Scanning the Issue and Beyond: Toward ITS Knowledge Automation

STARTING with the first issue of the bimonthly version of IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, I will begin each issue by scanning and summarizing each article in a format that is suitable for presentation at *Weibo* (Micro blogs in Chinese), Twitter, and Facebook. Please check @IEEE-TITS (http://www.weibo.com/u/3967923931) for *Weibo*, https://www.facebook.com/IEEEITS for *Facebook*, and @IEEEITS (https://twitter.com/IEEEITS) for *Twitter*. In addition, I will go beyond the papers published here and give my thought on issues that I consider interesting or important for current or future research and development in the area of intelligent transportation.

SCANNING THE ISSUE

Symmetrical SURF and Its Applications to Vehicle Detection and Vehicle Make and Model Recognition
J.-W. Hsieh, L.-C. Chen, and D.-Y. Chen

A new symmetrical SURF descriptor is presented to enhance SURF's power to detect all possible symmetrical matching pairs through a mirroring transformation. To deal with multiplicity and ambiguity, a grid division scheme is also proposed to separate a vehicle into several grids in which different weak classifiers are trained and then integrated to build a strong ensemble classifier. Due to the rich representation power of the grid-based method and the high accuracy of vehicle detection, the ensemble classifier can accurately recognize each vehicle.

Sensor Fusion-Based Vacant Parking Slot Detection and Tracking
J. K. Suhr and H. G. Jung

A vacant parking slot detection and tracking system is proposed and expected to help drivers select available parking slots. The system fuses the sensors of an around view monitor system and automatic parking system. The experimental results show that the proposed method can recognize the positions and occupancies of various types of parking slot markings and stably track them in real time.

Probabilistic Aircraft Midair Conflict Resolution Using Stochastic Optimal Control
W. Liu and I. Hwang

This paper proposes a stochastic optimal control method to resolve the conflicts between aircraft and moving convective weather regions. The proposed method is able to incorporate uncertainties in both aircraft and wind dynamics. The simulation results show that the proposed algorithm provides robustness against uncertainties in the system and is suitable for real applications.

A Car Pooling Model and Solution Method With Stochastic Vehicle Travel Times
S. Yan, C.-Y. Chen, and S.-C. Chang

A stochastic car pooling model that considers the influence of stochastic travel times is developed. A solution algorithm for this model and a simulation-based evaluation method are presented. A case study is performed based upon data reported from a past study carried out in northern Taiwan. The results show the effectiveness of the proposed model and a solution algorithm.

Envelope Level Crossing Rate and Average Fade Duration of Nonisotropic Vehicle-to-Vehicle Ricean Fading Channels
X. Cheng, C. X. Wang, B. Ai, and A. Hadi

A generic geometry-based stochastic model for nonisotropic scattering vehicle–to-vehicle Ricean fading channels is proposed. The level crossing rate and average fade duration are derived from the proposed model. Experimental results demonstrate the utility of the proposed model.

Portable Roadside Sensors for Vehicle Counting, Classification, and Speed Measurement
T. Saber and R. Rajesh

A portable roadside sensor system for measuring traffic flow rate, vehicle speeds, and vehicle classification is developed. An algorithm based on a magnetic field model is proposed to make the system robust. In addition, an algorithm to automatically correct for any small misalignment of the sensors is applied. The accuracy and benefits of the developed sensor system is discussed.

Analytical Hierarchy Process Using Fuzzy Inference Technique for Real-Time Route Guidance System
C. Li, S. Anavatti, and T. Ray

An optimum route search function in the in-vehicle routing guidance system is discussed. An analytical hierarchy process using Fuzzy inference technique based on the real-time traffic information is proposed to realize the dynamic route guidance. The proposed method can simplify the definition of decision strategy and represent the multiple criteria explicitly. A simulation system is developed based on the proposed method.

