Scanning the Issue and Beyond: Five Transportations in One—A New Direction for ITS From Qingdao

I had a great experience at the 18th IEEE International ITS Conference held from September 13 to 18, 2015, at Las Palmas de Gran Canaria, Spain. This has been one of the most enjoyable ITSC I have attended over the last 18 years. I am also pleased to announce that, during the conference, the Board of Governors of IEEE ITS Society has accepted our proposal to rename the Best Regular Paper Award for the IEEE Transactions on Intelligent Transportation Systems to the George N. Saridis Award for the IEEE Transactions on Intelligent Transportation Systems, effective next year. Dr. Saridis, the Founding Director of US NSF's Systems Engineering and Control Program and the Founding President of the IEEE Robotics and Automation Society, was a pioneer in Intelligent Control, Robotics, and Intelligent Transportation Systems, and led the effort in initiating research and development of those fields in 1970s.

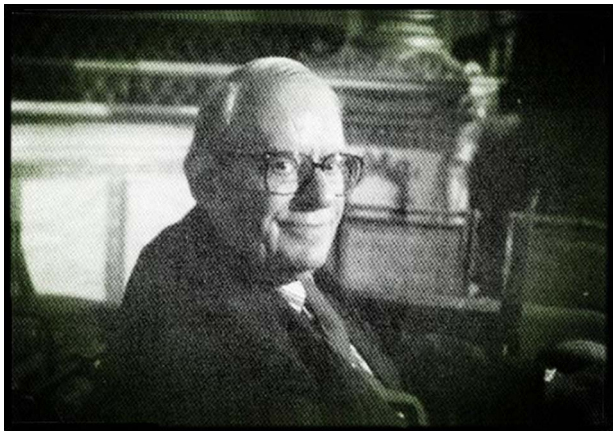

Fig. 1. George N. Saridis (1931–2006).

The motion was made by George's former students and colleagues with a donation to ITSS in memory of 10th anniversary of his death. I am glad to meet two of them, Profs. Petros Ioannou and Markos Pagageorgiou, at the conference. It is interesting to know that George was the first Greek American Professor Petros ever met as a graduate student at IEEE CDC 1981 and wrote a chapter on intelligent control and management of urban traffic systems for the first Concise Encyclopedia of Traffic and Transportation Systems by Markos in 1991. What a small world!

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Fig. 2. Saridis Award Proposers Fei-Yue Wang, Markos Papageorgiou, and Petros Ioannou at ITSC 2015.

Scanning the Issue

Vehicle Detection Techniques for Collision Avoidance Systems: A Review

A. Mukhtar, L. Xia, and T. Boon Tang

A comprehensive survey of the state-of-the-art on-road vision-based vehicle detection and tracking systems for collision avoidance system (CAS) is provided. The survey is structured in accordance with a vehicle detection process starting from sensor selection to vehicle detection and tracking. Emphases are placed on motorcycle detection techniques and sensor comparison in terms of cost and range parameters. Finally, an optimal choice with a low cost and reliable CAS design is proposed.

Routing in Internet of Vehicles: A Review

J. J. Cheng, J. L. Cheng, M. C. Zhou, F. Q. Liu, S. C. Gao, and C. Liu

The routing protocols for Internet of Vehicles (IOV) from routing algorithms to evaluation approaches is reviewed. It first provides five different taxonomies in terms of 1) transmission strategies, 2) information required to perform routing, 3) delay-sensitive/tolerant information, 4) applicability in different dimensions, and 5) target networks. Afterward, the approaches to evaluate IoV routing protocol is discussed.

A Review of Three-Dimensional Imaging Technologies for Pavement Distress Detection and Measurements

S. Mathavan, K. Kamal, and M. Rahman

The main impetus here is derived from the rarity of 3-D industrial imagers that employ alternative techniques for use in transportation. We highlight the need for this kind of work by showing the lack of literature that evaluates the relative merits/demerits of various imaging methods for different distress measurement situations in relation to pavements, thus creating

awareness of available 3-D imaging methods to help make a fast initial technology selection and deployment.

A Multiple Train Trajectory Optimization to Minimize Energy Consumption and Delay

N. Zhao, C. Roberts, S. Hillmansen, and G. Nicholson

A train trajectory optimization study of coordinating the trade-off between reductions in train energy usage against increases in delay penalty with a fixed block signaling system is described. The interactions between trains are considered by recalculating the behavior of the second and subsequent trains. A multi-train simulator is specifically developed. Three searching methods are implemented to quickly and efficiently find the optimal results, which illustrate that interactions between trains can be reduced, thereby improving performance and reducing the energy required.

