Scanning the Issue

Exploring the Congestion Pattern at Long-Queued Tunnel Sag and Increasing the Efficiency by Control

J. Sun, T. Li, M. Yu, and H. M. Zhang

The tunnels are usually natural bottlenecks due to the changes in gradient, which is known as sag. Once a queue propagates from the sag to upstream bottleneck, the induced multi-bottleneck congestion shows a more complicated pattern than an isolated one. In this paper, the congestion pattern of the long-queued tunnel sag is empirically investigated in Shanghai. Three distinctive congestion stages are observed from day-to-day traffic flow data. The mechanisms of congestion are discussed. Based on the understanding of the congestion pattern, a novel control strategy is proposed which cooperatively controls the tunnel sag mainline and the on-ramp. The control objective is to maximize the throughput and minimize the breakdown probability using quantitative risk analysis method. The control strategy is validated in the field experiment. The traffic features (volume, speed, and productivity) in the tunnel sag are found to be significantly enhanced by the control.

Two-Yard Crane Scheduling With Dynamic Processing Time and Interference

F. Zheng, X. Man, F. Chu, M. Liu, and C. Chu

This paper investigates the two-yard crane scheduling with storage and retrieval tasks in a container block. The main contributions are: 1) container reshuffling operations and inter-crane interference constraint are both considered and 2) the dynamic processing times for retrieval containers are taken into consideration. These typical operation characteristics complicate the yard crane scheduling and cause late delivery and economic loss. In this paper, the authors focus on minimizing the maximum tardiness of the container task and establishing an integer linear programming model. Regarding the NP-hardness nature of the problem, they develop a heuristic named dividing, sequencing, and comparing (DSC) and a genetic algorithm (GA) based on the characteristics of the problem. The computational results show the efficient performance of the developed algorithms, compared with the exact solutions via Cplex software for small size instances. The efficiency and effectiveness of the DSC outperform a those of the GA for practical size instances.

Resilience of the U.S. National Airspace System Airport Network

K. L. Clark, U. Bhatia, E. A. Kodra, and A. R. Ganguly

The U.S. national airspace system, like other regional lifeline networks across the world, is subject to shocks from natural hazards, such as technological failures and terror attacks. The disruptions can percolate along the network and may even cascade across systems. Understanding robustness at the system level, and developing principled approaches for recovery, is a prerequisite to embedding resilience. Reliable, cost-effective, and timely recovery is crucial to enable the essential services for which the lifeline infrastructure network was designed. While network science methods are relatively well developed for robustness, recovery methods are less well developed. Here, the authors further develop a network-science-based recovery strategy and demonstrate how it can be applied to the U.S. national airspace system airport network, based on historical shocks. The future research may need to balance the top-down network-based recovery developed here, with bottom-up component-based approaches, to inform tactical, operational, and strategic post-disaster recovery.

ADS-BI: Compressed Indexing of ADS-B Data

S. Wandelt, X. Sun, and H. Fricke

A novel compressed index structure for managing ADS-B data is proposed, which exploits spatio-temporal reference partitioning, reordering, and compression of satellite-based aircraft tracking data. Comparison against 10 standard competitors, evaluated on worldwide ADS-B data for a week in November 2016, reveals that the novel index structure is the only one which addresses a sweet spot between fast query answering and small storage costs. The proposed index structure contributes toward the efficient handling of the increasing amount of traffic data in air traffic management, and eventually, toward more efficient and safer air transportation. The method can be extended to other domains dealing with large amounts of trajectories which need to be compressed and indexed without loss of information.

Optimal Stochastic Eco-Routing Solutions for Electric Vehicles

Z. Yi and P. H. Bauer

A stochastic energy aware routing framework is proposed for electric vehicles with the goal of enhancing the sustainability of future electrified transportation systems. Aiming to handle the random effects of environmental factors on transportation energy cost, the problem of optimal routing is formulated as a stochastic programming problem and risk control of the overall energy is applied to find the minimum energy route. The original discrete optimization problem is tackled using convex relaxation and transformation. The optimal path is constructed using a highly efficient primal-dual interior point algorithm for the relaxed problem with a subsequent reconstruction of the solution for the original discrete problem. Two electric drive limitations, i.e., battery capacity and driveline efficiency, are made an integral part of the decision-making framework in order to obtain realistic results by incorporating actual vehicle data.