Receiver Autonomous Integrity Monitoring of GNSS Signals for Electronic Toll Collection
D. Salós, A. Martineau, C. Macabiau, B. Bonhoure, and D. Kubrak

The use of Receiver Autonomous Integrity Monitoring (RAIM) in electronic toll systems (ETC) is studied. The

Digital Object Identifier 10.1109/TITS.2014.2298352

weighted least squares residual RAIM used in civil aviation is analyzed and an algorithm modification for ETC is proposed. Simulation results show that the performance of the proposed algorithm has a superior level over civil aviation based RAIM procedures, particularly in urban environments.

A Wireless Accelerometer-Based Automatic Vehicle Classification Prototype System

W. Ma, D. Xing, A. McKee, R. Bajwa, C. Flores, B. Fuller, and P. Varaiya

The problem of automatic vehicle classification (AVC) systems is addressed. A prototype axle count and spacing AVC system based on wireless accelerometers and magnetometers is introduced. The detected parameters and the installation of the system are presented. Through an experiment under various traffic conditions, the prototype AVC system is proved to be reliable in classifying vehicles with an accuracy of 99% even under congested traffic.

Study of the Track–Train Continuous Information Transmission Process in a High-Speed Railway

L. Zhao, B. Cai, J.-J. Xu, and Y. Ran

It is experimentally and practically observed that the carrier frequency of the sampled signal (CFSS) sometimes goes beyond the upper limitation of jointless track circuit with train speed change, which has a direct effect on the safety and efficiency of train control system. A model of the track-to-train continuous information transmission process is developed using transmission line theory to explore the relation between the deviation of CFSS and train speed. The correctness of the analysis is presented by experimental results.

Stochastic Characterization of Information Propagation Process in Vehicular Ad hoc Networks

Z. Zhang, G. Mao, and B. Anderson

The information propagation process in vehicular ad-hoc networks on highways is addresed. It is assumed that vehicles in the network are categorized into different traffic streams with regard to their types and lanes, whose speed distributions are the same within the category and different from those of other categories. An analytical formula for the information propagation speed is obtained by analyzing the information propagation process. Using the formula, the impact of some parameters is studied. Simulations are conducted to validate the accuracy of the analytical results.

Speed and Texture: An Empirical Study on Optical-Flow Accuracy in ADAS Scenarios

N. Onkarappa and A. Sappa

Regarding the problem of weighting the regularization terms of formulating variation optical flow, this paper presents the polar representation of optical flow. Then the influence of vehicle speed and scene texture on optical flow accuracy is studied. The relationships of these specific characteristics on a driving scenario with the regularization weights in optical flow are further analyzed for a better accuracy, and several synthetic sequences along with ground-truth flow fields are generated.

Reducing the Error Accumulation in Car-Following Models Calibrated With Vehicle Trajectory Data

J. Jin, D. Yang, and B. Ran

Considering the error accumulation problem in the calibration of car-following models using trajectory data, this paper proposes an error dynamic model. The stability conditions for the derived error dynamic model are different from the model stability conditions. The traditional and the proposed error measures through the calibration of representative car-following models are compared.

Tactical Driving Behavior With Different Levels of Automation

K. Kircher, A. Larsson, and J. A. Hultgren

The ways of affecting tactical driving behavior with different types of automation are discussed. The behavioral and gaze data from 30 participants driving an advanced simulator are collected in four driving conditions: manual driving, intentional car following, ACC and ACC with adaptive steering, and the trust in the systems are surveyed with a questionnaire. Meanwhile, three fairly common traffic events requiring a driver response are also analyzed.

Automated Detection of Driver Fatigue Based on Entropy and Complexity Measures

C. Zhang, H. Wang, and R. Fu

Since some traffic accidents are caused by driver's fatigue, this paper proposes a real-time method to detect and identify driving fatigue based on various entropy and complexity measures from some records. It is shown that the proposed approach is effective and it is valuable for the application of avoiding some traffic accidents caused by driver's fatigue.

Two-Dimensional Sensor System for Automotive Crash Prediction

S. Taghvaeeyan and R. Rajamani

The use of magnetoresistive and sonar sensors for imminent collision detection in cars is investigated. An adaptive estimator is proposed and both sonar and magnetoresistive sensors are used to estimate the parameters to determine cars' position and orientation. Experimental results show this approach's effective for a range of relative motions at different oblique angles.