Coordinated Adaptive Cruise Control System With Lane-Change Assistance

R. Dang, J. Wang, S. E. Li, and K. Li

A novel coordinated adaptive cruise control (ACC) system with a lane-change assistance function is proposed. It addresses the problem caused by a conventional ACC hindering drivers from changing lanes, and enables dual-target tracking, safe lane change, and longitudinal ride comfort. A coordinated control algorithm using model predictive control theory is designed after analyzing the lane-change risks. Tracking performance is designed on the basis of tracking errors of the host car and two leading vehicles, safety performance is realized by considering the safe distance between the host car and surrounding vehicles, and ride comfort performance is realized by limiting the vehicle's longitudinal acceleration.

Feedback-Coordinated Ramp Control of Consecutive On-Ramps Using Distributed Modeling and Godunov-Based Satisfiable Allocation

S. Agarwal, P. Kachroo, S. Contreras, and S. Sastry

A feedback control design for a coordinated ramp metering problem for two consecutive on-ramps is proposed. The authors design a traffic allocation scheme for ramps based on Godunov's numerical method and use a distributive model, which is applied to construct a control condition for regulating the traffic density at critical density. A Godunov-method-based satisfiable allocation scheme is then designed to provide the actual control for each ramp individually.

Measurements and Analysis of Large-Scale Fading Characteristics in Curved Subway Tunnels at 920 MHz, 2400 MHz, and 5705 MHz

K. Guan, B. Ai, Z. Zhong, C. F. López, L. Zhang, C. Briso-Rodríguez, A. Hrovat, B. Zhang, R. He, and T. Tang

Extensive propagation measurements conducted in two types of subway tunnels with 300- and 500-m radii of curvature with different configurations—horizontal and vertical polarization at 920 MHz, 2400 MHz, and 5705 MHz—are investigated. Comprehensive insight into the propagation in various scenarios where the intelligent transportation systems are deployed is given. Furthermore, extensive analysis and discussions are made to reflect the physical laws behind the observations.

Applying Machine Learning Techniques to Transportation Mode Recognition Using Mobile Phone Sensor Data

A. Jahangiri and H. A. Rakha

Different supervised learning methods for multi-class classifiers that distinguish between different transportation modes are developed. K-nearest neighbor, support vector machines, tree-based models, and random forest methods are investigated using data from smartphone sensors including accelerometer, gyroscope, and rotation vector sensors. K-fold cross-validation as well as out-of-bag error are used for model selection and validation. Finally, an effort was made to develop a new feature that entails creating a combination of other features by adopting a simulated annealing algorithm and a random forest method.

Tracking With a High-Resolution 2-D Spectral Estimation Based Automotive Radar

S. A. Askeland and T. Ekman

Tracking automotive targets with a radar using a high-resolution 2-D spectral estimator is studied. Employing a combination of a waveform solving the target ambiguity problem within a short measurement time and a conformal array design, the authors eliminate the problems of limited field of view, poor angular accuracy, and low measurement update rate. Using the 2-D APES estimator, the authors achieve a high angular resolution to improve the tracking. Results show that a laterally moving vehicle can be tracked accurately and that the tracking filter achieves robust and accurate tracking along with a short initialization time.

Dynamic Prediction of Vehicle Cluster Distribution in Mixed Traffic: A Statistical Mechanics-Inspired Method

K. Jerath, A. Ray, S. Brennan, and V. V. Gayah

A statistical mechanics-inspired method of simulating traffic flow at a microscopic scale via the generalized Ising model is presented. In microscopic simulations, traffic systems dominated by adaptive cruise control-enabled vehicles exhibit a higher probability of formation of moderately sized clusters, compared with the traffic systems dominated by human-driven vehicles. However, the trend is reversed for the formation of large-sized clusters. The qualitative results are significant as it is easier to predict and control fewer large localized clusters instead of several smaller clusters spread across different locations on a highway.

Development of a Deceleration-Based Surrogate Safety Measure for Rear-End Collision Risk

S. Tak, S. Kim, and H. Yeo

Deceleration-based Surrogate Safety Measure (DSSM) is proposed as a safety indicator for rear-end collision risk evaluation based on the safety conditions and decision-making process during human driving. It shows how drivers deal with collision risk differently in acceleration and deceleration phases. Validation results indicate the strong relationship between the proposed surrogate safety measures and crash potential. DSSM has merit in that it reflects the characteristics of both vehicle and driver.

