



**INTELLIGENT
TRANSPORTATION
SYSTEMS**

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IEEE ITS SOCIETY NEWSLETTER

Vol. 10, No. 2, April 2008

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

www.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 c.herget@ieee.org.

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Society News



From the Editor

by Charles Herget

The IEEE Technical Activities Board Periodical Reviews Committee conducts a review of each Society's publications every five years. In February, our Society's Transactions and Newsletter were reviewed by this committee. The Editors-in-Chief of the two publications were required to submit a report to the committee prior to the review. The entire report submitted for the Newsletter can be found in Appendix 1 of this Newsletter.

Here I will include some parts of the report along with comments that I think may be of interest to our readers.

subscriptions

Anyone may subscribe to the Newsletter free of charge. The number of subscribers, approximately 10,000, is far larger than the number of members of the Society. Our Society has about 1,000 members, so we have ten times as many subscribers as we have members.

finances

The Newsletter is published and distributed electronically. Announcements are sent out to subscribers using IEEE ListServ. The issues are posted on the Society's web site where they can be downloaded in Adobe portable document (pdf) format. The Newsletter is published at very little expense to the Society. The only expense has been a nominal charge for support staff of the Editor-in-Chief and reimbursement for some expenses for the EIC to attend Executive Committee and Board of Governor meetings.

future plans

The Society will begin the publication of a Magazine in 2008 and the scope of the Newsletter will change somewhat. After the new Magazine becomes fully operational, the Newsletter will focus on Society news, calls for papers of upcoming conferences and special issues of the Transactions and Magazine, announcements for new books (reviews to be in the Magazine), officer's reports, conference reports, job announcements, Letters to the Editor, and feature articles on current events in ITS. The intention of the Newsletter is to contain material and announcements of interest to the entire ITS community, not just members of the Society.

The first issue of the Society's new Magazine is currently in preparation. The plan is to have the first three issues in electronic form available to the members of the Society for download from the IEEE. The fourth issue will be a paper issue mailed to all members of the Society. The Editor-in-Chief of the Magazine for the first two issues is Prof. Fei-Yue Wang. Your Newsletter Editor will take over as Editor-in-Chief of the Magazine for the next two issues, serving as Editor-in-Chief of both the Newsletter and the Magazine for the last six months of this year. The intention is to make sure that the two publications are well coordinated during this startup period.



From The Editor-in-Chief of the IEEE Transactions on ITS

by Alberto Broggi

Authors, please advertise your papers:

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For complete guidelines, please check
<http://www.ieee.org/web/publications/rights/policies.html>

Type of accepted manuscripts:

From Jan 1, 2007, T-ITS accepts the following type of manuscripts:

- regular papers
- short papers (formerly known as 'technical correspondences')
- survey papers (formerly known as 'reviews')
- practitioners papers

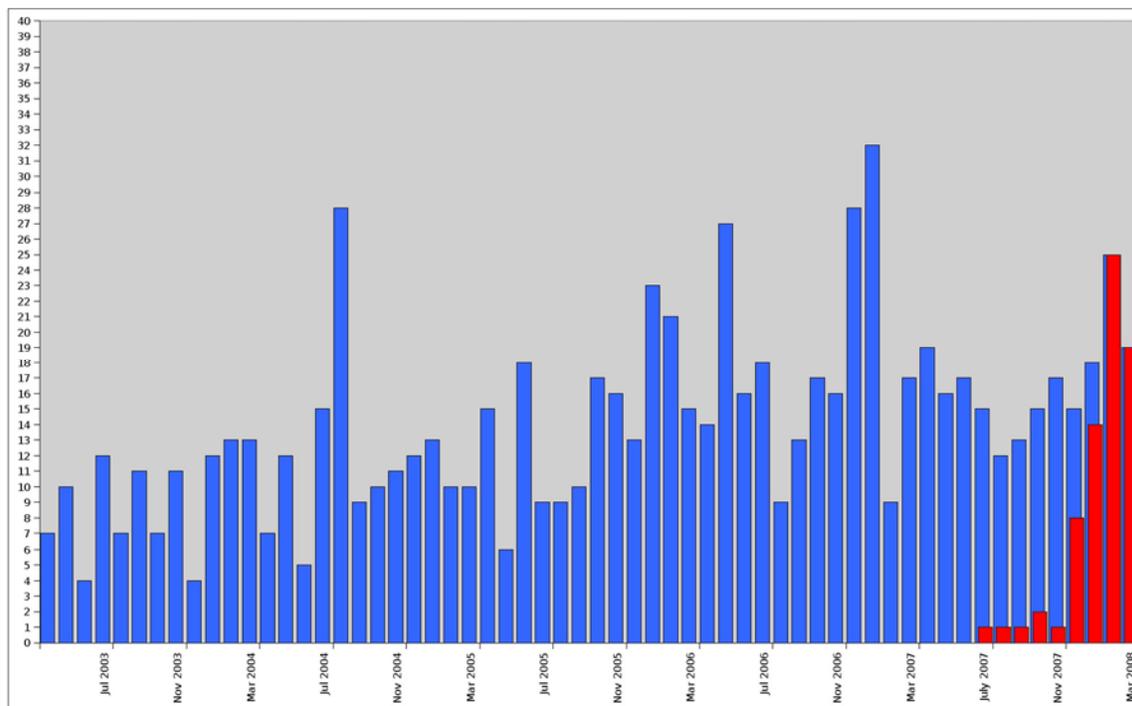
Maximum number of pages:

From the 2007 September issue, the policy on the maximum number of pages will change: regular papers will be allowed 10 pages, short papers and practitioners papers 6, while there will be no limit to survey papers.

Current status:

The figure shows: in blue the number of papers submitted in each month from April 2003 (when we switched to electronic submission), and in red the number of papers still without a decision; this means that either the first submission did not come to an end, or that a new revision is currently under evaluation.

The figure shows that the trend is positive, and, apart from isolated cases, all submitted papers receive a notification in a reasonably short time.



	Submissions	Page budget	Published papers
2004	167	360	36
2005	157	480	42
2006	234	620	49
2007	205	720	60

Acceptance ratio: about 24%

Average time from submission to first decision
(2007): **87.5 days**

ITS Conferences

Announcements for the conferences the IEEE ITS Society will sponsor in 2008 can be found on the following pages.

June 4-6, 2008

2008 IEEE Intelligent Vehicles Symposium

Eindhoven, the Netherlands,

www.iv2008.nl

June 17-20, 2008

2008 IEEE International Conference on Intelligence and Security Informatics

Taipei, Taiwan

isi2008.cpu.edu.tw

September 22-24, 2008

2008 IEEE International Conference on Vehicular Electronics and Safety

Columbus, Ohio, USA

www.ece.osu.edu/ICVES08

October 12-15, 2008

The 11th International IEEE Conference on Intelligent Transportation Systems

Beijing, China

www.ieeeitsc.org

October 12-15, 2008,

2008 IEEE/INFORMS International Conference on Service Operations and Logistics, and Informatics

Beijing, China

www.ieeesoli.org

October 12-15, 2008

2008 IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications

Beijing, China

www.asmemesa.org

Announcements for the following conferences on ITS are also included.

July 9-11, 2008

Safety in Mobility

Klagenfurt, Austria

www.lakeside-conference.at

June 30-July 3, 2008

The 11th International Conference on Information Fusion

Cologne, Germany

www.fusion2008.org

September 1-3, 2008

International Trade and Freight Transportation Conference

Ayia Napa, Cyprus

feweb.vu.nl/ITFTC

September 4-5, 2008

Infoconnectivity: Intertwined information for interconnected transport networks

Vienna, Austria

www.iiid-expertforum.net



Call for registration

2008 IEEE Intelligent Vehicles Symposium

June 4-6, 2008, Eindhoven, the Netherlands

Don't miss it! The 2008 IEEE Intelligent Vehicles Symposium (IV'08) is an annual forum sponsored by the IEEE Intelligent Transport Systems Society. It will take place in Eindhoven, the Netherlands during June 4-6, 2008. Eindhoven provides a splendid conference location. The conference site at the Eindhoven University of Technology, hotels and demonstration sites are all in walking distance, right in the City centre, next to the railway station. A Phileas semi-automated bus system to the airport. Welcome to Eindhoven!

The Intelligent Vehicles Conference gathers researchers from industry, universities and public authorities to discuss research and applications for intelligent vehicles, including the communication between vehicles and between vehicles and infrastructure.

The technical sessions of the symposium consist of plenary presentations, including keynote presentations by Dr Carlo van de Weijer (TomTom), Dr Hans-Georg Metzler (Daimler) and Dr Steven Shladover (PATH/UC Berkeley) and interactive poster sessions. A record number of 300 contributions were received of which 200 were selected for presentation.

On June 6, the road next to the conference venue will be closed for normal traffic in order to provide a perfect site for demonstrations of intelligent vehicles. Already more than 20 demonstrations have been confirmed amongst which four participants to the famous DARPA Urban Challenge.

On June 3, meetings and workshops in conjunction to the conference will be held.

All activities, sessions as well as the demonstrations are at the campus of the Eindhoven University of Technology. Eindhoven (and its region) is a key area of the Dutch High Tech Industry, including the Dutch automotive industry that consists of over 200 companies. A range of Dutch automotive companies belong to the world top ranking companies. In the weekend following IV'08 the city will be bustling with automotive activities during an 'Automotive Weekend' with vintage cars, future technology, city races etc. Come to IV'08 and enjoy your weekend in Eindhoven!

The registration site is open. Given the record number of paper submissions and demonstrations, we are expecting a large number of participants. As the symposium room has limited capacity, registrations will be accepted on a first-come first-served basis.

For more information, including travel and hotel information visit our website www.iv2008.nl

Henk Nijmeijer & Bart van Arem
General chairs IV 2008

Organizing parties



Main sponsors



Sponsor





IEEE International Conference on Intelligence and Security Informatics (IEEE ISI-2008)

Taipei, Taiwan

June 17-20, 2008

isi2008.cpu.edu.tw

Intelligence and Security Informatics (ISI) is concerned with the study of the development and use of advanced information technologies and systems, computer science, and algorithms for national, international, and societal security-related applications, through an integrated technological, organizational, and policy based approach. The annual IEEE International Conference series (<http://www.isiconference.org>) on ISI was started in 2003 and the first five meetings were held in Tucson, AZ (twice), Atlanta, GA, San Diego, CA, and New Brunswick, NJ in the United States. Besides the established and emerging ISI research topics of ISI conferences and workshops, we also extend ISI to cover related rapid growing areas, such as computer forensics and cyber investigation.