Robust Vehicle Sideslip Angle Estimation through a Disturbance Rejection Filter That Integrates a Magnetometer With GPS

J.-H. Yoon and H. Peng

A cost-effective method is proposed to estimate the vehicle sideslip angle for a wide range of surface frictions and road bank angles by combining measurements of a magnetometer, Global Positioning System, and Inertial Measurement Unit. The paper also proposes a new stochastic filter which is designed and integrated on the Kalman Filter framework. The performance and accuracy of the proposed methods are given.

Utilizing Microscopic Traffic and Weather Data to Analyze Real-Time Crash Patterns in the Context of Active Traffic Management
R. Yu, M. A. Abdel-Aty, M. M. Ahmed, and X. Wang

The effects of microscopic traffic, weather, and roadway geometric factors on the occurrence of specific crash types for a freeway are studied. The authors propose to expand the purpose of the existing ITS system and suggest Active Traffic Management strategies by identifying the real-time crash patterns. Numerical simulation results show that single-vehicle crashes are more probable to occur in snow seasons, at moderate slopes, three-lane segments, and under free-flow conditions.

Prediction of Traffic Flow at the Boundary of a Motorway Network
Y. Wang, J. H. van Schuppen, and J. Vrancken

The need of 30 minutes ahead for predictions of the traffic flow is discussed. The paper proposes an adaptive prediction algorithm for the inflows into the network in regular traffic situations based on stochastic control theory. It is shown that the algorithm can provide robust predictions of traffic demand with relatively small errors for the next 30 minutes in a real-time environment.

Text Detection and Recognition on Traffic Panels From Street-Level Imagery Using Visual Appearance
Á. González, L. M. Bergasa, and J. J. Yebes

This paper studies the problem of the detection of traffic panels in street-level images and the recognition of the information contained on them. The visual appearance categorization method is used for traffic panel detection, and then their own text detection and recognition method is applied to read and save the information depicted in the detected panels. A language model partly based on a dynamic dictionary for a limited geographical area using a reverse geocoding service is proposed. The efficiency of the proposed method is demonstrated based on experimental results.

Actuator-Redundancy-Based Fault Diagnosis for Four-Wheel Independently Actuated Electric Vehicles
R. Wang and J. Wang

An actuator-redundancy-based fault diagnosis approach for four wheels independently actuated (FWIA) in-wheel motor electric ground vehicles is proposed. Each of the in-wheel motors has an observer to generate a tire-road friction coefficient (TRFC) which needs to be accurately estimated to calculate the in-wheel motor torque and evaluate the fault in real-time. The accurate TRFC estimate resulted from a voting scheme is used to detect the possible actuator fault. The effectiveness of the proposed method is demonstrated with experimental results from a prototype FWIA electric ground vehicle.

Modeling and Forecasting the Urban Volume Using Stochastic Differential Equations
R. Tahmasbi and S. M. Hashemi

To deal with the problem of short-term prediction of traffic flow, a methodology is developed in this paper using the stochastic differential equation. The Hull-White model is used to consider the time dependency of short term traffic volume. It may simulate traffic conditions easily and detecting incidents precisely. It is illustrated that a better fit to the traffic volume is obtained using the proposed method compared to the previous artworks.

Observability Analysis of Collaborative Opportunistic Navigation With Pseudorange Measurements
Z. M. Kassas and T. E. Humphreys

It deals with the observability analysis of a collaborative opportunistic navigation (COpNav) environment within which receivers locate their position, velocity and time (PVT) by obtaining and possibly sharing information from ambient signals of opportunity (SOPs). The minimum conditions for the completely observable COpNav environment are given. The unobservable COpNav environment and the unobservable directions in the state space are specified.

Observer-Based Robust Control of Vehicle Dynamics for Rollover Mitigation in Critical Situations
H. Dahmani, O. Pagès, A. El Hajjaji, and N. Daraoui

A fuzzy control method of vehicle dynamics to improve stability and minimize the rollover risk is proposed. The authors take into account several aspects to obtain a robust controller, where the nonlinearities of the lateral forces is represented using aTakagi-Sugeno (TS), changes in road friction is considered by introducing parameter uncertainties and road bank angle is set as an unknown input. The linear matrix inequalities constraints are solved to obtain the observer and controller gains.