Neuro-Adaptive Fault-Tolerant Approach for Active Suspension Control of High-Speed Trains

D.-Y. Li, Y.-D. Song, and W.-C. Cai

The investigation of how to suppress excessive lateral and roll motions of a high-speed train via an active-suspension method is conducted. A new control scheme capable of attenuating immeasurable disturbances, compensating modeling uncertainties, and accommodating actuation faults is developed. The proposed method does not require precise information on the suspension parameters and the detail system model. Moreover, the magnitude of the actuation fault and the time instant at which the actuation fault occurs are not needed in setting up and implementing the control scheme.

Using Mobile LiDAR Data for Rapidly Updating Road Markings

H. Guan, J. Li, Y. Yu, Z. Ji, and C. Wang

Development and implementation aspects of an automated object extraction strategy for rapid and accurate road marking inventory is presented. The strategy is based on 2-D georeferenced feature (GRF) images interpolated from 3-D road surface points through a modified inverse distance weighted interpolation. Weighted neighboring difference histogram-based dynamic thresholding and multiscale tensor voting are used to segment and extract road markings from the noisy corrupted GRF images.

Modeling Traffic Control Agency Decision Behavior for Multimodal Manual Signal Control Under Event Occurrences

N. Ding, Q. He, C. Wu, and J. Fetzer

Traffic control agency (TCA) based traffic signal control is crucial to mitigate nonrecurrent traffic congestion caused by planned and unplanned events. The authors propose a pressure-based human behavior model to mimic TCA's decision-making behavior, which calculates TCA's pressure based on two attributes: vehicle and pedestrian queue dynamics, and the red time duration for each phase. A manual signal control simulator is built to study TCA behavior. A series of human subject experiments are conducted with real-world TCAs. The proposed behavior model is then calibrated, validated, and tested.

Development of a Driver Lateral Control Model by Integrating Neuromuscular Dynamics Into the Queuing Network-Based Driver Model

L. Bi, M. Wang, C. Wang, and Y. Liu

A novel driver lateral control model, which integrates the driver's neuromuscular dynamics into the Queuing Network (QN)-based driver lateral control model, is developed. Experimental results show that compared to the QN-based model, performance of the proposed model is much closer to that of drivers when a vehicle runs at a relatively high speed. The proposed model not only covers the advantages of models based on a cognitive architecture but also captures the dynamic interaction between the vehicular steering system and the driver's neuromuscular system.

State-Driven Priority Scheduling Mechanisms for Driverless Vehicles Approaching Intersections

K. Zhang, D. Zhang, A. de La Fortelle, X. Wu, and J. Grégoire

A novel centralized priority scheduling mechanism is explored considering the cyber-physical-fused and social-service oriented ITS. The authors model the related pivotal aspects of environment and driverless vehicles, abstract the passing-through intersection related motions, and further design an event-triggered and state-driven autonomous control procedure. By mapping vehicular relations in spatiotemporal domain into time-distance windows, a universal passing-through principle, rules, and priority-based scheduling mechanism is proposed and described. Finally, a priority scheduling algorithm (sPriorFIFO) is designed.

Extended-State-Observer-Based Double-Loop Integral Sliding-Mode Control of Electronic Throttle Valve

Y. Li, B. Yang, T. Zheng, Y. Li, M. Cui, and S. Peeta

An extended-state observer-based double-loop integral sliding-mode controller for electronic throttle (ET) is proposed, which circumvents the parametric uncertainties and nonlinearities by factoring the gear backlash torque and external disturbance. The extended state observer is designed based on a nonlinear model of ET to estimate the change of throttle opening angle and total disturbance. A double-loop integral sliding-mode controller consisting of an inner loop and an outer loop is then presented. Numerical experiments show that the accuracy and the response time of the proposed controller are better than those of the back-stepping and sliding mode control.

Learning to Detect Vehicles by Clustering Appearance Patterns

E. Ohn-Bar and M. M. Trivedi

Efficient means in dealing with intracategory diversity in object detection is studied. Strategies for occlusion and orientation handling are explored by learning an ensemble of detection models from visual and geometrical clusters of object instances. An AdaBoost detection scheme is employed with pixel lookup features for fast detection. The analysis provides insight into the design of a robust vehicle detection system, showing promise in terms of detection performance and orientation estimation accuracy.

Establishing Style-Oriented Driver Models by Imitating Human Driving Behaviors

L. Xu, J. Hu, H. Jiang, and W. Meng

A modeling scheme based on distal learning control and real-world vehicle test data to study the style-oriented driver modeling for speed control is proposed. The driver model is accomplished under the distal guidance of the discrepancy between the actual and the desired vehicle speed. To tackle the divergence and local mutability of real-world vehicle data, the partly connected multilayered perceptron is utilized to fulfill the imitating of human operations on gas or brake pedals during real-world driving. Established driver models are tested, and driving styles of the original human drivers are retained and reproduced while accomplishing the speed following task.