Conference Organization

Steering Committee

- Dr. Pei-Zen Chang, The Science and Technology Advisory Group of Executive Yuan, Taiwan
- Deputy Director Wei-Hsien Wang, Vice Admiral, Science Research Office, National Security Bureau, Taiwan
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- Director Der-Tsai Lee, Institute of Information Science, Academia Sinica, Taiwan
- Professor Hsinchun Chen, University of Arizona, USA.



2008 IEEE International Conference on Vehicular Electronics and Safety

Sponsored by the IEEE Intelligent Transportation Systems Society

September 22-24, 2008, Columbus Ohio, USA

2.nd Call for Papers

The International Conference on Vehicular Electronics and Safety (ICVES) is an annual meeting sponsored by the IEEE Intelligent Transportation Systems (ITS) Society as a forum for researchers from industry and universities to discuss research and applications. Papers dealing with all aspects of vehicle electronics and vehicle safety-related intelligent systems are solicited for this third meeting. Topics include the following:

- Active and Passive Safety Systems
- Telematics
- Vehicular Power Networks
- X-By Wire Technology
- System-On-a-Chip
- Vehicular Sensors
- Vehicle Bus Systems
- On-Vehicle Sensor Networks
- Embedded Operating Systems
- Electro Magnetic Compatibility
- Inter-Vehicular Communication
- Vehicle Testing
- Navigation and Localization Systems
- Vehicular Measurement Technology
- Vehicular Signal Processing
- Micro-electromechanical Systems
- Image Sensors
- Vehicle/Engine Control
- Driver Assistance and Warning Systems
- Adaptive Cruise Control Systems
- Pattern Recognition for Vehicles
- Human Machine Interaction
- Diagnostics
- Vehicle Hardware /Software

IMPORTANT DATES:

Paper submission deadline-----May 15, 2008
 Notification of acceptance-----July 1, 2008
 Camera-ready copy due----- August 1, 2008

FURTHER INFORMATION: <http://www.ece.osu.edu/ICVES08>

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Call for Papers



The 11th International IEEE Conference on Intelligent Transportation Systems Beijing, China, October 12-15, 2008

Sponsored by the IEEE Intelligent Transportation Systems Society
Organized by Institute of Automation, Chinese Academy of Sciences
Conference site: www.ieeeitsc.org Email: itsc08@gmail.com

The IEEE Intelligent Transportation Systems Society (ITSS) is sponsoring a conference on basic research and applications of leading advances in communications, computer, control, and electronics technologies related to Intelligent Transportation Systems (ITS). IEEE ITSC 2008 is technical-sponsored by Key Lab for Complex Systems & Intelligence Science (CSIS) in the Chinese Academy of Sciences (CAS).

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Topics

Travel and Traffic Management

Travel Information and Guidance
Ride Matching And Reservation
Traveler Services Information
Traffic Control
Incident Management
Travel Demand Management
Emissions Testing And Mitigation
Highway-rail Intersection
Complex Adaptive Systems for Transportation

Public Transportation Management

Public Transportation Management
En-route Transit Information
Personalized Public Transit
Public Travel Security

Commercial Vehicle Operations

Commercial Vehicle Electronic Clearance
Automated Roadside Safety Inspection
On-board Safety Monitoring
Commercial Vehicle Administrative Processes
Hazardous Material Incident Response
Commercial Fleet Management

Advanced Vehicle Safety Systems

Collision Avoidance
Vision Enhancement
Advanced Safety Systems
Automated Vehicle Operation

Electronic Payment

Electronic Payment Services

ITS Modeling and Analysis

Data Mining and Analysis
Travel Behavior Under ITS
Simulation and Modeling
Traffic Theory for ITS
Statistical Modeling
Optimization and Control: Theory and Modeling
Geographic Information Systems
Hardware in the Loop Simulation
Software in the Loop Simulation
Artificial Transportation Systems

Emergency Management and Transportation Security

Emergency Notification & Personal Security
Emergency Vehicle Management
ITS and National Security
Parallel Management Systems for Transportation Emergency

Other Topics

Imaging and Image Analysis
Multi-Sensor Fusion
Cooperative Psychologies
Intelligent Transportation Space
Agent-based Methods for Traffic and Vehicular Systems
Ad Hoc Networks

Paper Submission

Complete manuscripts in PDF format must be electronically submitted for peer-review in IEEE standard-format. Detailed submission instructions can be found on the paper submission website: <http://www.ieeeitsc.org>

Submission Deadline:
Notification of acceptance date:
Final paper submission date:

June 1, 2008
July 15, 2008
August 15, 2008



IEEE ITSC 2008 will be held together along with the 2008 IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications and 2008 IEEE Intl Conf on Service Operations and Logistics, and Informatics.



CALL FOR PAPERS

2008 IEEE/INFORMS International Conference on Service Operations and Logistics, and Informatics (IEEE/SOLI'2008)

October 12-15, 2008, Beijing, China

<http://www.ieeesoli.org>

Sponsored by IEEE/ITSS, Technical-sponsored by INFORMS and Hosted by Beijing Jiaotong University

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Conference Scope and Themes



areas.

Conference Proceedings

All papers in the Proceedings of IEEE/SOLI are indexed by ISTP and included in the IEEE Xplore.

Areas of Interest

Papers relating to Services/Logistics Design, Innovations, Marketing, Operations, and Engineering; Information Technology / Systems, and their specific applications are strongly encouraged. Special sessions on specific service topics are also welcome. Topics include, but are not limited to:

- ◆ **Service Design, Engineering, Operations, and Innovations** - Service planning and design • Service process engineering • Expedited services and extreme logistics • Healthcare systems • Financial services • Retail and services management • Quality and customer satisfaction • Metrics and benchmarks • Security & safety-related services and management • Contingency planning • Operations research • Production engineering • Intelligent traffic • Engineering consulting • Traffic planning • Integrated transportation • Service operation
- ◆ **Logistics & Supply Chain Management** - On-demand delivery • Logistics planning • Freight forwarding and customs clearance • Venue logistics management • Warehouse and distribution • Transportation management systems • Reverse logistics • Logistics visibility and control • Procurement • supply chain collaboration • supply chain process • supply chain networks
- ◆ **Material Flow (MF) Science and Technology** - MF fundamental sciences (MF mathematics, physics, chemistry, biology, etc.) • Comprehensive MF theory • MF in the natural world • Material flow in the social world • Material flow in the economic world • MF element theory • MF nature • MF engineering • MF Industry • MF Technological economics • Cycle MF System • X party material flow (XPMF) • The MF complexity and emergence • The MF information and simulation technology • MF systems and networks • Financial Measures of MF
- ◆ **Service/Event Management & Manufacturing** - Demand forecasting • Customer relationship management • Event communication and alerting • Services training • Services sustaining • Services quality • Services bundling • E-market for services • Event management system • Event sponsorship • Event-based production and supply chain • Event-based products and manufacturing • Intelligent manufacturing • Customization
- ◆ **Information & Communications Technology and Systems (ICTS)** - ICTS services design and management • ICTS services standards, locating, composition, and bundling • Process modeling, augmentation, and automation • Real time identification & tracking • Pervasive and ubiquitous computing in logistics • Decision support systems • Software agent based systems • RFID • data warehousing and data/Web mining • Business intelligence • Systems interoperability and integration • Information security • IT Project Management • Information Management in construction project
- ◆ **Electronic Commerce & Knowledge** - Wireless Communication and mobile commerce • Mobile services • Electronic government • Information resource management • IT and enterprise innovation management • IT and strategy for the sustainable development of enterprises • Semiotics • Business performance management • Customer relationship management • Information economics • Network culture and harmonious society • Distributed computing • Sensor networks

Paper Submission

Manuscripts in English must be electronically submitted at the conference website: <http://www.ieeesoli.org> They should be at most six pages in the IEEE two-column conference paper format. A LaTeX style file and a Microsoft Word template are available from the IEEE web site (<http://www.ieee.org/pubs/transactions/stylesheets.xml>). The submissions, however, need to be in PDF.

Important date

June 1, 2008	Deadline for submission of full papers
July 15, 2008	Acceptance/Rejection notification
August 15, 2008	Final camera-ready papers due



CALL FOR PAPERS



**MESA08 --- 2008 IEEE/ASME International Conference
on Mechatronic and Embedded Systems and Applications**
Beijing, China, October 12-15, 2008
<http://www.asmemesa.org>

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Mechatronic and Embedded System Applications

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Ying Chen, Zhejiang University, China

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Sunil Agrawal, University of Delaware, USA

Micro Air vehicles

Xinyan Deng, University of Delaware, USA

Intelligence in Mechatronic and Embedded Systems

Hyo-Sung Ahn, Gwangju Institute of Science and Tech, Korea

Special Topics and Sessions

Hami Kazerooni, Univ. of California, Berkeley, USA

Xudong Hu, Zhejiang Sci-Tech University, China

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<http://www.asmemesa.org>

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IEEE Intelligent Transportation Systems Society

ASME Division of Design Engineering

Chinese Academy of Sciences

Chinese Association for Automation

Chinese Mechanical Engineering Society

Co-sponsor

National Natural Science Foundation of China

Objectives

Mechanical and electrical systems show an increasing integration of mechanics with electronics and information processing. This integration is between the components (hardware) and the information-driven functions (software), resulting in integrated systems called mechatronic systems. The development of mechatronic systems involves finding an optimal balance between the basic mechanical structure, sensor and actuators, automatic digital information processing and control in which embedded systems play a key role. The field of embedded system and mechatronics is becoming evermore challenging; issues in embedded software lie at the focus of researchers both in industry and academia. The goal of this 4th IEEE/ASME MESA, MESA08, is to bring together experts from the fields of mechatronic and embedded systems, disseminate the recent advances made in the area, discuss future research directions, and exchange application experience. The conference program is organized in a number of symposia.

Venue

MESA08 will be held together along with the 11th Intl IEEE Conf on Intelligent Transportation Systems and 2008 IEEE Intl Conf on Service Operations and Logistics, and Informatics.

Paper Submission

Complete manuscripts in PDF format must be electronically submitted to the conference website <http://www.asmemesa.org>. Submitted manuscripts should be six (6) pages or less in IEEE two-column format, including figures, tables, and references.