Vehicle Path Prediction Using Yaw Acceleration for Adaptive Cruise Control

W. Kim, C. M. Kang, Y. S. Son, S.-H. Lee, and C. C. Chung

In this paper, a vehicle path prediction employing yaw acceleration for adaptive cruise control is proposed. A path prediction method employing yaw acceleration improves the

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path prediction performance of ego vehicles. The vehicle path is predicted by using a clothoidal cubic polynomial curve model. For this purpose, the curvature rate, yaw rate, and longitudinal velocity are used. The curvature rate can be mathematically obtained by differentiating the yaw rate without a camera sensor. Then, the Kalman filter (KF) is designed to estimate the yaw acceleration. A multirate longitudinal control method improves the longitudinal control performance. The multirate KF employs the constant acceleration model in order to estimate the relative distance and velocity of the target vehicle at a faster sampling rate. The whole ACC system operates with a faster sampling rate so that the multirate control scheme reduces ripples in both the relative longitudinal distance and the desired acceleration.

Airport Ground Movement Problem: Minimization of Delay and Pollution Emission

L. Adacher, M. Flamini, and E. Romano

The authors present different routing heuristics, and they use a new optimization model to minimize the total routing taxiing delay and the pollution emission in terms of the total waiting time the aircraft engines are turned ON. They propose several routing heuristics, and they use the alternative graph model to represent the routing solution and to solve the airport ground movement problem. The experimental results based on real data are reported. They validate their model and algorithms in the Malpensa Terminal Area (MXP Airports), whose layout induces several risky runway crossing operations. By shifting the waiting times from the stop bars to the parking stands, they also improve the safety, since the total time in which two aircrafts are close together is reduced.

Using Roads for Autonomous Air Vehicle Guidance

R. Hartley, B. Kamgar-Parsi, and C. Narber

This is a study on the development of a road following a vision-based guidance system for unmanned air vehicles (UAV) in real-world applications. Currently, autonomous navigation requires the use of GPS. For various reasons, however, the dependence on GPS is undesirable in many applications. Therefore, vision-based navigation has been gaining popularity. The vision-based guidance requires the existence of extended landmarks for air vehicles to detect and follow. Roads are the most commonly available path to follow. Moreover, the abundance of events that happen along roads makes them appealing subjects of surveillance. Many road detection (single images) and road tracking (videos) algorithms have been proposed in the literature. Due to the complexity of road detection, the authors not only need advanced software but also the most effective sensors. They propose a road following algorithm that uses both RGB camera and hyperspectral sensor and report results of actual test flights conducted in different locations and different seasons.

A Security Credential Management System for V2X Communications

B. Brecht, D. Therriault, A. Weimerskirch, W. Whyte, V. Kumar, T. Hehn, and R. Goudy

The U.S. Department of Transportation (USDOT) issued a proposed rule on January 12, 2017, to mandate vehicle-to-vehicle safety communications in light vehicles in the U.S. Cybersecurity and privacy are major challenges for such a deployment. The authors present a Security Credential Management System (SCMS) for vehicle-to-everything (V2X) communications in this paper, which has been developed by the Crash Avoidance Metrics Partners LLC under a cooperative agreement with the USDOT. This system design is a leading candidate to support the establishment of a nationwide Public Key Infrastructure for V2X security. It issues digital certificates to participating vehicles and infrastructure devices for trustworthy communications among them. The main design goal is to provide both security and privacy to the largest extent reasonable and possible.

Data-Driven State-Increment Statistical Model and Its Application in Autonomous Driving

C. Ma, J. Xue, Y. Liu, J. Yang, Y. Li, and N. Zheng

The traditional vehicle models do not consider the influence of the control system and the underlying execution system on the vehicle motion, and cannot quantitatively describe uncertainties of the vehicle motion. In order to solve this problem, a statistical model based on the statistics of state increments is proposed to quantitatively describe uncertainties of the vehicle motion by taking the control system and the underlying execution system into account. Compared with traditional vehicle models, the state increment statistical model has two advantages. One is that the model is driven by driving data of autonomous vehicles so that it can accurately describe the motion characteristics of autonomous vehicles. The other is that the model models the control system and the underlying execution system as a whole so that the model can probabilistically describe the state increment outputs under certain control inputs, and quantitatively analyze uncertainties of the vehicle motion.

Uplink Resource Allocation for Relay-Aided Device-to-Device Communication

J. Sun, Z. Zhang, C. Xing, and H. Xiao

Aiming at maximizing the sum throughout of the network with a low computation complexity, a new scheme, which jointly considers a number of critical aspects, such as power control, interference limit based on the location information, optimal relay selection based on delineated area, and optimal link selection-based range division, and so on, is proposed in this paper. The numerical results reveal that the proposed scheme is capable of substantially improving the system performance compared with either the existing brute-force technique or the area-division scheme. In addition, the proposed scheme also exhibits its advantages over the existing techniques in terms of computational complexity.