Methodology for Multiobjective Optimization of the AC Railway Power Supply System

M. Soler, J. López, J. M. Mera Sánchez de Pedro, and J. Maroto

A methodology and related system to improve the decision making about the electrical dimensioning design are presented. The final set of possible solutions that the method achieved are based on a pair of main objectives including installation costs, environmental impact, main electrical components costs, and exploitation costs. A specific line discretization has been developed to distribute the critical zones along the line. Electrical analysis, railway systems using single alternate current (1×25), and a simplification during simulations are conducted to minimize the quantity of studies.

Moment Analysis of Highway-Traffic Clearance Distribution

S. M. Abuelenin and A. Y. Abul-Magd

The authors study the traffic behavior and traffic phase transition in an intervehicular communication networks using empirical data collected in a multilane highway in California, USA. The intervehicle spacings and the correlation coefficients for spacings between vehicles in individual lanes are calculated. The first four moments for individual lanes at regular time intervals, namely, the mean, variance, skewness, and kurtosis are determined. The authors follow the evolution of these moments as the traffic condition changes from the low-density free flow to high-density congestion. The data shows a considerable scatter near the peak positions, which suggests that the critical behavior may depend on other parameters in addition to the traffic density.

The Cellular Network as a Sensor: From Mobile Phone Data to Real-Time Road Traffic Monitoring

A. Janecek, D. Valerio, K. A. Hummel, F. Ricciato, and H. Hlavacs

A method to infer vehicle travel times and detect congestion along highways in real time using anonymized signaling messages of the mobile phone network is proposed to explore the whole set of signaling events generated by both idle and active devices. The combined use of data from idle and active devices improve congestion detection performance in terms of coverage, accuracy, and timeliness. The method is then applied to real mobile signaling data obtained from an operational network on a sample highway segment in the proximity of a European city, and is validated from a rich set of reference data sources—road sensor data, toll data, taxi floating car data, and radio broadcast messages.

A Program for Simultaneous Network Signal Timing Optimization and Traffic Assignment

A. Hajbabaie and R. F. Benekohal

This study formulates a program for simultaneous signal timing optimization and traffic assignment for urban transportation networks with a novel objective function called weighted trip maximization, and explicit constraints that are specifically designed to address oversaturated conditions. It improves system-wise performance while locally prevents queue spillovers, de-facto reds, and gridlocks. A customized solution technique to efficiently find near-optimal solutions and a framework to calculate an upper bound on the objective value are also proposed, with case study results indicating an average delay reduction of 3% to 26% under various operational conditions.

A Partition-Based Match Making Algorithm for Dynamic Ridesharing

D. Pelzer, J. Xiao, D. Zehe, M. H. Lees, A. C. Knoll, and H. Aydt

A method aimed to best utilize ridesharing potential while keeping detours below a specific limit is proposed. It specifically targets ridesharing systems on a very large scale and with a high degree of dynamics, which are difficult to address using classical approaches known from operations research. For this purpose, the road network is divided into distinct partitions that define the search space for ride matches. The size and shape of the partitions depend on the topology of the road network as well as on two free parameters, which allowing optimize the partitioning with regard to sharing potential utilization and inconvenience minimization. The algorithm has been applied to investigate the potential for taxi sharing in Singapore considering about 110,000 daily trips and allowing up to two sharing partners.

Vision-Based Nighttime Vehicle Detection Using CenSurE and SVM

N. Kosaka and G. Ohashi

This paper proposes a method for detecting vehicles from a nighttime driving scene taken by an in-vehicle monocular camera, which focuses on the Laplacian of Gaussian operator to derive the response of luminance difference between the blob and its surroundings. Center Surround Extremas are used to detect the blobs at high speed and low computational cost. Finally, we applied the proposed method to nighttime driving sequences and confirmed the effectiveness of its classification process.

RECIFE-MILP: An Effective MILP-Based Heuristic for the Real-Time Railway Traffic Management Problem

P. Pellegrini, G. Marlière, R. Pesenti, and J. Rodriguez

Real-time railway traffic management problems including selecting appropriate train routes and schedules for minimizing the propagation of delay in case of traffic perturbation are tackled by using RECIFE-MILP, a heuristic algorithm based on a mixed-integer linear programming model. RECIFE-MILP is robust to its configuration and is able to find the optimal solution to instances within the short computation time available in real-time applications.