Important Dates

June 1, 2008

Full paper, proposal for special session, workshop and tutorial

July 15, 2008

Notification of acceptance

August 15, 2008

Camera ready paper submission

→ **Be sure to save the date!**



The Lakeside Conference **Safety in Mobility 2008**

Intelligent Weather Information Systems and Services in Traffic and Transport



Contact address:
Lakeside Science & Technology Park
Lakeside B01
9020 Klagenfurt
Austria
Tel.: +43 (0)463 22 88 22-21
Fax: +43 (0)463 22 88 22-10
office@lakeside-conference.at
www.lakeside-conference.at

The Lakeside Conference on Safety in Mobility

Intelligent Weather Information Systems and Services in Traffic and Transport

July 9-11, 2008

Lakeside Science and Technology Park in Klagenfurt, Austria

Transportation professionals from across Europe and the United States are cordially invited to participate in this exciting event, which will highlight the latest technology in intelligent weather information systems and services for traffic and transportation applications.

- Discover state of the art technologies available now to help operators understand and quickly act on weather information;
- Identify the challenges European road, rail, inland waterway and public transportation operators are facing as they manage dangerous weather situations;
- Explore the future of intelligent weather information systems and services with top-notch experts in the field;
- Learn about U.S. and European regulatory and policy decisions and how they impact the way in which infrastructure management entities deal with hazardous weather.

The Call for Papers is open now! Sponsorship and exhibition options are available.

For more information about how you or your organization can participate in this important event, please visit our website at www.lakeside-conference.at, or contact our conference management at office@lakeside-conference.at

Yours sincerely,

Conference Host: Maria Mack

FUSION 2008



The 11th International Conference on Information Fusion

Cologne, Germany June 30 - July 03, 2008

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Opening a new decade of fusion research, FUSION 2008 will be covering all aspects of all-source information fusion and its vast, ever increasing scope of applications.

Let FUSION 2008 be an opportunity for our community to demonstrate that Information Fusion is evolving into a mature branch of applied science characterised by its own methodologies, technologies, and fields of application.

What's New?

- (Apr 03) [Tutorial outlines](#) available.
- (Mar 31) Link to [registration opened](#)
[Hotel information available](#).
- (Mar 26) Link to [visa information](#)
- (Mar 5) New Information [About Cologne](#)
(Travelling, Sight Seeing, Shopping, etc.)
- (Feb 25) Announcement of [Panel Discussions](#)
- (Feb 13) Extension of Deadlines

Important Deadlines

- | | |
|--------------------------------------|-----------------------------|
| Special session proposal | Feb 1, 2008 |
| Tutorial proposal | Feb 1, 2008 |
| Regular paper submission | Mar 1, 2008 |
| Notification of acceptance of papers | Apr 11, 2008 |
| Final paper submission | May 5, 2008 |
| Authors' registration | May 5, 2008 |
| Early registration | Apr 1 – May 15, 2008 |

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Last Update 2008-04-08

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Conferences ▶

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Call for papers

International Trade and Freight Transportation Conference 1-3 September 2008, Ayia Napa, Cyprus

Abstract Submission: May 30th, 2008
Notification of acceptance: June 15th, 2008
Final Paper submission: August 15, 2008

Scope:

Freight transportation is facing new challenges as the demand rapidly increases, competition puts tight constraints on costs and pricing, globalization introduces interdependencies not well understood and decisions have to be made under more constraints than ever before. Advances in technology and research in the area open the way for better solutions and approaches to a wide range of problems facing the industry. Technology alone however will not resolve all problems as socioeconomic, labor, environment and other issues influence decisions made throughout the world. The purpose of this conference is to bring together experts from different areas to address current and future technologies, policies and approaches related to freight transportation. The form of the conference is intended to allow extensive informal interactions among participants, something that cannot be found in some of the large conferences.

Topics:

Focus will be on three thematic Areas

- I. Intelligent Freight Transportation Technologies
- II. Modeling, Optimization and Simulation Tools
- III. Policy, Economy and Environment

Specific topics include:

Logistics, Intelligent Transportation Systems, Container Terminals, Container ships, Container Trains, Modeling and Simulation Tools, Agile Ports, Labor Issues, Truck Routing, RFID, Empty Container reuse, Port and Terminal Technologies, Gate appointment system, Policy and environmental issues, etc.

A selected number of papers will be considered for publication in a special issue Journal.

Organization Committee:

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<http://feweb.vu.nl/ITFTC>



IIID Expert Forum Traffic Guiding Systems 2008

Infoconnectivity

Intertwined information for interconnected transport networks

in partial correspondence with Call FP7- TRANSPORT (TPT)-2008-RTD-1 / TPT.2008.13. New mobility / organisational schemes:

Interconnection between short and long-distance transport networks

4/5 September 2008, Tech Gate Vienna, Wien/Vienna, Austria

Organiser:

International Institute for Information Design (IIID)

The effectiveness of public transport often depends on how long it takes to change between different modes of transport. This can become even more critical when it comes to transferring from long- to short-distance transport networks and vice versa. If "inter-connectivity" between transport networks is to be enhanced, measures focusing on improving "INFOconnectivity" between transport networks and their customers are indispensable. Highest possible effects in accelerating passenger transfers may be expected by introducing the concept of "intertwined information" of and between transport networks.

[Call for Speakers](#) (Submission deadline: 11 June 2008)



Conference Calendar

by Massimo Bertozzi and Paolo Grisleri

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

2008

May 11-14
IEEE Vehicular Technology Conference Spring 2008
Marina Bay, Singapore
<http://www.ieeevtc.org/vtc2008spring>

May 19-23
IEEE International Conference on Robotics and Automation (ICRA 2008)
Pasadena, California (USA)
<http://www.icra2008.org>

May 27-31
10th International Conference on Application of Advanced Technologies in Transportation
Athens, Greece
<http://www.civil.ntua.gr/aatt/>

June 30-July 2
1st Mediterranean Conference on Intelligent Systems and Automation
Annaba, Algeria
<http://lsc.univ-evry.fr/cisa08/doku.php>

August 6-8
3rd International Symposium on Transport Simulation
Queensland, Australia
<http://civil.eng.monash.edu.au/conferences/ists08>

September 21-24
IEEE Vehicular Technology Conference Fall 2008
Calgary, Canada
<http://www.ieeevtc.org/vtc2008fall>

September 22-26
International Conference on Intelligent Robots and Systems
Nice, France
<http://iros2008.inria.fr>

2009

July 16-18
International Symposium on Transportation and Traffic Theory
Hong Kong
<http://www.isttt18.org>



Announcements

by Angelos Amditis

This section contains announcements of general interest to the ITS community. You may submit articles you would like to have included to a.amditis@iccs.gr.

ITS Short Courses

8th SHORT COURSE 2008

DYNAMIC TRAFFIC FLOW MODELLING AND CONTROL

Lecturer:

Prof. Markos Papageorgiou

Technical University of Crete

Dynamic Systems and Simulation Laboratory Chania 73100, Greece

Date: 21-25 July 2008

Location: Chania (Crete), Greece

Fee: 1.200 EURO (for graduate students: 800 EURO) (20% reduction is granted in case of more than one participation from the same institution)

Scope

The design, analysis, and evaluation of Intelligent Transportation Systems (ITS) requires a good knowledge of traffic flow modelling and control techniques as well as of powerful methodologies from the areas of optimisation, control, networks and dynamic systems. The purpose of the intensive 5-day course is to cover the basic theory and tools necessary for efficient design and evaluation of ITS on road and freeway networks. The course will begin with traffic flow modelling and validation that includes a coverage of the various traffic flow models, the modelling of traffic networks, and simulation tools. Measurement devices and estimation problems in traffic networks, that include automatic incident detection and O-D estimation, will be presented and discussed. The state-of-the art techniques on freeway control, road traffic control, and integrated control employing ramp metering, signal control, and route guidance via application of modern optimisation, control, and estimation techniques, together with several case studies will be presented. Some 50 exercises will be used for consolidation of the provided knowledge. Extensive written materials, including all transparency copies, will be handed out.

Who Should Attend?

Graduate students, engineers, researchers, consultants, and government employees who are interested in improving their understanding of advanced traffic flow modelling and control tools and in becoming familiar with their application in ITS.

For More Information

<http://www.dssl.tuc.gr/en/shortcourse/8thShortCourse2008.doc>

MODELING AND SIMULATION OF TRANSPORTATION NETWORKS

July 28 - August 1, 2008

Lecturer-In-Charge
Professor Moshe Ben-Akiva
Director of the MIT ITS Laboratory

Introduction

Modeling and simulation methods are essential elements in the design and operation of transportation systems. Congestion problems in cities worldwide have prompted at all levels of government and industry a proliferation of interest in Intelligent Transportation Systems (ITS) that include advanced supply and demand management techniques. Such techniques include real-time traffic control measures and real-time traveler information and guidance systems whose purpose is to assist travelers in making departure time, mode and route choice decisions. Transportation researchers have developed models and simulators for use in the planning, design and operations of such systems. This course draws heavily on the results of recent research and is sponsored by the Intelligent Transportation Systems Laboratory of the Massachusetts Institute of Technology.

The course studies theories and applications of transportation network demand and supply models and simulation techniques. It provides an in-depth study of the world's most sophisticated traffic simulation models, demand modeling methods, and related analytical techniques, including discrete choice models and their application to travel choices and driving behavior; origin-destination estimation; prediction of traffic congestion; traffic flow models and simulation methods (microscopic, mesoscopic and macroscopic); and alternative dynamic traffic assignment methods. Uses lectures, case studies and software dealing with the design, evaluation and operation of transportation systems.

For more information

http://web.mit.edu/mitpep/pi/courses/simulation_transportation.html



Book Reviews

by Algirdas Pakstas

Editor's note: If you are the author or editor of a book that would be of interest to the Intelligent Transportation Systems community, please send an email to a.pakstas@londonmet.ac.uk requesting an announcement in the Newsletter and a review in the Magazine.



INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY MAGAZINE



Scope

The IEEE ITS Magazine will publish peer-reviewed articles that

- provide innovative research ideas and application results,
- report significant application case studies, and
- raise awareness of pressing research and application challenges in all areas of intelligent transportation systems.

In contrast to the archival publications in the IEEE Transactions on ITS, the ITS Magazine will focus on providing information of general interest to all members of ITS society, serving as a dissemination vehicle for ITS Society members and others to learn the state of the art development and progress on ITS research and applications.

