Emerging mobility systems featured with capacities of big data processing and analytics, advanced vehicle technologies, and novel service paradigms are transforming our urban environment and life style. These innovations and breakthroughs have motivated researchers on Intelligent Transportation Systems (ITS) to expand the frontiers of ITS concepts and skillsets, to identify new opportunities and challenges in integrating emerging vehicle technologies and mobility services, and to produce theories, models, algorithms, field experiments and real world applications for establishing a unique ITS discipline. To this end, this special issue is focused on cutting edge ideas, knowledge, techniques, tools and applications in the broad areas on emerging mobility systems. It is exciting to have 17 papers with novel and high quality research outcomes accepted for publication. These papers cover diverse topics including data analytics methods (Papers 1, 2, 5, 7, 8 11–15 and 17; tagged with #data), novel vehicle technologies such as connected vehicles, autonomous vehicles, electric vehicles and aerial vehicles (Papers 2, 3, 6 and 9; tagged with #vehicle), advanced computing methods (Papers 4, 10 and 16; tagged with #computing), and thriving mobility services including ridesplitting and carpooling (Papers 11 and 15; tagged with #sharing). As the guest editors of this special issue, we would like to summarize the 17 accepted papers below.

Paper 1: [#data] Understanding and predicting travel time with spatio-temporal features of network traffic flow, weather and incidents by Shuguan Yang and Sean Qian. It is critical to understand to what extent the variation of travel time on a route is correlated with various factors, such as weather, incidents, events or travel demand level in the context of dynamic networks. This paper proposes a data-driven approach to predict highway travel time using spatio-temporal features of those factors from multiple data sources. It is found that bottlenecks scattered in the network can imply congestion on those corridors at least 30 minutes in advance. Further, all the spatio-temporal information together significantly improves prediction accuracy, compared to using only speed data. Using a simple linear model, this study fuses multiple data sources that are over multiple years and across both time and space, to substantially improve the current methods for predicting traffic, both in terms of accuracy and prediction time span.

Paper 2: [#vehicle; #data] An automated vehicle fuel economy benefits evaluation framework using real-world travel and traffic data by Lei Zhu, Jeffrey Gonder, Eric Bjärkvik, Mitra Pourabdollah and Björn Lindenberg.

Real-world evaluation of energy consumption differences between automated vehicles and comparable manually driven vehicles is not well investigated. To fill this gap, this study compares motion smoothness and fuel economy of vehicles in adaptive cruise control (ACC) and non-ACC modes, based on the field test data collected by Volvo Cars from vehicles traveling on the designated “Drive Me” project road network in Gothenburg, Sweden. It was found that vehicles tended to drive more smoothly in ACC mode than in non-ACC mode. Further, the corresponding travel-weighted fuel consumption rate for vehicles in ACC mode was about 5%–6% lower than for vehicles in non-ACC mode when traveling in similar conditions. These empirical findings allude to research opportunities in quantifying comprehensive impacts of ACC and more advanced autonomous vehicle technologies on road way driving comfort and fuel consumption in the near future.
Paper 3: [vehicle] Energy-efficient adaptive cruise control for electric connected and autonomous vehicles by Chaoru Lu, Jing Dong and Liang Hu.

This study proposes an Energy-Efficient Electric Driving Model (E3DM), for electric, connected, and autonomous vehicles (e-CAVs) in a mixed traffic stream. E3DM is able to maintain high energy efficiency of regenerative braking by adjusting the spacing between the leading and the following vehicles. The impact of E3DM on vehicle energy consumption is investigated using a proposed power-based energy consumption model. The results show that E3DM outperforms existing adaptive cruise control (i.e. Nissan-ACC) and cooperative adaptive cruise control (i.e. Enhanced-IDM and Van Arem Model) strategies in terms of energy consumption. This study will help develop longitudinal control algorithms for electric autonomous vehicles.

Paper 4: [computing] Distributed traffic speed control for improved vehicle throughput by Yue Zu, Chenhui Liu and Ran Dai.

This article presents a real-time speed control strategy for vehicle throughput improvement on highways. A Convex Quadratic Optimization Problem (CQOP) is formulated and solved with Quadratic Programming (QP). A distributed framework is constructed based on a dual decomposition and subgradient method via networked Road Infrastructures (RIs). Instead of relying on complex RIs networks for information collection, the distributed method only depends on local traffic information and iteratively approaches to the feasible solutions constrained by flow consensus. This work contributes to the modelling and algorithmic aspects of speed control.

Paper 5: [data] Low-cost road traffic state estimation system using time-spatial image processing by Ekalux Ua-Areemit, Agachai Sumalee and William H.K Lam.