Integrating the Bus Vehicle Class Into the Cell Transmission Model

H. Liu, J. Wang, K. Wijayaratna, V. V. Dixit, and S. T. Waller

A model called BUS-CTM considers the moving bottlenecks caused by buses traveling within a mixed car–bus network is proposed. By using methods from the lagged CTM, speed differentials between the free-flow speed of buses and cars are recognized. The impact of capacity reduction caused by buses

is incorporated. A variant of CTM was utilized to determine a system optimal assignment that minimizes the total passenger travel time across cars and buses. Numerical results and the depiction of the bottleneck phenomenon within the model suggest that the BUS-CTM obtains more realistic results in a mixed car-bus transportation system.

Mitigation of Vehicle Distribution in an EV Sharing Scheme for Last Mile Transportation

K. K. Tan, K. K. K. Htet, and A. S. Narayanan

A system platform for mitigation of vehicle distribution in an electric vehicle sharing scheme for last mile transportation by means of a remote driving approach is designed, where a driver at a remote destination is enabled to maneuver the vehicle wirelessly and assist in the proper redistribution of the shared vehicle. Technical challenges include handling wireless transmission latency, minimizing blind spots, and enhancing reliability, safety, and security in the context of the remote driving system are identified while appropriate solutions are proposed and implemented.

Demand-Driven Train Schedule Synchronization for High-Speed Rail Lines

H. Niu, X. Tian, and X. Zhou

A new class of train scheduling problems with two interconnected high-speed rail lines under given and precise time-dependent origin-destination demand input is addressed. The proposed approach focuses on satisfying the requirements of transfer passengers from one rail line to another. Aiming to minimize passenger waiting times and crowding disutility, a nonlinear optimization model for a single-line case is formulated to demonstrate the modeling framework of train scheduling problems. The model is extended to a two-line case by explicitly taking into account the number of boarding and alighting passengers at the connection station.

The Impact of Driving Styles on Fuel Consumption: A Data-Warehouse-and-Data-Mining-Based Discovery Process

J. C. Ferreira, J. de Almeida, and A. R. da Silva

The results of applied research on the eco-driving domain based on a huge dataset produced from a fleet of Lisbon's public transportation buses for a three-year period are discussed. The authors apply online analytical processing and knowledge discovery techniques to manage the high volume of this dataset and determine the major factors that influence the average fuel consumption, and then classify the drivers involved according to their driving efficiency. Findings show that obvious fuel consumption reduction can be achieved by introducing simple practices such as optimal clutch, engine rotation, and engine running in idle.

Finite-Time Stabilization for Vehicle Active Suspension Systems With Hard Constraints

H. Pan, W. Sun, H. Gao, and J. Yu

The problem of finite-time stabilization for vehicle suspension systems with hard constraints based on terminal sliding-mode (TSM) control is investigated. Considering the singularity and chattering in TSM control systems, the authors propose a novel second-order sliding-mode algorithm to soften the switching control law, and a chattering-free TSM control scheme for suspension systems. Finally, the effectiveness of the proposed approach is illustrated by both theoretical analysis and comparative experiment results.

Spatial Coordinated Medium Sharing: Optimal Access Control Management in Drive-Thru Internet

H. Zhou, B. Liu, F. Hou, T. H. Luan, N. Zhang, L. Gui, Q. Yu, and X. Shen

A unified analytical framework to evaluate the performance of Drive-Thru Internet is developed. It accommodates various vehicular traffic flow states and is compatible with IEEE 802.11a/b/g networks with a distributed coordination function. Analysis is conducted to evaluate the mean saturated throughput of vehicles and the transmitted data volume of a vehicle per drive-thru. Simulation results show that the optimal access control management approach can efficiently work in IEEE 802.11b/g networks.

Improving the Efficacy of Car-Following Models With a New Stochastic Parameter Estimation and Calibration Method

M. Rahman, M. Chowdhury, T. Khan, and P. Bhavsar

A process of applying a stochastic calibration method with appropriate regularization to estimate the distribution of parameters for car-following models is developed. The method is based on the Markov chain Monte Carlo simulation that uses the Bayesian estimation theory and evaluated with an intelligent driver model and Helly's car-following model. Analysis reveals that the Bayesian approach can predict drivers' speed and acceleration/deceleration profiles closely to the real-world data.

Improved Protocols and Stability Analysis for Multi-vehicle Cooperative Autonomous Systems

Y. Liu and B. Xu

Two distributed control protocols are proposed in which both lateral control and longitudinal control are considered and their stability analysis for lane-following are analyzed. Furthermore, in order to make vehicles stop at the desired target stopping position (TSP), a new braking control protocol is also designed. Analysis results show that under three kinds of distinct braking control parameters, the position of the mass center of all vehicles exponentially converges to the TSP and the velocity of the mass center of all vehicles exponentially converges to zero, providing a guide for selecting the braking control parameters in real engineering applications.