Real-Time Detection and Estimation of Denial of Service Attack in Connected Vehicle Systems

Z. Abdollahi Biron, S. Dey, and P. Pisu

Connected vehicles have the potential to improve the traffic throughput, minimize the risk of accidents, and reduce vehicle energy consumption. Despite these promising features, connected vehicles suffer from safety and security issues. In order to improve the safety and security, advanced vehicular control systems must be designed that are resilient to such cyber-attacks. A real-time scheme is proposed to potentially: 1) detect the occurrence of a particular cyber-attack, namely denial of service and 2) estimate the effect of the attack on the connected vehicle system. The scheme consists of a set of observers, which are designed using sliding mode and adaptive estimation theory.

Consensus Ensemble System for Traffic Flow Prediction

H. Zhan, G. Gomes, X. S. Li, K. Madduri, A. Sim, and K. Wu

An ensemble learning scheme for traffic flow prediction is developed in this paper, which combines individual models to produce a consensus prediction. The proposed learning model exploits the temporal characteristics of the data and balances the accuracy of individual models and their mutual dependence through a covariance-regularizer. The proposed method is evaluated for multi-step-ahead arterial traffic forecasting. The experiments demonstrate the better performance of the proposed scheme compared with several other model-combination methods.

GNSS Time Synchronization in Vehicular Ad-Hoc Networks: Benefits and Feasibility

K. F. Hasan, Y. Feng, and Y.-C. Tian

This paper examines the requirements, potential benefits, and feasibility of a global navigation satellite system (GNSS)-based time synchronization in vehicular ad-hoc networks (VANETs). The availability of GNSS time synchronization is characterized by almost 100% in the authors' experiments in high-rise urban streets, where the availability of GNSS positioning solutions is only 80%. Experiments are also conducted to test the accuracy of time synchronization with 1-PPS signals output from consumer-grade GNSS receivers. They have shown 30-ns synchronization accuracy between two receivers of different models. All these experimental results demonstrate the feasibility of GNSS time synchronization for stringent VANET applications.

An Adaptive Forward Collision Warning Framework Design Based on Driver Distraction

S. M. Iranmanesh, H. N. Mahjoub, H. Kazemi, and Y. P. Fallah

A new adaptive Forward Collision Warning methodology is proposed, which considers the cognitive state of the individual drivers to fine-tune the warning generation process. This method continuously adjusts its warning triggering threshold based on the driving history of each driver in conjunction with his/her cognitive status in terms of cautiousness. Driver distraction is determined using machine learning-based approaches. False warning generation, which is the most serious application oversight causing the driver to deactivate the system, is noticeably reduced by this method while no critical warning is missed.

A Kinect-Based Approach for 3D Pavement Surface Reconstruction and Cracking Recognition

Y. Zhang, C. Chen, Q. Wu, Q. Lu, S. Zhang, G. Zhang, and Y. Yang

A cost-effective Kinect device-based approach is developed for 3D pavement surface reconstruction and cracking recognition. A comprehensive computational solution is established for detecting and identifying pavement distress features. Various pavement cracking measurements such as alligator cracking, traverse cracking, longitudinal cracking, and so on, are identified and recognized for their severity examinations based on their associated geometrical features. The experimental results indicate that this method is effective in extracting analytical information on pavement cracking measurements as a viable, applicable solution to automatic pavement surface condition detection and evaluation. The proposed methodology is transferable for pavement surface reconstruction and distress condition identification based on the other types of 3D cloud point data.

Energy-Efficient Train Timetable Optimization in the Subway System with Energy Storage Devices

P. Liu, L. Yang, Z. Gao, Y. Huang, S. Li, and Y. Gao

This paper investigates the impact of energy storage devices on the train timetabling problem, in which both the instant utilization process and delayed utilization process of the regenerative braking energy are considered. A mathematical optimization model is formulated with the minimization of total energy consumption and a hybrid algorithm is designed to obtain the optimal train timetable. The numerical experiments demonstrate the effectiveness of the energy storage device and the proposed algorithm.

Implicit Cooperative Positioning in Vehicular Networks

G. Soatti, M. Nicoli, N. Garcia, B. Denis, R. Raulefs, and H. Wymeersch

A novel framework of cooperative positioning in vehicular networks is proposed where vehicles localize, in a distributed way, a set of jointly sensed non-cooperative features (e.g., people) and use them as common noisy reference points to implicitly improve their location estimates with respect to the Global Navigation Satellite System (GNSS) approach. Distributed Gaussian message passing is combined with consensus-based estimation of the features' positions to enable cooperative localization of vehicles. The simulation results demonstrate that the proposed methodology can accurately estimate the features' positions and (implicitly) improve the vehicle positioning accuracy compared with the stand-alone GNSS solution, especially in harsh environments such as urban canyons. Moreover, the proposed algorithm is validated in a real urban scenario using the Simulation of Urban MObility for traffic data generation.