High quality tutorials, surveys, successful implementations, technology reviews, lessons learned, policy and societal impact, and ITS educational issues will be published.

CALL FOR PAPERS

Suggested topics for authors include, but are not limited to, information technologies, infrastructure protection, public policy, and social and economic studies on ITS-related topics. Papers focusing on successful implementations, practical challenges, lessons learned, and policy considerations are encouraged.

If you are interested in submitting a paper, please contact the Editor-in-Chief, Dr. Fei-Yue Wang, at itseic@gmail.com for more information on submission procedures.

CALL FOR VOLUNTEERS

An editorial board for the new Magazine is now being established. If you are interested in serving as an Associate Editor, please send your curriculum vitae to the Editor-in-Chief, Dr. Fei-Yue Wang at itseic@gmail.com along with a cover letter indicating the topics on which you feel qualified to serve as an Associate Editor.

The Editor-in-Chief is Dr. Fei-Yue Wang. Dr. Wang is a Professor of Systems and Industrial Engineering at the University of Arizona. He also directs the University's Program for Advanced Research in Complex Systems and the Key Laboratory of Complex Systems and Intelligence Science at the Chinese Academy of Sciences. Dr. Wang is the Immediate Past President of the ITS Society.



IEEE ITSS Best PhD Dissertation Award

IEEE ITSS Best Practice Award for Engineers



Call for Proposals

IEEE ITSS Best PhD Dissertation Award

Purpose and Selection Criteria

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

Application material

Each application must consist of the following material:

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 PhD candidate highlighting the significance of the problem, the technical approach taken, application context and potential, and the scope of the dissertation.
3. A self-contained paper in English based on the dissertation written primarily by the PhD. candidate following the Transactions on ITS regular paper requirements.
4. A letter of recommendation from the applicant's dissertation advisor that comments on the significance of the research, attests to the originality of the work, and comments on the engagement of the student in the field of ITS and the ITSS.

IEEE ITSS Best Practice for Engineers

Purpose. and Selection Criteria

The IEEE ITSS Best Practice Award for ITS Engineers is given annually for ITS engineers and teams who have developed and deployed successful ITS systems or implementations. This award is established to recognize, promote, and publicize major application innovations with real-world impact.

Application material

Each application must consist of the following material:

1. A 5-page summary of the ITS application providing sufficient detail for evaluation of the novelty and impact of the work
2. At most 3 letters of recommendation from the customers or users of the developed application attesting to its significance and practical impact

Application and Selection Process for either Award

Please upload the application packet in pdf-format before May 1, 2008 to the following Internet address:

<https://xchange.mrt.uni-karlsruhe.de/itssAward/>

Applications by email are not accepted.

Dedicated selection committees will evaluate the applications for the IEEE ITSS Awards and propose candidates for final approval from the ITSS Board of Governors. The first prize winners will receive awards of US\$ 1000 each. The second prize winner of the *Best PhD Dissertation Award* will receive US\$ 500. Award certificates will be given out at the ITSS Conference in Beijing where the recipients will be asked to give a presentation of their work.

Abstracts of Papers

IEEE Transactions on Intelligent Transportation Systems, vol.9, no.1, March 2008

Nunes, U.; Rakha, H.; Wang, Y.; Lee, D.-H., "Special Issue on ITSC 2006," pp.1-4

Abstract: This special issue contains revised versions of selected papers originally presented at the 9th IEEE International Conference on Intelligent Transportation Systems (ITSC 2006) held in Toronto, Canada, on September 17-20, 2006.

Jwa, S.; Özgüner, Ü; Tang, Z., "Information-Theoretic Data Registration for UAV-Based Sensing," pp.5-15

Abstract: This paper presents a new approach to data fusion for automatic recognition, surveillance, and tracking in intelligent transportation systems. Robust data alignment (RDA), i.e., finding relational maps among a sequence of invariant feature data sets, is one of the key requirements for successful data fusion. To achieve RDA for correspondenceless data fusion, we construct a cost criterion based on the information theory and solve an optimization problem with a mixed search strategy that combines the Nelder–Mead simplex and random search methods. We evaluate the cost criterion and search strategy by a numerical stability test and suggest an outlier rejection technique for refining the previous feature data and, at the same time, extracting moving vehicles that are contained in the collected outliers. Experimental results on a video sequence that is collected from an unmanned aerial vehicle indicate the potential of aerial monitoring and tracking systems built on our information-theoretic RDA.

Kim, Z., "Robust Lane Detection and Tracking in Challenging Scenarios," pp.16-26

Abstract: A lane-detection system is an important component of many intelligent transportation systems. We present a robust lane-detection-and-tracking algorithm to deal with challenging scenarios such as a lane curvature, worn lane markings, lane changes, and emerging, ending, merging, and splitting lanes. We first present a comparative study to find a good real-time lane-marking classifier. Once detection is done, the lane markings are grouped into lane-boundary hypotheses. We group left and right lane boundaries separately to effectively handle merging and splitting lanes. A fast and robust algorithm, based on random-sample consensus and particle filtering, is proposed to generate a large number of hypotheses in real time. The generated hypotheses are evaluated and grouped based on a probabilistic framework. The suggested framework effectively combines a likelihood-based object-recognition algorithm with a Markov-style process (tracking) and can also be applied to general-part-based object-tracking problems. An experimental result on local streets and highways shows that the suggested algorithm is very reliable.

Paz, A.; Peeta, S., "Fuzzy Control Model Optimization for Behavior-Consistent Traffic Routing Under Information Provision," pp.27-37

Abstract: This paper presents an H-infinity filtering approach to optimize a fuzzy control model used to determine behavior-consistent (BC) information-based control strategies to improve the performance of congested dynamic traffic networks. By adjusting the associated membership function parameters to better respond to nonlinearities and modeling errors, the approach is able to enhance the computational performance of the fuzzy control model. Computational efficiency is an important aspect in this problem context, because the information strategies are required in subreal time to be real-time deployable. Experiments are performed to evaluate the effectiveness of the approach. The results indicate that the optimized fuzzy control model contributes in determining the BC information-based control strategies in significantly less computational time than when the default controller is used. Hence, the proposed H-infinity approach contributes to the development of an efficient and robust information-based control approach.

Lint, J. W. C., "Online Learning Solutions for Freeway Travel Time Prediction," pp.38-47

Abstract: Providing travel time information to travelers on available route alternatives in traffic networks is widely believed to yield positive effects on individual drive behavior and (route/departure time) choice behavior, as well as on collective traffic operations in terms of, for example, overall time savings and—if nothing else—on the reliability of travel times. As such, there is an increasing need for fast and reliable online travel time prediction models. Previous research showed that data-driven approaches such as the state-space neural network (SSNN) are reliable and accurate travel time predictors for freeway routes, which can be used to provide predictive travel time information on, for example, variable message sign panels. In an operational context, the adaptivity of such models is a crucial property. Since travel times are available (and, hence, can be measured) for realized trips only, adapting the parameters (weights) of a data-driven travel time prediction model such as the SSNN is particularly challenging. This paper proposes a new extended Kalman filter (EKF) based online-learning approach, i.e., the online-censored EKF method, which can be applied online and offers improvements over a delayed approach in which learning takes place only as realized travel times are available.

Du, J.; Barth, M. J., "Next-Generation Automated Vehicle Location Systems: Positioning at the Lane Level," pp.48-57

Abstract: The majority of today's automated vehicle location (AVL) systems use Global Positioning System (GPS) technology, which can provide position information with an accuracy of approximately 15 m. Recently, low-cost Differential GPS (DGPS) receivers, which have a positioning accuracy of approximate 2–3 m, have become available. With this increased accuracy, it is now possible to perform AVL down to specific roadway lanes. In this paper, a vehicle-lane-determining system is described, consisting of an onboard DGPS receiver that is connected with a wireless communications channel, a unique lane-level digital roadway database, a developed lane-matching algorithm, and a real-time vehicle location display. Lane-level positioning opens up the door for a number of new intelligent transportation system applications such as better fleet management, lane-based traffic measurements from probe vehicles, and lane-level navigation. The developed low-cost system has been tested on a number of roadways and has performed very well when used with accurately surveyed map data. Based on more than 100 000 s, it has correctly determined the lane 97% of the time.

X.-B.; Qiao, H.; Keane, J., "A Low-Cost Pedestrian-Detection System With a Single Optical Camera, by Cao," pp.58-67

Abstract: The ultimate purpose of a pedestrian-detection system (PDS) is to reduce pedestrian-vehicle-related injury. Most such systems tend to adopt expensive sensors, such as infrared devices, in expectation of better performance. In comparison, a low-cost optical-camera-based system has much potential practical value, including a greater detection range, and can easily be trained to detect other objects. However, such low-cost systems are difficult to design (e.g., little original information can be collected, and the scene is very complex). To address these problems, an effective and reliable classifier is needed. The classifier should have a proper structure, its features need to be well selected, and a large number of high-quality samples are necessary for training. In this paper, we present a low-cost PDS which only uses a single optical camera. We design a cascade classifier to achieve an effective and reliable detection. First, our system scans two sequential frames at each zoom scale with a sliding window. Second, with each window, both appearance and motion features are extracted. A well-trained cascade classifier, combining statistical learning with a decomposed support-vector-machine classifier, then determines whether the window contains a human body. At the same time, to provide as much information as possible about the pedestrian, a small-scale weighted template tree trained by a coevolutionary algorithm is adopted to identify each pedestrian's direction, and the distance of each from the vehicle is also provided using an estimation algorithm. During the training procedure, we select key features by using the AdaBoost algorithm and a large number of high-quality samples. Experimental results demonstrate that the system is suitable for pedestrian detection in city traffic: The detection speed is more than 10 ft/s, the detection rate reaches 80%, and the false positive rate is no more than 0.3%.

Tsang, C. W.; Ho, T. K., "Optimal Track Access Rights Allocation for Agent Negotiation in an Open Railway Market," pp.68-82

Abstract: In open railway access markets, a train service provider (TSP) negotiates with an infrastructure provider (IP) for track access rights. This negotiation has been modeled by a multiagent system in which the IP and the TSP are represented by separate software agents. One of the tasks of the IP agent is to generate feasible (and preferably optimal) track access rights, subject to the constraints submitted by the TSP agent. This paper formulates an IP–TSP transaction and proposes a branch-and-bound algorithm for the IP agent to identify the optimal track access rights. Empirical simulation results show that the model is able to emulate rational agent behaviors. The simulation results also show good consistency between the timetables that were attained from the proposed methods and those that were derived by the scheduling principles adopted in practice.