Services-Oriented Computing Using the Compact Genetic Algorithm for Solving the Carpool Services Problem

M.-K. Jiau and S.-C. Huang

BlueNet-Ride, an intelligent carpool system, is developed. It provides appropriate matches by using the proposed Low-Complexity and Low-Memory Carpool Matching method. The compact genetic algorithm consists of three proposed

modules—Evolutionary Model Initialization, Evolutionary Process Operation, and Evolutionary Model Modification—which are then applied to the method. Experimental results demonstrate that this method achieves the highest degree of performance with regard to solution quality, processing time, and memory requirements of all evaluated methods.

Robust Vehicle Detection and Distance Estimation Under Challenging Lighting Conditions

M. Rezaei, M. Terauchi, and R. Klette

A collision warning system by detecting vehicles ahead and by identifying safety distances to assist a distracted driver, prior to the occurrence of an imminent crash, is developed. The authors introduce adaptive global Haar-like features for vehicle detection, tail-light segmentation, virtual symmetry detection, and intervehicle distance estimation, as well as an efficient single-sensor multi-feature fusion technique, to enhance the accuracy and robustness of our algorithm. Experimental results under various weather and lighting conditions show that the proposed algorithm outperforms state-of-the-art algorithms.

Urban Traffic Flow Prediction System Using a Multifactor Pattern Recognition Model

S.-D. Oh, Y.-J. Kim, and J.-S. Hong

An urban traffic flow prediction using a multifactor pattern recognition model, which combines the Gaussian mixture model clustering with the artificial neural network, is proposed. It forecasts traffic flow by combining road geographical factors and environmental factors with traffic flow properties from detectors. Experimental results demonstrate that the proposed model produces more reliable predictions compared to existing methods.

A Rule-Based Decision Support System in Intelligent Hazmat Transportation System

R. Asadi and M. Ghatee

A new rule-based decision support system (RB-DSS) to find the safest solutions for routing, scheduling, and assignment in Hazmat transportation management is developed. To define the safe program in RB-DSS, the accident frequency and severity are estimated for different scenarios of transportation, and are used to classify the scenarios by a new structure of decision tree (DT). The outputs of the DT are stated in the form of if–then rules trained by a multilayer neural network to generalize the safe programs.

Toward BIM-Enabled Decision Making for In-Building Response Missions

A. Y. Chen and T. Huang

The authors consider the decision making for rescue and evacuation for disaster response operations in buildings, and combine network analysis with building information modeling (BIM) to facilitate the decision making process. Building geometry is retrieved from the BIM model for graph construction and route finding. The visibility graph (VG) and medial axis transform (MAT) are evaluated for graph construction. Furthermore, a hybrid method that combines VG and MAT is proposed.

ALIMC: Activity Landmark-Based Indoor Mapping via Crowdsourcing

B. Zhou, Q. Li, Q. Mao, W. Tu, X. Zhang, and L. Chen

Activity Landmark-Based Indoor Mapping system via Crowdsourcing (ALIMC) is developed to automatically construct indoor maps for anonymous buildings without any prior knowledge using crowdsourcing data collected by smartphones. After activity detection, ALIMC extracts landmarks and clusters them into different classes, while each class is treated as a node of the indoor map. ALIMC then estimates the relative distances between all the nodes to obtain a distance matrix and generates a relative indoor map using the multidimensional scaling technique. Finally, ALIMC converts the relative indoor map into an absolute one based on several reference points.

Energy-Optimal Speed Control for Electric Vehicles on Signalized Arterials

X. Wu, X. He, G. Yu, A. Harmandayan, and Y. Wang

An analytical model that determines a time-dependent optimal velocity profile for electric vehicles in order to minimize the electricity usage along a chosen route by considering road characteristics and real-time traffic conditions is presented. In particular, the proposed multi-stage optimal control model uniquely considers the impact of intersection queues in both temporal and spatial dimensions. An approximation model, which further simplifies the optimal speed profile, is also developed to increase the computation efficiency for real-time applications.

Recursive Path Planning Using Reduced States for Car-Like Vehicles on Grid Maps

S. Yoon, S.-E. Yoon, U. Lee, and D. H. Shim

The authors propose a recursive path-planning method that generates a path by using reduced states of the search space and taking into account the kinematics, shape, and turning space of a vehicle. The method is based on a kinematics aware node expansion that checks for collisions based on the shape and turning space. Two heuristics that simultaneously consider the kinematics with and without obstacles are presented. For challenging environments containing complex obstacles and even narrow passages, the method recursively identifies intermediate goals and nodes that allow the vehicle to compute a path to its destination.