This paper proposes a low-cost image processing system for road traffic state estimation using time-spatial image (TSI) processing. The TSI is an image processing technique to transform a series of video images into a single image. Therefore, the TSI can reduce memory resources compared with the traditional methods. A camera can be exploited for traffic-state estimation by integrating with TSI generating and processing modules. In addition, traffic state variables such as space-mean-speed, flow and density can be estimated. Empirical results show that TSI processing is an effective approach to traffic state estimation despite its low cost. The TSI method can be used to expand traffic sensor networks to obtain better traffic estimation and prediction results with minimum additional costs.

Paper 6: [vehicle] An optimal game approach for heterogeneous vehicular network selection with varying network performance by Xiangmo Zhao, Xiaochi Li, Zhigang Xu and Ting Chen.

To remedy the assumption of homogenous vehicular networks in traditional studies, this paper proposes a multi-play non-cooperative game model for heterogeneous vehicular network selection. A system prototype was built at the Connected and Automated Vehicle Test bed of Chang’an University (CAVTest). The test results indicate that the proposed approach can effectively suppress the ping-pong effect caused by massive handoffs due to varying network performance and thus well outperforms the single-play strategy. This study contributes to enhancing connected vehicle communication technologies to fit more heterogeneous operational environments.


This paper proposes a method to estimate multimodal traffic volume on the urban road networks using cellphone location data considering multiple phone users in a driving vehicle. A two-stage approach is adopted to first identify vehicles and then classify them based on their estimated occupancies. The predicted traffic volumes are compared with the actual traffic volumes, and the result confirms that the proposed method well estimates the hourly traffic volumes. This development will enhance mobile sensor based traffic volume estimation with more accuracy and richer mode information.

Paper 8: [data; vehicle] Demand estimation for aerial vehicles in urban settings by Milos Balac, Amedeo Vetrella, Raoul Rothfeld and Basil Schmid.

The need to develop appropriate planning tools for aerial transportation significantly increases as various types of aerial vehicles thrive in recent years. This paper presents a method for demand estimation for personal aerial vehicles (PAVs) in urban settings. The findings show that with higher automation and falling prices, PAVs have a potential to be an important transportation mode, by serving not only mid-distance trips, but also shorter trips in urban settings. Furthermore, an optimization procedure that minimizes fixed and variable costs of PAVs for the estimated demand in the region of Zurich, Switzerland, is proposed. The proposed methods provide means for better estimating and preparing for emerging aerial vehicle systems.

Paper 9: [vehicle] A speed control method at successive signalized intersections under connected vehicles environment by Yingrong Lu, Xiaotong Xu, Chuan Ding and Guangquan Lu.

Despite numerous control methods developed for signalized intersections, few studies address fuel consumption and emissions along successive signalized intersections. This paper proposes a model to optimize the vehicles’ speed to reduce fuel consumption and emissions based on the upcoming traffic signal phasing and timing information and the vehicle queues at successive signalized intersections. To validate its effectiveness, a simulation including the characteristics of the connected
Paper 10: [#computing] Dynamic cellular learning automata for evacuation simulation by Ruan, Xin, Jin, Zeren, Tu, Huizhao and Li, Yu.

The existing models for pedestrian evacuation simulations mainly address the extension of information in a spatial concept yet overlook their experiences accumulated throughout the evacuation process over the temporal dimension. This paper develops a model to achieve an adaptive choice-making process via two learning automata that update the imitation preference for certain pedestrians and make decisions between independent movement and imitation. The proposed model shows better performance in describing pedestrian movement characteristics compared with existing models. This work can improve the prediction capability of evacuation simulation by incorporating richer experience information.

Paper 11: [#data; #sharing] How does on-demand ridesplitting influence vehicle use and purchase willingness? A case study in Hangzhou, China. Considering the modal shift from public transit to ridesplitting, the findings indicate that (I) in the short term, ridesplitting services reduce the number of vehicles on road; (II) in the intermediate term with the development of ridesplitting, the total decreased number of vehicles is nearly 5.6% of vehicle ownership in the urban area of Hangzhou; and (III) in the long term, ridesplitting will influence people’s travel behavior and reduce the car purchase willingness. This paper sheds light on exploring the influence of on-demand ridesplitting on the vehicle use and purchase willingness.

Paper 12: [#data] Spatial interpolation of missing annual average daily traffic data using copula-based model by Xiaolei Ma, Sen Luan, Chuan Ding, Haode Liu and Yumpeng Wang.