Wang, C.-C. R.; Lien, J.-J. J., "Automatic Vehicle Detection Using Local Features—A Statistical Approach," pp.83-96

Abstract: This paper develops a novel statistical approach for automatic vehicle detection based on local features that are located within three significant subregions of the image. In the detection process, each subregion is projected onto its associated eigenspace and independent basis space to generate a principal components analysis (PCA) weight vector and an independent component analysis (ICA) coefficient vector, respectively. A likelihood evaluation process is then performed based on the estimated joint probability of the projection weight vectors and the coefficient vectors of the subregions with position information. The use of subregion position information minimizes the risk of false acceptances, whereas the use of PCA to model the low-frequency components of the eigenspace and ICA to model the high-frequency components of the residual space improves the tolerance of the detection process toward variations in the illumination conditions and vehicle pose. The use of local features not only renders the system more robust toward partial occlusions but also reduces the computational overhead. The computational costs are further reduced by eliminating the requirement for an ICA residual image reconstruction process and by computing the likelihood probability using a weighted Gaussian mixture model, whose parameters and weights are iteratively estimated using an expectation–maximization algorithm.

Jula, H.; Dessouky, M.; Ioannou, P. A., "Real-Time Estimation of Travel Times Along the Arcs and Arrival Times at the Nodes of Dynamic Stochastic Networks," pp.97-110

Abstract: Route planning in uncertain and dynamic networks has recently emerged as an active and intense area of research, both due to industry needs and technological advances. This paper investigates methods to predict travel times along the arcs and estimate arrival times at the nodes of a stochastic and dynamic network in real time. It is shown that, under fairly mild conditions, the developed travel and arrival time estimators are unbiased and that the error variance of the arrival time estimator is bounded. Simulation results are used to demonstrate the efficiency of the proposed algorithm.

Papamichail, I.; Papageorgiou, M., "Traffic-Responsive Linked Ramp-Metering Control," pp.111-121

Abstract: A new traffic-responsive ramp-metering strategy is presented that coordinates local ramp-metering actions, thus enabling the linked control of the inflow from two (or more) consecutive on-ramps to the freeway main-stream. The proposed linked ramp-metering scheme is simple and utterly reactive, i.e., based on readily available real-time measurements without any need for real-time model calculations or external disturbance prediction. The well-known feedback strategy, known as Asservissement LINÉaire d'EntrÉE AutoroutiÈre (ALINEA), is used at a local level. Simulation results are presented for a hypothetical freeway axis with two successive on-ramps. Some

pitfalls and misapplications of the local ramp metering are also illustrated via appropriately designed simulation scenarios. The proposed linked strategy is demonstrated to outperform the uncoordinated local ramp metering and, thus, to increase the achievable control benefit over the no-control case. In fact, the new strategy is shown to reach the efficiency of sophisticated proactive optimal control schemes.

Wu, S.-J.; Wu, C.-T.; Chang, Y.-C., "Neural-Fuzzy Gap Control for a Current/Voltage-Controlled 1/4-Vehicle MagLev System," pp.122-136

Abstract: A magnetically levitated (MagLev) vehicle prototype has independent levitation (attraction) and propulsion dynamics. We focus on the levitation behavior to obtain precise gap control of a 1/4 vehicle. An electromagnetic levitation system is highly nonlinear and naturally unstable, and its equilibrium region is severely restricted. It is therefore a tough task to achieve high-performance vehicle-levitated control. In this paper, a MagLev system is modeled by two self-organizing neural-fuzzy techniques to achieve linear and affine Takagi-Sugeno (T-S) fuzzy systems. The corresponding linear-type optimal fuzzy controllers are then used to regulate both physical systems (voltage- and current-controlled systems). On the other hand, an affine-type fuzzy control design scheme is proposed for the affine-type systems. Control performance and robustness to an external disturbance are shown in simulation results. Affine T-S fuzzy representation provides one more adjustable parameter in the neural-fuzzy learning process. Therefore, an affine T-S-based controller possesses better performance for a current-controlled system since it is nonlinear not only to system states but also to system inputs. This phenomenon is shown in simulation results. Technical contributions include a nonlinear affine-type optimal fuzzy control design scheme, self-organizing neural-learning-based linear and affine T-S fuzzy modeling for both MagLev systems, and the achievement of an integrated neural-fuzzy technique to stabilize current- and voltage-controlled MagLev systems under minimal energy-consumption conditions.

Eidehall, A.; Petersson, L., "Statistical Threat Assessment for General Road Scenes Using Monte Carlo Sampling," pp.137-147

Abstract: This paper presents a threat-assessment algorithm for general road scenes. A road scene consists of a number of objects that are known, and the threat level of the scene is based on their current positions and velocities. The future driver inputs of the surrounding objects are unknown and are modeled as random variables. In order to capture realistic driver behavior, a dynamic driver model is implemented as a probabilistic prior, which computes the likelihood of a potential maneuver. A distribution of possible future scenarios can then be approximated using a Monte Carlo sampling. Based on this distribution, different threat measures can be computed, e.g., probability of collision or time to collision. Since the algorithm is based on the Monte Carlo sampling, it is computationally demanding, and several techniques are presented to increase performance without increasing computational load. The algorithm is intended both for online safety applications in a vehicle and for offline data analysis.

Kanhere, N. K.; Birchfield, S. T., "Real-Time Incremental Segmentation and Tracking of Vehicles at Low Camera Angles Using Stable Features," pp.148-160

Abstract: We present a method for segmenting and tracking vehicles on highways using a camera that is relatively low to the ground. At such low angles, 3-D perspective effects cause significant changes in appearance over time, as well as severe occlusions by vehicles in neighboring lanes. Traditional approaches to occlusion reasoning assume that the vehicles initially appear well separated in the image; however, in our sequences, it is not uncommon for vehicles to enter the scene partially occluded and remain so throughout. By utilizing a 3-D perspective mapping from the scene to the image, along with a plumb line projection, we are able to distinguish a subset of features whose 3-D coordinates can be accurately estimated. These features are then grouped to yield the number and locations of the vehicles, and standard feature tracking is used to maintain the locations of the vehicles over time. Additional features are then assigned to these groups and used to classify vehicles as cars or trucks. Our technique

uses a single grayscale camera beside the road, incrementally processes image frames, works in real time, and produces vehicle counts with over 90% accuracy on challenging sequences.

Zhang, W.; Wu, Q. M. J.; Yang, X.; Fang, X., "Multilevel Framework to Detect and Handle Vehicle Occlusion," pp.161-174

Abstract: This paper presents a multilevel framework to detect and handle vehicle occlusion. The proposed framework consists of the intraframe, interframe, and tracking levels. On the intraframe level, occlusion is detected by evaluating the compactness ratio and interior distance ratio of vehicles, and the detected occlusion is handled by removing a "cutting region" of the occluded vehicles. On the interframe level, occlusion is detected by performing subtractive clustering on the motion vectors of vehicles, and the occluded vehicles are separated according to the binary classification of motion vectors. On the tracking level, occlusion layer images are adaptively constructed and maintained, and the detected vehicles are tracked in both the captured images and the occlusion layer images by performing a bidirectional occlusion reasoning algorithm. The proposed intraframe, interframe, and tracking levels are sequentially implemented in our framework. Experiments on various typical scenes exhibit the effectiveness of the proposed framework. Quantitative evaluation and comparison demonstrate that the proposed method outperforms state-of-the-art methods.

Zografos, K. G.; Androutopoulos, K. N., "Algorithms for Itinerary Planning in Multimodal Transportation Networks," pp.175-184

Abstract: The itinerary planning problem in an urban public transport system constitutes a common routing and scheduling decision faced by travelers. The objective of this paper is to present a new formulation and an algorithm for solving the itinerary planning problem, i.e., determination of the itinerary that lexicographically optimizes a set of criteria (i.e., total travel time, number of transfers, and total walking and waiting time) while departing from the origin and arriving at the destination within specified time windows. Based on the proposed formulation, the itinerary planning problem is expressed as a shortest path problem in a multimodal time-schedule network with time windows and time-dependent travel times. A dynamic programming-based algorithm has been developed for the solution of the emerging problem. The special case of the problem involving a mandatory visit at an intermediate stop within a given time window is formulated as two nested itinerary planning problems which are solved by the aforementioned algorithm. The proposed algorithm has been integrated in a web-based journey planning system, whereas its performance has been assessed by solving real-life itinerary planning problems defined on the Athens urban public transport network, providing fast and accurate solutions.

Hsu, H. C.-H.; Liu, A., "Kinematic Design for Platoon-Lane-Change Maneuvers," pp.185-190

Abstract: For the lane-change maneuvers under the architectures of automated highway systems, most researchers focus on the maneuvers for a single vehicle to change lanes. However, not only are the lane-change maneuvers for a single vehicle needed, but a platoon-lane-change (PLC) maneuver is also required in some situations for an entire platoon to change lanes. The goal of this paper is to design PLC maneuvers under the coordinated- and noncoordinated-platooning infrastructures. Two PLC maneuvers are proposed in this paper, and they are the leader and predecessor PLC maneuvers, where the predecessor PLC maneuver is considered in two cases, i.e., the intraplatoon spacing less than or greater than the minimum safety spacing. We use SmartAHS to simulate these PLC maneuvers, and the simulation results demonstrate the feasibility of these PLC maneuvers while taking the safety and comfort of passengers into account.

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Technical Contributions

Brian Park, Associate Editor for Technical Contributions

This Newsletter contains one technical contribution entitled: “A Genetic-Fuzzy Control Application to Ramp Metering and Variable Speed Limit Control,” by Amir Hosein, Ashkan Rahimi Kian, and Masoud Tabibi, reprinted, with permission, from the IEEE International Conference on Systems, Man, and Cybernetics, Montreal, Canada, October 2007.

With the launch of the ITSS Magazine, future technical contributions will be published in the Magazine. I would like to thank past technical paper contributors and look forward to receiving new contributions to the Magazine.