Real-Time Multipedestrian Tracking in Traffic Scenes via an RGB-D-Based Layered Graph Model

S. Gao, Z. Han, C. Li, Q. Ye, and J. Jiao

A layered graph model in image (RGB) and depth (D) domains is proposed for real-time robust multipedestrian tracking, which aims to investigate high-level constraints in RGB-D data association and to improve the optimization from the trajectory to the layer level. We define constraints in the depth domain so that pedestrian objects in the image domain are assigned to proper layers. An online updating depth factor is defined to describe the depth relationships among the observations in and out of the layers, and the occlusion issue is processed with an analytical layer-level strategy.

Sparse Vehicular Sensor Networks for Traffic Dynamics Reconstruction

E. del Arco, E. Morgado, M. I. Chidean, J. Ramiro-Bargueño, I. Mora-Jiménez, and A. J. Caamaño

Using a static roadside unit (RSU) to gather data from passing sensor vehicles, the speed/position information or space–time velocity (STV) field is then reconstructed in a data fusion center with simple interpolation techniques. Widely accepted theoretical traffic models are then used to replicate the nonlinear characteristics of the STV field in representative situations. The multihop ad-hoc wireless network is finally simulated with an IEEE 802.11p PHY layer to obtain realistic information packet losses.

Robust Nighttime Vehicle Detection by Tracking and Grouping Headlights

Q. Zou, H. Ling, S. Luo, Y. Huang, and M. Tian

We present a robust nighttime vehicle detection system by detecting, tracking, and grouping headlights. First, we train AdaBoost classifiers for headlights detection to reduce false alarms caused by reflections. Second, we alternately optimize grouping and tracking. For grouping, motion features produced by tracking are used by headlights pairing, while a maximal independent set framework for effective pairing is adopted. For tracking, context information provided by pairing is employed by multiple object tracking.

Empirical Geometry-Based Random-Cluster Model for High-Speed-Train Channels in UMTS Networks

X. Yin, X. Cai, X. Cheng, J. Chen, and M. Tian

A recently conducted measurement campaign for high-speed-train (HST) channels is introduced, where the downlink signals of an in-service Universal Mobile Terrestrial System deployed along an HST railway between Beijing and Shanghai were acquired. Within 1318 km, 144 base stations were detected. Multipath components estimated from the CIRs are clustered and associated across the time slots. A new geometry-based random-cluster model is established for the clusters' behavior in delay and Doppler domains. Different from conventional models, the time-evolving behaviors of clusters are characterized by random geometrical parameters.

DMAP: Density Map Service in City Environments

P. Kumar Sahu, A. Hafid, and S. Cherkaoui

A novel mechanism to create density map for city environments called DMAP is designed. A hierarchy is used to collect, aggregate and propagate density information. For efficient aggregation of density information, an effective curve-fitting based method is proposed to transmit data using equations. Simulation results show that the proposed mechanism allows highly accurate computing of density map while generating low network overhead.

Counting and Classification of Highway Vehicles by Regression Analysis

M. Liang, X. Huang, C.-H. Chen, X. Chen, and A. Tokuta

A novel algorithm that counts and classifies highway vehicles based on regression analysis is proposed. The algorithm requires no explicit segmentation or tracking of individual vehicles, which is particularly useful when there are severe occlusions or vehicle resolution is low and extracted features are highly unreliable. Three different regressors are designed and evaluated for it, which prove that the regression-based algorithm is accurate and robust for poor-quality videos.

A Simulation Study on the Design of a Novel Automated Container Terminal

X. Yang, W. Mi, X. Li, G. An, N. Zhao, and C. Mi

A novel automated container terminal (ACT) called the rail-shuttle based ACT is studied. Two different microscopic rail-shuttle based ACT simulation models employed with either straddle carriers (SCs) or automated guided vehicles with lifting devices (lift-AGVs), are formulated. Simulation results indicate that the performance of conventional ACTs can be improved if equipped with rail shuttles, and the performance of the rail-shuttle based ACT with SCs exceeds that with lift-AGVs.

