Scanning the Issue

An Analytical Model to Characterize the Spatiotemporal Propagation of Information Under Vehicle-to-Vehicle Communications

Y. H. Kim, S. Peeta, and X. He

Modeling the spatiotemporal propagation characteristics of information under vehicle-to-vehicle communications is critical for developing information-enabled applications to improve traffic safety and mobility. Existing analytical approaches assume instantaneous information flow propagation to simplify the communication constraints arising from the traffic flow dynamics. Consequently, information flow propagation characteristics such as the information flow propagation wave have not been analyzed. They are necessary to describe the interactions with the underlying traffic flow dynamics. An analytical model, which integrates an epidemic model with a traffic flow model, is developed to account for such interactions. The proposed model is able to capture the dynamics of information flow and traffic flow in an integrated formulation that circumvents key analytical and numerical challenges. Results from computational experiments demonstrate the effectiveness of the proposed model and its ability to describe the dynamic characteristics of information flow propagation along with the traffic flow dynamics.

A Two-Level Traffic Light Control Strategy for Preventing Incident-Based Urban Traffic Congestion

L. Qi, M. Zhou, and W. Luan

This paper designs a strategy at signalized traffic intersections to prevent urban road traffic congestion caused by incidents. It needs two kinds of additional traffic signal lights named ban and warning ones. The ban light helps to stop the traffic flow driving toward some directions, while the warning one is used to give traffic flow a recommendation of not driving to some directions. Timed Petri nets are utilized to describe the cooperation between traffic lights and warning lights and then verify their correctness. The effectiveness of the strategy is evaluated through simulations in the grid traffic network modeled via a cell transmission model. The results reveal the influences of some major parameters, such as the route-changing rates of vehicles, operation time interval of the proposed strategy, and traffic density of the traffic network on a congestion dissipation process.

Application of Evolutionary Computation for Berth Scheduling at Marine Container Terminals: Parameter Tuning Versus Parameter Control

M. A. Dulebenets

A novel evolutionary algorithm is proposed to assist with berth scheduling at marine container terminals. Unlike published studies on berth scheduling, the developed algorithm applies a parameter control strategy. Specifically, an adaptive mechanism is developed for the mutation operator, where the mutation rate is altered based on feedback from the search. A set of numerical experiments are conducted to assess the performance of the developed algorithm based on a comparison against a typical evolutionary algorithm that applies a constant mutation rate value. Results indicate that deployment of the adaptive mechanism for the mutation operator yields on average 5.4% and 8.5% savings in terms of the total weighted vessel service cost for medium and large size problem instances, respectively, without a significant increase in computational time.

Nonlane-Discipline-Based Car-Following Model for Electric Vehicles in Transportation-Cyber-Physical Systems

Y. Li, L. Zhang, H. Zheng, X. He, S. Peeta, T. Zheng, and Y. Li

This paper proposes a new car-following (CF) model, incorporating the effects of lateral gap and roadside device communication to capture the characteristics of electric vehicle (EV) traffic stream in transportation-cyber-physical-systems. Stability of the proposed CF model is analyzed using the perturbation method. Furthermore, the energy consumption of EV traffic stream is investigated based on the drive cycles produced by the proposed model. Results demonstrate that: 1) the nonlane-discipline-based model is more responsive than the lane-discipline-based model; 2) the nonlane-discipline-based model for EV traffic stream consumes more energy in the acceleration phase and recuperates more energy in the deceleration phase compared with the lane-discipline-based model; and 3) the nonlane-discipline-based model with roadside device communication for EV traffic stream consumes more energy in the acceleration phase and recuperates more energy in the deceleration phase than the model without roadside devices.

Airspace Collision Risk Hot-Spot Identification Using Clustering Models

M.-H. Nguyen and S. Alam

A key safety indicator for airspace is its collision risk estimate, which is compared against a target level of safety to provide a quantitative basis for judging the safety of operations in airspace. However, this quantitative basis does not provide any insight regarding the spatial–temporal distribution of collision risk in an airspace. In this paper, the authors propose a methodology for identification of collision risk hot-spots in a given airspace. Air traffic data are used to project air-traffic crossings and cluster potential collisions. The proposed method then estimates the collision risk for each identified cluster, culminating in risk assessment for the entire airspace. The model extends state-of-the art clustering models to systemically identify airspace collision risk hot spots and analyze cluster features with flight levels and time of day. By visualizing crossing points and clustering them, the authors are able to identify collision risk hot-spots that contribute significantly to overall collision risk.

Decision-Making Framework for Automated Driving in Highway Environments

S. Noh and K. An

This paper presents a decision-making framework for automated driving in highway environments. The framework is

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capable of reliably, robustly assessing a given highway situation (with respect to the possibility of collision) and of automatically determining an appropriate maneuver for the situation. The types of the determined maneuver include both simple maneuvers, such as slowing down to avoid collision with a vehicle in front, and complex maneuvers, such as lane changes and overtaking. The presented decision-making framework is tested and evaluated—both on a closed high-speed test track in simulated traffic with various driving scenarios and on public highways in real traffic through in-vehicle testing—to verify that it can provide sufficiently reliable performance for automated driving in highway environments in terms of safety, reliability, and robustness.