A Genetic-Fuzzy Control Application to Ramp Metering and Variable Speed Limit Control

Amir Hosein Ghods, *Student Member, IEEE*, Ashkan Rahimi Kian, *Member, IEEE*, Masoud Tabibi

Abstract—This paper proposes a fuzzy control approach for the traffic-responsive ramp metering and variable speed limits control, in order to reduce the peak-hour congestion on freeways. The objective of control is to minimize the total time spent in the traffic network. To ease the calibration process of fuzzy controller and improve the overall performance of ramp metering and variable speed limits, genetic algorithm is applied for tuning the fuzzy sets parameters. In order to evaluate the controller's efficiency and applicability, a comparison is made with traditional ALINEA based controller and the fuzzy ramp metering only case by a case-study. The macroscopic traffic model METANET and its extension for dynamic speed limits are used for optimization procedure and presenting the simulation results. The paper concludes that genetic fuzzy control of ramp metering and speed limits is expected to enhance the performance of the freeway traffic network.

I. INTRODUCTION

THE expansion of car-ownership in many countries all over the world has led to daily occurrence of congestion in urban areas. Traffic control is intended to reduce the congestion and its negative impacts on traffic safety, environment, quality of life and etc. There are a number of approaches have been implemented to control the freeway traffic network such as on-ramp metering, dynamic routing and speed limits.

Ramp metering is the most widely used type of freeway traffic control. The set-up consists of a traffic light placed on the entrance and controlled by a control strategy. During the green phase only one vehicle is allowed to enter the freeway. Therefore ramp metering can prevent traffic breakdown by adjusting the metering rate such that the density remains below the critical value. Many algorithms have been applied so far to adjust the metering rate, some of them are mostly empirical, and others are based on optimal control problems. A more detailed overview of ramp metering is reported in [1].

Variable speed limits are considered as a tool of homogenization and breakdown prevention of traffic flow by reducing the speed differences between vehicles. In the homogenization case, the speed limits that are close to, but above the critical speed (the speed corresponding to the maximum flow) is used. Whereas in breakdown prevention, the focus is on preventing very high densities,

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and speeds lower than critical speed are allowed [2]. The results related to the model predictive control for optimal coordination of ramp metering and variable speed limits are considered in [2]. The effect of speed control to increase safety is reported in [3].

Fuzzy logic algorithms appear to be suitable for ramp metering and speed control, because they can handle systematically inaccurate information e.g. inexact traffic model and sensor noisy measurements. The rule base logic presents linguistic knowledge and human expertise for fuzzy sets. Since rules are easily defined, changed and removed, fuzzy logic can be developed and modified simply. The nonlinear and non-stationary behavior of traffic makes the modeling procedure extremely difficult. Therefore many traditional models force the non-linear system into linear context with precision loss [4]. Because a fuzzy controller can deal with nonlinear systems with unknown models, it has a significant advantage over other traditional controllers. On the other hand modern optimal control techniques are too complex to be implemented in real world of freeway operation while the implementation of fuzzy is fairly simple (see [5]). Furthermore fuzzy controller allows smooth transition between metering rate that is an important feature.

In this paper we use fuzzy ramp metering and variable speed limits controller. It's demonstrated in [3] that speed limits can complement ramp metering, when the traffic demand is too high that ramp metering is not effective anymore. In addition traffic fuzzy controller presents a good performance in the real-world traffic conditions because they can regulate nonlinear, stochastic and time delayed systems, while keeping robustness and computational simplicity. In order to take the advantages of fuzzy controller and ramp metering in the presence of speed limits, at the same time, we use the combination of both approaches in this paper.

II. FUZZY RAMP METERING AND VARIABLE SPEED LIMITS

To develop a fuzzy controller for ramp metering and variable speed limits, some input information that corresponds to the traffic conditions of controlled area is needed. In this paper, the local flow, local speed and queue occupancy are considered as input data. The outputs of fuzzy controller are the specific metering rate and the dynamic speed limit that is displayed on the main-stream (Fig. 1).

A. Fuzzification

The first stage inside the controller block in Fig. 1 is fuzzification block which transforms crisp input values into

grades of membership for linguistic terms of fuzzy sets. This procedure determines how well the particular input matches the conditions of the rules.

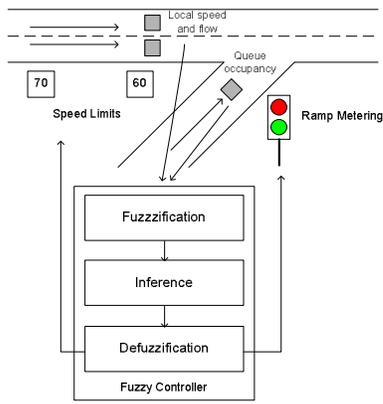


Fig 1 Fuzzy ramp metering and variable speed limits

There are three measured inputs for the fuzzy on-ramp and dynamic speed controller which must be fuzzified. The local speed and local traffic flow are measured just upstream of the on-ramp. Three different values "small", "medium" and "high" describe the speed and flow variable and the queue occupancy is described by the term "very high".

Also the output variables have to be fuzzified. The metering rate and the dynamic speed limits are the outputs which the terms "low", "medium" and "high" are assigned to. The Gaussian distribution curve is taken for membership function of two inputs including local flow and speed and outputs. For the queue occupancy the sigmoid shape is assumed.

B. Inference

The core of a fuzzy system is the part, which combines the facts obtained from the fuzzification with the rule base, and conducts the fuzzy reasoning process. The rules are based on expert opinions, operator experiences and system knowledge. Basically, these rules have the following format.

If <antecedent1> and/or <antecedent2>...
Then <consequent1>, <consequent2>...

All rules are evaluated in parallel based on fuzzy set theory that describes interpretation of the logical operations such as the complement, intersection and unions of sets. For complementation, one minus the membership function has been chosen. AND and OR operations corresponds to the minimum and maximum functions respectively.

The consequent of a fuzzy rule assigns an entire fuzzy set to the output. This fuzzy set is represented by a membership function that is chosen to indicate the qualities of the consequent. Therefore each rule has a nonzero degree overlapping with other rules. To combine the inference

results of these rules the aggregation method is used.

The rules for our controller were determined from expert knowledge and evaluation of simulation results. The rule-base for fuzzy ramp metering and variable speed limits is shown in Table. 1.

C. Defuzzification

After the aggregation process, there is a fuzzy set for each output variable that needs to be converted into a single number (defuzzification process). For the defuzzification of both the ramp meter rate and the value of speed limit, the center of gravity (COG) function is used.

TABLE I
IMPLEMENTED RULES FOR THE FUZZY RAMP METERING AND SPEED LIMIT CONTROLLER

Antecedent	Consequent
If speed is small and flow is small	Metering rate is low and speed limit is high
If speed is high and flow is small	Metering rate is high and speed limit is medium
If speed is medium and flow is high	Metering rate is low and speed limit is high
If speed is high and flow is medium	Metering rate is medium and speed limit is medium
If queue occupancy is too high	Metering rate is high and speed limit is high

III. MACROSCOPIC TRAFFIC FLOW MODEL

The traffic flow model adopted here is the destination independent METANET model (see [6] for more details) and an extension to the model for speed limits (see [2] for more details). This model is used to evaluate the effectiveness of the fuzzy controller to achieve the optimal solution in the tuning procedure of controller's parameters.

A. Original METANET model

The METANET model is a second-order model that is discrete in both space and time. The model represents the network by a directed graph with the links corresponding to freeway stretches. Each link has uniform characteristics i.e. no on-ramp or off-ramp and no major changes in geometry ([6]). The nodes of the graph are placed between links where the major change in road geometry occurs, such as on-ramps and off-ramps. A freeway link m is divided into N_m segments (indicated by the index i) of length $l_{m,i}$ and by the number of lanes n_m . Each segment i of link m at the time instant $t = kT$, $k = 0, \dots, K$ is macroscopically characterized by the traffic density $\rho_{m,i}(k)$ (veh/lane/km), the mean speed $v_{m,i}(k)$ (km/h) and the traffic volume $q_{m,i}(k)$ (veh/h). The time step used for simulation is denoted by T . The following equations describe the evolution of the network for each segment i of link m at each time step k .

$$q_{m,i}(k) = \rho_{m,i}(k)v_{m,i}(k)n_m \quad (1)$$

$$\rho_{m,i}(k+1) = \rho_{m,i}(k) + \frac{T}{l_{m,i}n_m} [q_{m,i-1}(k) - q_{m,i}(k)] \quad (2)$$

$$v_{m,i}(k+1) = v_{m,i}(k) + \frac{\Delta T_{sim}}{\tau_m} \{V[\rho_{m,i}(k)] - v_{m,i}(k)\} + \frac{T}{l_{m,i}} v_{m,i}(k) [v_{m,i-1}(k) - v_{m,i}(k)] - \frac{\mathcal{G}_m T}{\tau_m l_{m,i}} \frac{\rho_{m,i+1}(k) - \rho_{m,i}(k)}{\rho_{m,i}(k) + \kappa_m} \quad (3)$$

$$V[\rho_{m,i}(k)] = v_{free,m} \exp\left(-\frac{1}{a_m} \left(\frac{\rho_{m,i}(k)}{\rho_{crit,m}}\right)^{a_m}\right) \quad (4)$$

Where a_m denotes a parameter of fundamental diagram (4) of link m , $v_{free,m}$ is the free-flow speed that drivers assume if traffic is freely flowing, and $\rho_{crit,m}$ is the critical density corresponding to the density where the maximum flow in the link occurs. Furthermore τ_m , a time constant, \mathcal{G}_m , an anticipation constant, and κ_m , are constant parameters for each link. The first two equations are based on physical principles and are exact, while (3) and (4) are heuristic.

For origins links the simple queue model is used. The queue model is described by the following equation.

$$w_o(k+1) = w_o(k) + T(d_o(k) - q_o(k)) \quad (5)$$

Thus (5) describes that the length of the queue $w_o(k+1)$, is equals the previous queue $w_o(k)$, plus the demand $d_o(k)$, minus the outflow $q_o(k)$. The outflow depends on the traffic condition on the main-stream and also depends on metering rate $r_o(k) \in [0,1]$, for metered on-ramp. The outflow $q_o(k)$ is determined as follow.

$$q_o(k) = r_o(k) \tilde{q}_o(k) \quad (6)$$

with

$$\tilde{q}_o(k) = \min\{\tilde{q}_{o,1}(k), \tilde{q}_{o,2}(k)\} \quad (7)$$

and

$$\tilde{q}_{o,1}(k) = d_o(k) + w_o(k)/T \quad (8)$$

$$\tilde{q}_{o,2}(k) = Q_o \min\left\{1, \frac{\rho_{max,m} - \rho_{m,1}}{\rho_{max,m} - \rho_{crit,m}}\right\} \quad (9)$$

where Q_o is the on-ramp capacity (veh/h) under free-flow traffic condition in the main-stream and $\rho_{max,m}$ (veh/lane/km) is the maximum density of link m .