Hierarchical Adaptive Path-Tracking Control for Autonomous Vehicles

C. Chen, Y. Jia, M. Shu, and Y. Wang

A hierarchical controller consisting of three layers, high, low, and intermediate, is proposed for an autonomous vehicle in the presence of uncertainties in both tire–road condition and external disturbance. The upper-layer module deals with the vehicle motion control objective, the low-level module handles the braking control for each wheel based on the wheel slip dynamics, while the intermediate-level controller generates the longitudinal slip reference for the low-level brake control module and the front-wheel steering angles.

On-Street and Off-Street Parking Availability Prediction Using Multivariate Spatiotemporal Models

T. Rajabioun and P. A. Ioannou

The authors study the nature of the parking availability data in a big city and propose a multi-variate auto-regressive model that takes into account both temporal and spatial correlations of parking availability. The model predicts parking availability with high accuracy. Meanwhile, the prediction errors are used to recommend the parking location with the highest probability of having at least one parking spot available at the estimated arrival time. The results of experiments using parking data in San Francisco show the effectiveness of the proposed model and the accuracy of the predictions.

Vehicle Color Recognition With Spatial Pyramid Deep Learning

C. Hu, X. Bai, L. Qi, P. Chen, G. Xue, and L. Mei

A deep learning based algorithm for automatic vehicle color recognition is proposed. The algorithm adaptively learns a representation that is more effective for the task of vehicle color recognition, which leads to higher recognition accuracy and avoids preprocessing. Moreover, we combine the widely used spatial pyramid strategy with the original convolutional neural network architecture to further boost the recognition accuracy, and achieve superior performance.

Perception in Disparity: An Efficient Navigation Framework for Autonomous Vehicles With Stereo Cameras

T. Cao, Z.-Y. Xiang, and J.-L. Liu

A novel navigation framework is proposed for autonomous vehicles equipped with stereo cameras, featuring finishing all of the perception and path planning tasks directly within disparity space. Two important properties concerning motion and slope in disparity space are presented for the first time. Experimental results show that the framework can efficiently perceive and plan on a much larger range and react to obstacles further beyond the traditional Cartesian-based method.

Low-Dimensional Models for Compressed Sensing and Prediction of Large-Scale Traffic Data

N. Mitrovic, M. T. Asif, J. Dauwels, and P. Jaillet

A low-dimensional network representation is proposed by only explicitly monitoring a subset of road segments. Traffic information for the subset of roads is then used to estimate and predict conditions of the entire network. Numerical results show that such approach provides 10 times faster prediction at a loss of performance of 3% and 1% for 5- and 30-min prediction horizons.

Predictability of Public Transport Usage: A Study of Bus Rides in Lisbon, Portugal

S. Foell, S. Phithakkitnukoon, G. Kortuem, M. Veloso, and C. Bento

The predictability of bus usage based on massive bus ride data collected from Lisbon, Portugal, is studied. The analysis of the data shows that there exists a regularity in the bus usage and daily bus rides can be predicted with a high degree of accuracy. Spatial and temporal factors such as bus usage frequency, number of different bus lines and stops used, and time of rides, can influence the bus usage predictability.

Five Transportations in One—A New Direction for ITS From Qingdao

Right before I came to Las Palmas for ITSC 2015, I had a series meetings with the leadership of Qingdao metropolitan government and its major incorporations. It is good to know that Qingdao has decided to make Intelligent Industries one of its main engines for future economic and social development. In particular, Transportation 5.0 or Five Transportations in One will lead the way, where urban traffic, public transport, parking management, regional logistics, and social transportation will be integrated and relevant data would be shared for scientific research, technology development, and better services. A cross-department agency will be created to implement Transportation 5.0, in which, in addition to Five Transportations in One, a smart automated harbor system will be built and a special road about 50 km long to the new international airport for autonomous vehicles will be constructed.

This will be a bold and difficult task. Big data and intelligent technology for cyber-social-physical systems, especially ACP-based parallel intelligent technology, will play a central role for its success. Qingdao's plan represents a new direction for ITS theory and application, and remind me of the effort of combining two different approaches by F. A. Hayek and J. M. Keynes, respectively, in economy. In Hayek's term, I hope Transportation 5.0 will lead to a new type of Transportation Catallactics, a self-organizing transport market for regulated coordination and voluntary cooperation, in which parallel systems serve as effective platforms and mechanisms for discovering and distributing information and knowledge for transportation activities.

Data and experience from Qingdao's Transportation 5.0 will be open to all ITS researchers and practitioners. Last year in Qingdao at ITSC 2014, International Joint Center for Intelligent Transportation Research was established with the help from the IEEE ITSS Technical Committee on Transportation 5.0. I hope this Center will enable ITSS and its members to play an importation role in helping Qingdao to achieve its dream for ITS, a dream that could benefit all cities in the world.

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