Radar Image-Based Positioning for USV Under GPS Denial Environment

H. Ma, E. Smart, A. Ahmed, and D. Brown

To overcome this positioning challenge for a USV under GPS denial environment, a real-time positioning algorithm based on radar and satellite images to determine the USV position was proposed. The algorithm takes coastline as a registration feature to implement an image registration between a horizontal viewing angle image from a radar and a vertical viewing angle image from a satellite. Contributions consist of two parts. First, a coastline feature extraction method based on edge gray features for both radar and satellite images is provided. Second, a high-efficiency image registration method that takes the dimensionality reduction distance as an indicator was proposed for the USV-embedded system.

Negotiated Decentralized Aircraft Conflict Resolution

A. R. Pritchett and A. Genton

This paper describes a sequential bargaining process that provides negotiated, decentralized aircraft conflict resolution allowing each aircraft to propose its own trajectories and assess their cost using its own private information. At each stage, an aircraft broadcasts to each other the proposed trajectories and then identifies the response trajectories they would need to fly to avoid a conflict with the other's proposed trajectories. Convergence of the process and methods for describing constraints on the trajectories is examined in computational experiments. Finally, the process is demonstrated in a large-scale simulation, spanning an en route air traffic control center's operations for 5 h.

Pedestrian-Aware Engine Management Strategies for Plug-In Hybrid Electric Vehicles

Y. Gu, M. Liu, J. Naoum-Sawaya, E. Crisostomi, G. Russo, and R. Shorten

In this paper, the authors present engine management strategies for plug-in hybrid electric vehicles aimed at minimizing environmental impacts of pedestrians outside of the vehicles. To do this, the authors propose a framework that manages the way in which a PHEV discharges its limited battery with response to the population density across various routes that may be traveled by a vehicle during a particular journey. The authors take the view that when a vehicle is in polluting mode (hybrid), the probability that it is causing harmful damage is proportional to the population density in that given location. Thus, the authors' strategy is to manage the switching of the engine to recommend vehicles to drive in electric mode in high-density areas. The authors implement the proposed approach in a real PHEV and evaluate the performance in a hardware-in-the-loop platform. A variety of simulation results are given to illustrate the efficacy of the authors' approach.

Fuel-Efficient En Route Formation of Truck Platoons

S. van de Hoef, K. H. Johansson, and D. V. Dimarogonas

The authors consider the problem of coordinating a large fleet of trucks with given itinerary to enable fuel-efficient platooning. The developed algorithm adapts the vehicles' speed profiles in a way that the overall fuel savings from platooning are maximized. The authors demonstrate that the method can compute plans for thousands of trucks and that significant fuel savings can be achieved.

Feedforward Strategies for Cooperative Adaptive Cruise Control in Heterogeneous Vehicle Strings

A. M. H. Al-Jhayyish and K. W. Schmidt

String stability is an essential property to ensure that fluctuations are attenuated along vehicle strings. This paper focuses on the fulfillment of string stability in the practical case of heterogeneous vehicle strings that comprise vehicles with different dynamic properties. Using predecessor following as the information flow topology, acceleration feedforward, predicted acceleration feedforward, and input signal feedforward are considered as different possible feedforward strategies. For all strategies, the parameter ranges of predecessor vehicles that ensure string stability of a given vehicle are characterized, computed, and validated by simulation.

In-Road Microwave Sensor for Electronic Vehicle Identification and Tracking: Link Budget Analysis and Antenna Prototype

Y. Wang, K. S. Bialkowski, A. J. Pretorius, A. G. W. du Plooy, and A. M. Abbosh

To reduce the cost and increase the reliability of vehicle radio-frequency identification and tracking systems, an alternative placement of the interrogator is investigated. Conventional systems make use of an overhead interrogator that reads a tag in a windscreen or a license plate. The alternative approach is to embed the interrogator in the road and exclusively read license plate tags. In this paper, the link-budget of such a system operating at the UHF band is fully characterized. The results indicate that a microwave sensor that has an elevated toroidal radiation pattern is desired. This is a challenging task as road regulations dictate that the sensor cannot exceed a profile of 2.5 cm above the road surface. As an example of a sensor that meets those requirements, a modified discone antenna with an improved impedance matching method is presented. To reduce the antenna's profile and give the required mechanical strength to withstand the weight of different vehicles on the road, the area between the disc and the cone is filled with Acetal, which has a high dielectric constant. The proposed microwave sensor is fabricated and successfully tested in a real road environment. The results confirm that the sensor meets the aforementioned strict requirements.

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