B. Extensions

Reference [2] has stated that the speed control changes

the shape of the fundamental diagram as shown in Fig. 2. Thus the desired speed is the minimum of the speed base on fundamental diagram, and the speed caused by the speed limit which is displayed on the variable message sign (VMS).

$$V(\rho_{m,i}(k)) = \min\left\{v_{free,m} \exp\left(-\frac{1}{a_m} \left(\frac{\rho_{m,i}(k)}{\rho_{crit,m}}\right)^{a_m}\right), (1+\alpha)v_{control,m,i}(k)\right\} \quad (10)$$

where $v_{control,m,i}(k)$ denotes the speed limit that corresponds to the segment i , link m , at time k , and $(1+\alpha)$ is the disobedience factor expressing the fact that driver's target speed is usually higher than what is displayed.

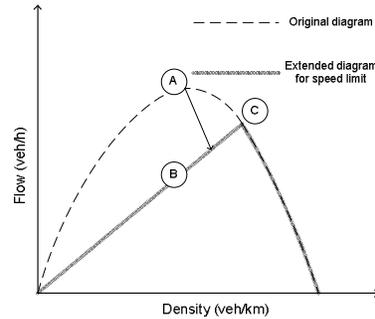


Fig. 2 Speed limits change the state from A to somewhere between B and C, and change the shape of the fundamental diagram

IV. GENETIC OPTIMIZATION OF FUZZY RAMP METERING AND VARIABLE SPEED LIMITS

To accomplish the optimal performance of the fuzzy controller the genetic algorithm is applied. The objective of genetic algorithm is to minimize the total time spent in the system by tuning the fuzzy parameters. To estimate the fitness function the METANET model and its extension to the speed limits are used (see Fig. 3).

A. Genetic algorithm

The origin of genetic algorithm was found in the studies for simulating the mechanism of the natural evolution and selection by John Holland. By adopting such concepts borrowed from nature, genetic algorithms are able to evolve optimal solutions to a large variety of problems. Genetic algorithm starts with an initial set of random solutions called population. Each individual in the population is called a chromosome, representing a solution to the problem. The evolution operation simulates the process of Darwinian evolution to create population from generation to generation by selection, crossover and mutation operations. The success of genetic algorithm is founded in its ability to keep existing parts of solution,

which have a positive effect on the outcome [7].

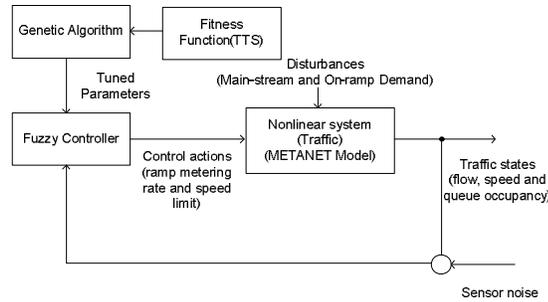


Fig 3 Genetic Fuzzy Control System

The two parameters of Gaussian fuzzy set (center points and the sigma values) and the two parameters of sigmoid fuzzy set are changed by the genetic algorithm. Therefore a total of 26 values for a controller are coded. To make a balance between computation time and precision the number of 30 individuals is selected.

After creating a new population the fitness value has to be calculated for each member in the population and then ranked based on the fitness value. The genetic algorithm selects 'parents' from the current population by using a selection probability. Then the reproduction of 'children' from the selected parents occurs by using recombination and mutation. The cycle of evaluation, selection and reproduction terminates when the convergence criteria is met.

B. Fitness function

An objective function that is often used in the literature ([1]) is the total time spent (TTS) by all vehicles in the freeway network. It has been proven that the minimization of the TTS results in the maximization of the network output. The precise cost criterion is as follows.

$$J(k) = T \sum_{j=0}^K \left\{ \sum_{m,i} \rho_{m,i}(j) l_{m,j} n_m + \sum_o w_o(j) + a_w \sum_o \Psi[w_o(j)]^2 \right\} \quad (11)$$

$$\Psi[w_o(j)] = \max\{0, w_o(k) - w_{o,max}\} \quad (12)$$

where a_w is a weighting factor. The first two terms of (11) correspond to the main-stream and origins queues respectively. The last term which is weighted by a non-negative weighting factor enables the control strategy to limit queue lengths at the origins to the maximum level. Since the fuzzy controller allows smooth transition in the control signal, we eliminate the terms that penalize abrupt changes in the ramp metering and speed limit control signals.

V. ALINEA CONTROLLER

ALINEA (Asservissement LINEaire d'Entree Aut routi ere) which could be translated as "Linear ramp metering control" is a PID-like feedback control methodology for ramp metering developed by Papageorgiou [8]. ALINEA adjusts the metering rate to keep the traffic density on the freeway at a preset level, called the occupancy set-point $\hat{\rho}$. Typically $\hat{\rho}$ is chosen smaller than or equal to the critical density ρ_{crit} . Therefore the maximum traffic flow on freeway can be obtained. The control law is as follow:

$$r_o(k) = r_o(k-1) + K_r(\hat{\rho} - \rho(k)) \quad (13)$$

where $r_o(k)$ is the metering rate at the time instant k , K_r is regulator parameter and $\rho(k)$ is the traffic density measured downstream of the on-ramp.

VI. CASE STUDY

This section presents the description of a benchmark network and simulation results of different scenarios. The performance of genetic-fuzzy ramp metering and variable speed limits is compared with the performance of ALINEA based ramp metering, the fuzzy ramp metering without speed control and the no-control case. The relevant quantity for comparing is the total time spent (TTS) on the network. The lower the TTS, the higher the performance of the scenario.

A. Benchmark network

In order to assess the performance of genetic-fuzzy ramp metering and variable speed limits, a stretch of 6km long consisting of six segments of 1km each, is considered as a case study in this paper (see Fig. 4). The network consists of two origins including a main-stream and an on-ramp. O_1 is the main origin connected to the link L_1 . The freeway link L_1 has two lanes with a capacity of 4000 veh/h. The last three segments of link L_1 (segments 2, 3 and 4) are equipped with VMS where speed limits are applied. At the end of link L_1 a single-lane metered on-ramp (O_2) with a capacity of 2000 veh/h is attached. The studied freeway follows via link L_2 with two lanes and two segments to the destination D_1 .

In order to prevent the spill-back of queue to the surface street, we limit the maximum queue length at O_2 to the 150 vehicles. The networks parameters as stated in [9] are as follows:

$$T = 10s, \tau = 18s, \kappa = 40 \text{ veh/lane/km}, \vartheta = 60 \text{ km}^2/h,$$

$$\rho_{max} = 180 \text{ veh/lane/km}, a_1 = a_2 = 1.867 \text{ and}$$

$$\rho_{crit} = 33.5 \text{ veh/lan/km}$$

Also we assume that the desired speed is 10% higher

than what is displayed by speed limits ($\alpha = 0.1$).

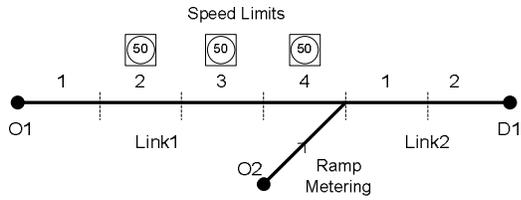


Fig 4 Benchmark network with on-ramp metering and speed limits

The main-stream demand increases from 1000 veh/h to the 3500 veh/h and remains constant for about 1 hour. Finally it drops to 1000 veh/h. The demand on the on-ramp has a constant value of 500 veh/h at the beginning and then raises to the 1500 veh/h. Then it remains constant for about 15 minutes. Finally it drops to the 500 veh/h again.

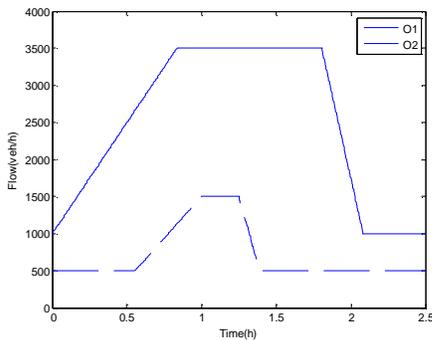


Fig 5 The demand scenario for simulation

B. Results

In no-control case, when demand increases on the on-ramp the congestion occurs and propagates through link 1 (Fig. 6). Consequently the density on the main-stream increases and the queue of approximately 240 vehicles is formed at the origin 1. In this case the measured value of TTS is 988.1 veh-h.

In Fig.7 the results of ALINEA ramp metering controller with $K_r = 0.005$ is presented. Since during ramp metering the queue cannot be allowed to grow larger than available capacity of the vehicles at the on-ramp, the metering rate becomes 1 as long as the queue length is above the threshold. As a result the oscillation of metering rate influences the traffic variables. These oscillations need to be suppressed when their amplitude become too large. The TTS in the ALINEA controller case is 932.4 veh h with an improvement of 5.6%.

The third scenario was fuzzy-genetic ramp metering only case. The optimized controller was applied to the case study. It is illustrated in Fig. 8 that the metering rate and evolution of traffic states are much smoother than the ALINEA case. In this case the maximum queue length of 150 vehicles is never exceeded. The TTS is 935.2, shows an improvement of 5.35% and close to the ALINEA case.

The last performed scenario was genetic fuzzy ramp metering and variable speed limits. The speed limits reduce the inflow of the critical segment and cause a lower density, which enable a higher outflow. The TTS in the speed limits and ramp metering case is 923.8, which is an improvement of 6.5 % (see Fig. 9).