Road-Segmentation-Based Curb Detection Method for Self-Driving via a 3D-LiDAR Sensor

Y. Zhang, J. Wang, X. Wang, and J. M. Dolan

The effective detection of curbs is fundamental and crucial for the navigation of a self-driving car. This paper presents a real-time curb detection method that automatically segments the road and detects its curbs using a 3D-LiDAR sensor. The proposed method is tested on the data sets acquired from the self-driving car of the Laboratory of VeCaN at Tongji University. Off-line experiments demonstrate the accuracy and robustness of the proposed method, i.e., the average recall, precision and their harmonic mean are all over 80%. Online experiments demonstrate the real-time capability for autonomous driving as the average processing time for each frame is only around 12 ms.

A New Take on Protecting Cyclists in Smart Cities

A. Herrmann, M. Liu, F. Pilla, and R. Shorten

An algorithm is developed that can be deployed in hybrid vehicles (HVs) to lower exhaust-gas emissions in areas with high cyclist traffic. Geofences (virtual geographic boundaries) are used to specify areas of low pollution around cyclists. The emissions level inside the geofence is controlled via a coin tossing algorithm to switch the HV motor into, and out of, electric mode, in a manner that is in some sense optimal. The optimality criterion is based on how many polluting vehicles are inside the geofence, and the expected density of cyclists near each vehicle. The algorithm is triggered once a vehicle detects a cyclist. Implementations are presented, both in simulation, and in a real vehicle, and the system is tested using a hardware-in-the-loop platform.

On the Optimal Speed Profile for Eco-Driving on Curved Roads

F. Ding and H. Jin

An algorithm is proposed to minimize fuel consumption for a vehicle travelling on a curve with the optimized speed profiles in this paper. Based on the established vehicle dynamics model and an instantaneous fuel consumption model, the optimal constant speeds corresponding to circular curves with different radii can be derived. When entering or departing a curve, a dynamic programming algorithm is tailored to obtain the optimal speed profiles in the vicinity of the curve. The algorithm is verified using co-simulation of CarSim and MATLAB/Simulink, and approximately 5.46%–17.64% of fuel can be saved compared with the typical driver model. This technology can not only improve the conventional vehicle fuel economy during cornering but also provide a decision-making reference for the autonomous vehicle speed control.

Powered Two-Wheelers Critical Events Detection and Recognition Using Data-Driven Approaches

F. Attal, A. Boubezoul, A. Samé, L. Oukhellou, and S. Espié

Observing and analyzing the evolution of powered two-wheeled vehicles (PTWs) riders' behavior in a real-life context is an important step in the identification of the road environment characteristics that constitute a risk factor for PTW riders. A relevant research issue in naturalistic studies is related to the detection and identification of critical riding events from among the vast amount of data recorded during the experiment. In this paper, two approaches were used to automatically detect such critical riding events. First, the authors formalized this problem in terms of detecting changes in the mean and variance of the signals generated by the acceleration and angular velocity sensors. The second approach was based on online fall detection.

Citywide Spatial-Temporal Travel Time Estimation Using Big and Sparse Trajectories

K. Tang, S. Chen, and Z. Liu

This paper develops a tensor-based model to estimate the travel time in urban road network from a network-wide perspective, using large-scale and sparse GPS trajectory data. The novel approach is comprised of four major components: map matching, travel time modeling, probabilistic traffic condition clustering, and travel time estimation. It incorporates both the spatial correlation between different road segments and the deviation between different traffic conditions, as well as the fine-grain temporal correlation between different time slots and the coarse-grain temporal correlation between recent and historical traffic conditions. A case study on the citywide road network in Beijing, China was conducted, based on the large-scale and sparse GPS trajectories data collected from taxicabs. The empirical results of extensive experiments demonstrate that the proposed model provides an effective and robust approach for urban travel time estimation and outperforms the competing methods.

Methodology and Key Performance Indicators (KPIs) for Railway On-Board Positioning Systems

J. Goya, G. De Miguel, S. Arrizabalaga, L. Zamora-Cadenas, I. Adin, and J. Mendizabal

A new methodology and unified key performance indicators are proposed to fill the gap between the current railway standardization process and an on-board positioning system. Comparison between RAMS standard and GNSS performance indicators is carried out, including simulated and real scenarios for the methodology validation. This approach is a step forward for the deployment of GNSS-based positioning systems for safety-critical applications.

Robust Lane Detection and Tracking for Real-Time Applications

C. Lee and J.-H. Moon

The challenges faced by the lane detection and tracking algorithm include the lack of clarity of lane markings, poor visibility due to bad weather, illumination and light reflection, shadows, and dense road-based instructions. In this paper, a robust and real-time vision-based lane detection algorithm with an efficient region of interest is proposed to reduce the high noise level and the calculation time. The proposed algorithm also processes a gradient cue and a color cue together and a line clustering with scan-line tests to verify the characteristics of the lane markings. It removes any false lane markings and tracks the real lane markings using the accumulated statistical data.

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