect phones in motion without the cost and coverage limitations associated with those infrastructure-based solutions. Utilizing existing cellular systems to capture traffic volume has a major advantage compared with other solutions, since it avoids new and expensive hardware installations of sensors, with a large number of cellular phones acting as probes. This paper proposes a set of models for inferring the number of vehicles moving from one cell to another by means of anonymous call data of phones. The models contain, in their functional form, terms related to the users' calling behavior and other characteristics of the phenomenon such as hourly intensity in calls and vehicles. A set of intercell boundaries with different traffic background and characteristics were selected for the field test. The experiment results show that reasonable estimates are achieved by comparison with volume measurements collected by detectors located in the same study area. The motion of phones while being involved in calls can be used as an easily accessible, fast, and low-cost alternative to deriving volume data on intercell boundaries.

Team AnnieWAY's Entry to the 2011 Grand Cooperative Driving Challenge

Geiger, A.; Lauer, M.; Moosmann, F.; Ranft, B.; Rapp, H.; Stiller, C.; Ziegler, J.

In this paper, we present the concepts and methods developed for the autonomous vehicle known as AnnieWAY, which is our winning entry to the 2011 Grand Cooperative

Driving Challenge. We describe algorithms for sensor fusion, vehicle-to-vehicle communication, and cooperative control. Furthermore, we analyze the performance of the proposed methods and compare them with those of competing teams. We close with our results from the competition and lessons learned.

Real-Time Vehicle Identification Performance Using FPGA Correlator Hardware

McDonald, G. J.; Ellis, J. S.; Penney, R. W.; Price, R. W.

A real-time automatic vehicle correlator system that is capable of identifying the make, model, and series of road traffic, e.g., a Volkswagen Golf Mark 4, has been implemented in field-programmable gate array (FPGA) hardware housed on a peripheral component interconnect (PCI)-format electronic board. The system is compatible with standard desktop personal computers and accepts imagery from networked cameras. The vehicle correlation operates in conjunction with an automatic number plate recognition (ANPR) system, which acts as a coarse filter and determines the presence of a new vehicle to be identified. When the vehicle correlator is presented with a new image by the ANPR system, it correlates this image against a large database of many thousands of reference images, which represent the many vehicle variants typically found in that regional jurisdiction. The FPGA vehicle correlator can perform 10 000 correlations per second, allowing timely vehicle identification in less than 1 s when comparing against 8192 reference vehicle images. In a large-scale trial of 991 input vehicles, the vehicle correlator correctly identified 84% of the test images using a database of 62 different vehicle variants.

Number of Lane Changes Determined by Splashover Effects in Loop Detector Counts

Knoop, V. L.; Wilson, R. E.; Buisson, C.; van Arem, B.

Lane changes are important in quantifying traffic for both operational and planning purposes. Traditional in-lane loop detectors do not count lane changes; hence, historically, traffic engineers have estimated them using other data sources. This paper provides a method for estimating the number of lane changes based on observations of “straddling” vehicles that are simultaneously detected by the loops in adjacent lanes. In the data considered here, such “straddles” almost always correspond to vehicles that are in the process of changing lanes. However, many lane changes take place between detector sites and, hence, do not result in straddles. The methods developed here estimate probability distribution for the number of lane changes given an observed number of straddles. The efficacy of this approach depends on calibration issues and on the size of the aggregation period. In the evaluation study presented here, the results are good: The proposed method gives the number of lane changes with approximately 10% error, even though the number of lane changes per aggregation period varies by a factor of 10 over time.

A Methodological Approach for Estimating Temporal and Spatial Extent of Delays Caused by Freeway Accidents

Chung, Y.

Given that reliable prediction of such relatively rare—and random—events as accident occurrence will remain elusive, the most important potentially soluble factor in the development of accident management strategies is to identify and quantify the conditions affecting the nonrecurrent congestion caused by accidents once they have been known to have occurred. The objective of the research reported in this paper is to develop a method of quantifying the delay due to accidents on urban freeways, as well as to identify the causal factors affecting the total delay caused by such accidents. Binary integer programming (BIP) is applied in estimating the temporal and spatial extent of delay caused by freeway accidents, based solely on commonly available inductance loop detector data. The basic idea behind the method is to estimate the most likely temporal and spatial extent of the region of congestion caused by an accident by solving a BIP problem that is consistent with the topology of the spatio-temporal region that defines candidate speed differences between normal flow conditions and accident conditions. The procedures developed in this paper will be useful for the performance evaluation of accident management systems by quantifying accident congestion in terms of the total delay to evaluate the benefit of accident management systems accrued from efficient traffic operations. The procedures are demonstrated by a case study using accident data collected from six major freeways in Orange County, CA.

Safety Benefits of Forward Collision Warning, Brake Assist, and Autonomous Braking Systems in Rear-End Collisions

Kusano, K. D.; Gabler, H. C.

This paper examines the potential effectiveness of the following three precollision system (PCS) algorithms: 1) forward collision warning only; 2) forward collision warning and precrash brake assist; and 3) forward collision warning, precrash brake assist, and autonomous precrash brake. Real-world rear-end crashes were extracted from a nationally representative sample of collisions in the United States. A sample of 1396 collisions, corresponding to 1.1 million crashes, were computationally simulated as if they occurred, with the driver operating a precollision-system-equipped vehicle. A probability-based framework was developed to account for the variable driver reaction to the warning system. As more components were added to the algorithms, greater benefits were realized. The results indicate that the exemplar PCS investigated in this paper could reduce the severity (i.e., $Delta{rm V}$) of the collision between 14% and 34%. The number of moderately to fatally injured drivers who wore their seat belts could have been reduced by 29% to 50%. These collision-mitigating algorithms could have prevented 3.2% to 7.7% of rear-end collisions. This paper shows the dramatic reductions in serious and fatal injuries that a PCS, which is one of the first intelligent vehicle technologies to be deployed in production cars, can bring to highway safety when available throughout the

fleet. This paper also presents the framework of an innovative safety benefits methodology that, when adapted to other emerging active safety technologies, can be employed to estimate potential reductions in the frequency and severity of highway crashes.

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