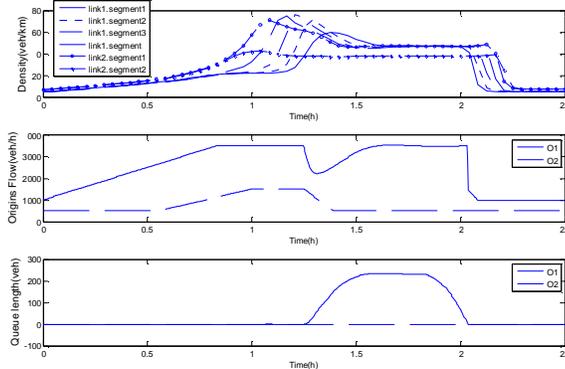


Fig 6 The simulation results for no-control case

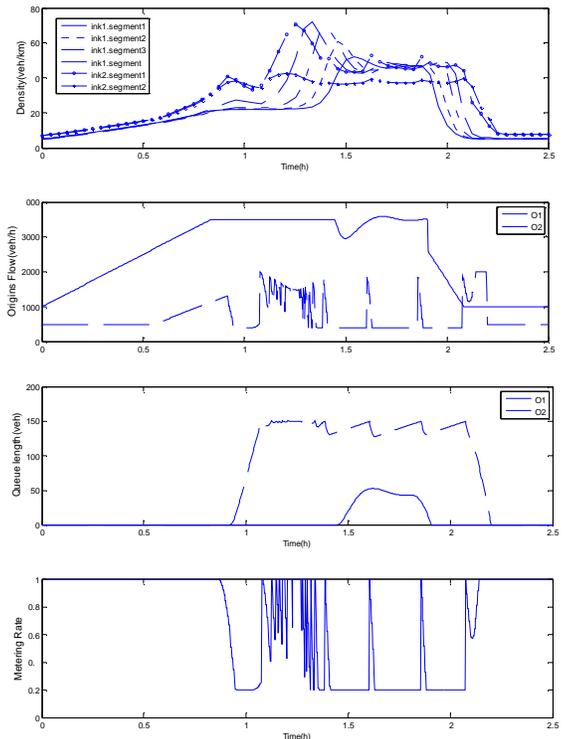


Fig 7 The simulation results for ALINEA controller case

VII. CONCLUSION

In this paper the genetic-fuzzy ramp metering and variable speed limits control were applied to achieve optimal solution such that the total time spent in the network becomes minimal.

It was observed that the ALINEA controller was unable to limit the queue almost to the maximal queue length. However the metering rate oscillated due to the constraints on maximal queue length which overrode the controller.

The genetic-fuzzy ramp metering controllers were observed to realize the close performance to the ALINEA controller. The fine tuning of the fuzzy controller parameters with the genetic algorithm could get us to the maximum queue length with much less oscillations.

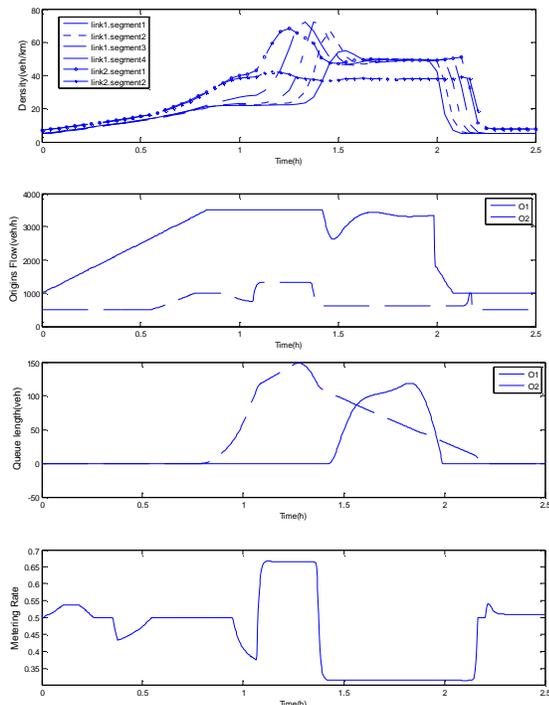


Fig. 8. The simulation results for fuzzy genetic ramp metering only case.

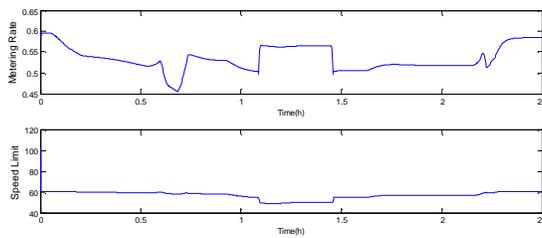
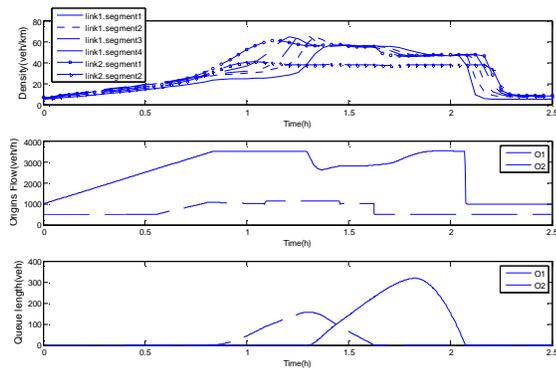


Fig. 9. The simulation results for fuzzy genetic ramp metering and variable speed limits.

Furthermore, the control signals were much smoother in the genetic-fuzzy controller.

The reported results demonstrated that the variable speed limits could improve the performance of the control, when the ramp metering was unable to keep the freeway congestion-free by itself. Also, the total time spent was improved by the genetic-fuzzy controller (with both ramp metering and variable-speed-limit control) compared to that of the ALINEA controller (with only ramp metering control).

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Appendix 1

IEEE Intelligent Transportation Systems Society – ITS38

Newsletter Editor's Report to IEEE Technical Activities Board Periodicals Committee

Scheduled date of review – 14 February 08

A. IEEE ITS SOCIETY NEWSLETTER

1. **Date of first issue** – January 1999
2. **Frequency of publication** – 4 issues per year
3. **List Editor-In-Chief Information For The Last Five Years**

Newsletter Editor in Chief:
July 2007 to present Dr. Charles J. Herget
Email c.herget@ieee.org

2005- June 2007 Prof. Bart van Arem
2004 Prof. Stefano Stramigioli
1999-2003 Prof. Alberto Broggi

B. EDITORIAL POLICIES AND PROCEDURES

1. Describe the membership and function of the Editorial Board.

Editor-in-Chief, responsible for overall production of the Newsletter
Associate Editors

Transactions on ITS report and abstracts, provides reports on the ITS Transactions and abstracts of papers of the most recent issue.

Technical Contributions, responsible for solicitation and reviews of technical articles.

Book Reviews, responsible for book reviews.

Conferences, workshops and journals, provides calendar of ITS conferences and workshops sponsored outside of IEEE.

Research Programs, provides articles on research programs at various laboratories.

2. Describe the membership, function, and make-up (for example, geographic distribution, academic versus industrial, and so forth) of the group of Associate Editors (for example, the Transaction's Editorial Board or Committee).

Current makeup of editorial board:

Editor-in-Chief, IEEE Life Senior Member. Ten years industrial experience, nine years academic experience, fifteen years experience at a major US government research laboratory, six years experience as an independent consultant. Location: USA.

All current associate editors are from academic institutions. Locations: USA, Italy, UK, and Greece.

3. Describe Editor-in-Chief (EIC) selection, training, and terms/term limits.

The Editor-in-Chief is typically selected from one of the associate editor positions. The current Editor-in-Chief is a past president of the Society. The Editor-in-Chief served as a technical associate editor of IEEE Control Systems Magazine from 1981-1989. He has served on TAB as President of the Control Systems Society in 1993, as President of the ITS Council from 2003-2004, and President of the ITS Society in 2005.

The Editor-in-Chief is appointed by the Society President with the approval of the Board of Governors. The Society’s constitution and bylaws do not provide for a term limit on this position.

C. TIMELINESS

Is every issue of this periodical mailed on or before the cover date? If No, comment on reason and corrective action plan:

Yes.

D. FINANCIAL AND SUBSCRIPTION INFORMATION

	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007B</u>	<u>2008B</u>
<u>Income</u>						
S/C Fees Hard Copy	0.0	0.0	0.0	0.0	0.0	0.0
Total Income	0.0	0.0	0.0	0.0	0.0	0.0
<u>Expense</u>						
Editorial Reimbursed Expenses	0.0	2.7	3.1	2.8	3.2	2.9
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0
Total Expense/PurSvc/ReimbSvc	0.0	2.7	3.1	2.8	3.2	2.9
Total Net	0.0	(2.7)	(3.1)	(2.8)	(3.2)	(2.9)

E. FINANCIAL AND SUBSCRIPTION DISCUSSION

Comment on any financial anomalies:

The Newsletter is published and distributed electronically. Announcements are sent out to subscribers using IEEE ListServ. The issues are posted on the Society’s web site where they can be downloaded in Adobe portable document (pdf) format. The only expense has been a nominal charge for support staff of the Editor-in-Chief.

Comment on any subscription anomalies:

Anyone may subscribe to the Newsletter free of charge. The number of subscribers, approximately 10,000, is far larger than the number of members of the Society.

F. COMPLIANCE WITH IEEE POLICIES AND PROCEDURES

The EIC shall have in his/her possession a current copy of the appropriate IEEE manuals regarding policies and procedures for publications. The EIC shall have read and be familiar with all sections of the above documents concerning publications. Please visit the following site for such documents:

<http://www.ieee.org/web/publications/home/index.html>

Comment regarding compliance with the above requirement, and compliance with the individual publication related policies of each document. Describe action plans to come into compliance if in default.

G. RECOMMENDATIONS FROM PREVIOUS PUBLICATIONS REVIEW

If applicable, list the date of the last IEEE TAB Periodicals review, and include a summary of recommendations made at that time. Describe how each recommendation was met.

The previous review of the Society's publications was held on February 14, 2002. No recommendations for the Newsletter were noted in the report.

H. NOTABLE FEATURES

Describe special issues, or other notable features.

None.

I. FUTURE PLANS

Describe future plans for this periodical.

The Society will begin the publication of a Magazine in 2008 and the scope of the Newsletter will change somewhat. After the new Magazine becomes fully operational, the Newsletter will focus on Society news, calls for papers of upcoming conferences and special issues of the Transactions and Magazine, announcements for new books (reviews to be in the Magazine), officer's reports, conference reports, job announcements, Letters to the Editor, and feature articles on current events in ITS. The intention of the Newsletter is to contain material and announcements of interest to the entire ITS community, not just members of the Society

J. SELF ASSESSMENT

This section provides an opportunity for self-assessment of this Newsletter. Please compose a narrative to reflect your S/C viewpoints on this Newsletter; in so doing, cite specific examples of strengths and weaknesses.

The purpose of the Newsletter is to contain reports on Society activities, messages from officers and the editor, letters from the readers, calls for papers, news from chapters, meeting notices, conference reports, awards publications of interest to the readers, and technical articles of general interest to the members. We believe the Newsletter is fulfilling its purpose very well.