Dynamic Control of Airport Departures: Algorithm Development and Field Evaluation
I. Simaiakis, M. Sandberg, and H. Balakrishnan

A controlling algorithm, called Pushback Rate Control protocols, of departure process at congested airports is proposed using dynamic programming in order to control congestion. This algorithm has been applied at Boston airport in 2011, and the analysis of data shows that the fuel use and taxi-out times were reduced.

Cooperative Adaptive Cruise Control in Real Traffic Situations
V. Milanés, S. E. Shladover, J. Spring, C. Nowakowski, H. Kawazoe, and M. Nakamura

This paper presents the design, development, implementation, and testing of a Cooperative Adaptive Cruise Control system. This system has been implemented on four production Infiniti M56s vehicles to validate the performance of the controller and the improvements.

Self-Adaptive Tolling Strategy for Enhanced High-Occupancy Toll Lane Operations
G. Zhang, X. Ma, and Y. Wang

A Self-Adaptive Tolling Strategy (SATS) for dynamically and systematically enhancing High Occupancy Toll (HOT) lane system operations is developed, which includes the

Lighthill-Whitham-Richards (LWR) kinematic and the unilateral Laplace transform. Microscopic traffic simulation experiments are performed using VISSIM to examine the effectiveness of the proposed tolling strategy.

Coding or Not: Optimal Mobile Data Offloading in Opportunistic Vehicular Networks
Y. Li, D. Jin, Z. Wang, L. Zeng, and S. Chen

The coding-based mobile data offloading problem is formulated as a users' interest satisfaction maximization problem with multiple linear constraints of limited storage. The problem is solved by an efficient scheme which provides a solution to decide when the coding should be used and how to allocate the network resource. The effectiveness of the algorithm is demonstrated extensive simulations using two real vehicular traces.

Estimating Dynamic Queue Distribution in a Signalized Network Through a Probability Generating Model
Y. Lu and X. Yang

A stochastic queue model using the probability generating function, which considers the strong interdependence relations between adjacent intersections, is proposed. Various traffic flow phenomena are formulated as stochastic events and obtain their distributions by iteratively computing through a stochastic network loading procedure. The effectiveness of the proposed approach is demonstrated by the theoretical derivation and numerical investigations.

The Process of Information Propagation Along a Traffic Stream through Intervehicle Communication
W. Wang, S. S. Liao, X. Li, and J. S. Ren

A model is proposed to calculate the average speed of transmission of inter-vehicle communication (IVC) messages in general traffic stream on highways in the early stage of deploying distributed traffic information systems (DTIS). The relationship between average IVC message speed and traffic parameters can be explained with this model. The correctness of the model is verified by simulation results, and the theoretical analysis is given.

Toward Real-Time Pedestrian Detection based on a Deformable Template Model
M. Pedersoli, J. Gonzàlez, X. Hu, and X. Roca

The problem of pedestrian detection in driving assistance systems which has a trade-off between accuracy and real-time is investigated. A pedestrian detection system using a hierarchical multi resolution part-based model is proposed and implemented on GPU. The proposed system can achieve the state-of-the-art pedestrian detection accuracy and show a speed-up of more than one order of magnitude, which is suitable for pedestrian detection with respect to both precision and real time.

An Event-Triggered Receding-Horizon Scheme for Planning Rail Operations in Maritime Terminals
C. Caballini, C. Pasquale, S. Sacone, and S. Siri

The problem of planning rail port operations is investigated where unexpected events or disturbances often affect seaport terminals. Based on a queue-based discrete-time model, the paper defines a mixed integer linear mathematical programming problem and proposes an event-triggered receding-horizon optimization approach. The test of the proposed approach based on data of a real terminal is given and discussed.

Understanding Bicycle Dynamics and Cyclist Behavior From Naturalistic Field Data *(November 2012)*
M. Dozza and A. Fernandez

Considering the significant role but the absence of models of bicycles in intelligent transportation systems, this paper presents a platform, based on which the bicycle dynamics and bicyclist behavior can be researched. In this platform, field data is collected continuously from sensors and can be employed to derive, develop, and test intelligent transportation systems including bicycles.