The kriging-based spatial interpolation approach for AADT (annual average daily traffic) estimation may yield inaccurate interpolation results under unstable and complex traffic patterns due to diverse road functions or land uses. This study proposes a copula-based model that combines spatial dependency and marginal distribution for missing AADT interpolation to remedy the limitation of the kriging method. The proposed model describes the spatial dependency in a manner robust to outliers. Results with empirical data suggest that the spatial copulas yield significantly higher accuracy rates than the kriging method for irregular travel patterns with high missing data rates. Overall, the proposed model has a great potential to improve the performance of large-scale transportation network-wide data imputation.


This study developed statistical models to provide insights into driver behavior with tens of thousands of driver logs from cell phone sensor data drawn from five hundred drivers in San Francisco. These models investigate the speed of traffic across the city as well as the maneuvers of drivers in different areas. Specifically, drivers are clustered based on their driving behavior. Driver norms and outliers deviating from the norm are investigated. This study provides insights into driving behavior from the speed profile perspective with real-world novel data sources.

Paper 14: [#data] Detecting pickpocketing gangs on buses with smart card data by Xia Zhao, Yong Zhang, Hao Liu, Shaofan Wang, Zhen Qian, Yongli Hu and Baocai Yin.

While real-time detection of pickpocketing gangs on buses would allow effective law enforcement and crime prevention, this issue has received very little attention in research. This study utilizes smart card data generated by bus riders to probabilistically identify pickpocketing gangs from regular passengers using their distinct characteristics from regular passengers. This model examines and classifies anomaly of passengers using the relative outlier cluster factor and local outlier factor. A network structure is constructed and a graph-based Louvain algorithm is adopted to detect pickpocketing gangs. Results show that the framework detects 65 pickpocketing gangs and verifies 54 gangs by microblogs, with a recall value of 0.85. Findings from this research can assist police and public safety departments across the city in taking pro-active actions to track down pickpocketing gangs.

Paper 15: [#data; #sharing] Analysis of the influencing factors of carpooling schemes by Kai Huang, Zhiyuan Liu, Inhi Kim, Yong Zhang and Ting Zhu.

Characteristics of convenience, cost-efficiency, and sustainability for a carpooling system, which are critical to the success of this emerging mode, have received little attention in quantitative
research. To bridge this gap, this study conducted a stated preference (SP) survey and found three key factors, i.e., travel time, travel cost, and safety, significantly affecting carpooling mode choices. The interaction of travel time and travel cost are explored by a binary logit regression analysis, respectively. The findings of the main factors and their interaction, related suggestions are helpful in evaluating and promoting carpooling systems.


This study proposes new methods for queue length estimation at signalized intersections through intrinsic connections between travel time of individual vehicles and queue composition in each cycle. Emerging LPR (license plate recognition) data and signal schemes are used to validate the methods. The queue length in the previous cycle is calculated by considering the detailed trajectories of individual vehicles, considering the hysteresis of the queue length in the previous cycle. The algorithms are evaluated using field data of Guiyang city in China, and the results indicate the proposed models fully estimate queue lengths even in congested conditions. This development provides new means to utilize emerging LRP data for estimating queue lengths as critical information for future congestion management.

Paper 17: [#data] Multi-source traffic data reconstruction using joint low-rank and fundamental diagram constraints by Yang Wang, Yong Zhang, Zhen Qian, Shaofan Wang, Yongli Hu, and Baocai Yin.

Despite many existing methods for multi-source traffic data reconstruction, two issues remain challenging and unaddressed: the effectiveness of reconstruction and the assumption on the probability distribution of data. This paper proposes a novel framework that integrates low-rank representation and fundamental traffic flow models into multi-source traffic data reconstruction. It simultaneously imputes missing data and eliminates outliers/errors. Multiple parameters in the traffic flow models are learned from large-scale spatiotemporal data, ensuring the extracted and imputed data consistent with traffic flow physics. The superiority of this method over existing methods is confirmed with empirical data. The proposed method holds promise for utilizing increasingly diverse data sources for more accurate traffic state reconstruction.

Information of Guest Editors

Xiaopeng (Shaw) Li received the Ph.D. degree in civil engineering from the University of Illinois at Urbana-Champaign in 2011. He is currently an Associate Professor and Susuan A. Bracken Faculty Fellow in the Department of Civil and Environmental Engineering at the University of South Florida (USF). He serves as an Associate Editor for the Department of Transportation Systems Analysis, IIE Transactions and he is on the editorial boards for Transportation Research Part B & Part C. He received the US National Science Foundation CAREER Award. His research focuses transportation and other interdependent infrastructure systems featured with emerging technologies and services.

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