Robust Control for Urban Road Traffic Networks
T. Tettamanti, T. Luspay, B. Kulcsár, T. Péni, and I. Varga

This paper proposes a robust real-time signal split algorithm to minimize the overall weighted queue lengths within an urban network area. The traffic control problem is formulated in a centralized rolling-horizon way, and the green time combination is obtained with an efficient constrained minimax optimization. The proposed algorithm is tested by using real-world traffic data and microscopic traffic simulation and compared with well-tuned fixed-time signal timing.

Multiobjective Departure Runway Scheduling Using Dynamic Programming
J. Montoya, S. Rathinam, and Z. Wood

The problem of scheduling the aircraft at the runway of airports is considered. A multiobjective dynamic programming model with respect to total aircraft delay and runway throughput is proposed An algorithm is developed to find Pareto-optimal solutions and the proof of the algorithm's correctness is given. The algorithm's performance against a baseline algorithm is also provided.

EasiSee: Real-Time Vehicle Classification and Counting via Low-Cost Collaborative Sensing
R. Wang, L. Zhang, K. Xiao, R. Sun, and L. Cui

A real-time vehicle classification and counting system called EasiSee is designed and implemented. A collaborative sensing mechanism is proposed by coordinating the power-hungry camera sensor and the power-efficient magnetic sensors to reduce the overall system energy consumption and maximizing system lifetime. A robust vehicle image processing algorithm (LIPA) is developed to reduce environment noise and interference with a low computation complexity. The proposed LIPA algorithm is verified to be of computational economical and EasiSee is a practical and low-cost affordable solution for traffic information acquisition based on the presented experiments and analysis.

A Survey of Traffic Control With Vehicular Communications
L. Li, D. Wen, and D. Yao

The problem of deploying vehicle-to-vehicle communications and/or vehicle-to-infrastructure communications to

coordinate vehicles and traffic signals in real time is addressed. A perspective of its research frontiers is given, early stage key technologies are identified, and the possible improvements are discussed. Furthermore, the prominence to scheduling based intersection control approaches is also given here. Moreover, this paper discusses two cultures including using rich information or concise information.

Fast and Secure Multihop Broadcast Solutions for Intervehicular Communication

W. Ben Jaballah, M. Conti, M. Mosbah, and C. E. Palazzi

This paper discusses the resilient ability to security attacks in data exchange system of intervehicular communication (IVC), in order to improve traffic safety and efficiency of IVC. Attacks to the state of the art IVC based safety applications are analyzed and then a Fast and Secure Multi-hop Broadcast Algorithm (FS-MBA) for vehicular communication is designed, which achieves resilience to the aforementioned attacks.

On Optimality Criteria for Reverse Charging of Electric Vehicles

S. Stüdli, W. Griggs, E. Crisostomi, and R. Shorten

The issue of the controllable loads and storage systems of electric vehicles, which can be utilized to mitigate the load on the grid during peak times by offering power, is investigated. The problem of returning electrical load to the grid as an optimization aiming at returning the desired energy in a fashion minimizing the cost on the environment is formulated. It is shown that this optimization is highly complex and the cost of vehicle to grid in some circumstances can be prohibitive.

ITS KNOWLEDGE AUTOMATION

While writing the summaries, I had really hoped that I could have an automatic summarization system that can do the job for me quickly and accurately, either by extraction or abstraction or both, and send the result to social media and interested readers immediately and automatically. It also reminded me of the recent report *Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy* by McKinsey Global Institute (MGI), where "automation of knowledge work" or "intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgments" was listed as the second most economically disruptive technology with $5.2 trillion to $6.7 trillion in potential economic impact annually by 2025 and an estimated task performance that would be equal to the output of 110 million to 140 million full-time equivalents. Actually, my editorial for the last issue of *Acta Automatica Sinica* in 2013 was entitled "The Destiny: Toward Knowledge Automation." For IEEE T-ITS and ITS R&D in general, my thoughts and goals are more specific: ITS knowledge automation.

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