Scanning the Issue

Autonomous Vehicles That Interact With Pedestrians: A Survey of Theory and Practice

A. Rasouli and J. K. Tsotsos

An analysis of more than five decades of research on pedestrian behavior understanding followed by a review of autonomous driving technologies designed for interaction with pedestrians is presented. The meta-analysis of past literature identifies more than 30 factors, ranging from social to environmental conditions, which can potentially influence the way pedestrians behave. Based on these findings and the current state-of-the-art solutions for interaction between autonomous vehicles (AVs) and pedestrians, a road map for future research is proposed regarding what methods and modalities of communication should be used by AVs, what information should be considered by algorithmic solutions for accurate prediction of pedestrians' intentions, and what behavioral studies are required to better understand pedestrians' actions in various situations.

Global and Local Pareto Optimality in Coevolution for Solving Carpool Service Problem With Time Windows

S.-C. Huang, J.-J. Lin, and M.-K. Jiau

A coevolutionary algorithm for two solution sets, population and archive, using objective-wise local search and set-based simulated binary operation in order to address the multiobjective carpool service problem with time windows. In the evolution module of the proposed algorithm, three different methods, namely, objective-wise local search in an archive, set-based simulated binary operation in a population, and set-based simulated binary operation both in a population and in an archive, were used to generate the offspring. The results of the quantitative comparison and objective visualization showed that the proposed algorithm can obtain superior Pareto-optimal solutions regarding convergence and diversity compared with a fast nondominated sorting genetic algorithm.

Defect Detection of Pantograph Slide Based on Deep Learning and Image Processing Technology

X. Wei, S. Jiang, Y. Li, C. Li, L. Jia, and Y. Li

The pantograph is one of the most important components in electrical railway vehicles. Periodical inspection and maintenance of the pantograph slide plate are significant in terms of safe and stable operation. In this article, an innovative and intelligent method based on deep learning and image processing technologies is proposed for online condition monitoring of the pantograph slide plate. In the first part, the surface defect detection and recognition method of the pantograph slide plate is proposed. Four typical surface defects of the slide are considered and a deep learning model, PDDNet is trained for defect detection and recognition. In the second part, the wear edge estimation based on image processing technology is investigated in detail. Furthermore, they are used to calculate the wear depth and evaluate the wear condition of the pantograph slide. The wear depth estimation results are compared with on-site measurement data.

A 3D CNN-LSTM-Based Image-to-Image Foreground Segmentation

T. Akilan, Q. J. Wu, A. Safaei, J. Huo, and Y. Yang

This work excogitates a DCNN model for video foreground/background segmentation. Initially, a Conv-LSTM2D image to image encoder-decoder (EnDec) model is designed. Then, using it as a baseline, a 3D CNN-LSTM EnDec network is implemented. The new architecture is optimized for trainable parameters but more in-depth than the baseline as it contains micro-autoencoders and slow decoding blocks with frequent residual feature forwarding. It captures short- and long-term spatiotemporal cues through 3D convolutions and LSTM units from a set of t frames before predicting the segmentation of the current frame. The model is a new addition to the state-of-the-art FG-BG segmentation algorithms as it produces very competitive performances on diverse conditions, like lighting variations, cast shadow, dynamic backgrounds, and nighttime in indoor and outdoor environments. The results show that the model superiorly performs when compared with traditional and modern NN-based methods. However, it lacks the capability of handling moving camera scenarios.

Deep Irregular Convolutional Residual LSTM for Urban Traffic Passenger Flows Prediction

B. Du, H. Peng, S. Wang, M. Z. A. Bhuiyan, L. Wang, Q. Gong, L. Liu, and J. Li

Urban traffic passenger flows prediction is practically important to facilitate many real applications including transportation management and public safety. In this article, the authors propose a deep irregular convolutional residual LSTM network model called DST-ICRL for urban traffic passenger flow prediction. They first modelled the passenger flows among different traffic lines in a transportation network into multichannel matrices analogous to the RGB pixel matrices of an image. Then, they propose a deep learning framework that integrates irregular convolutional residential network and LSTM units to learn the spatial-temporal feature representations. Third, they fuse other external factors further to facilitate a real-time prediction. They conduct extensive experiments on different types of traffic passenger flow data sets including subway, taxi, and bus flows in Beijing as well as bike flows in New York City. The results show that the proposed DST-ICRL

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significantly outperforms both traditional and deep learning-based urban traffic passenger flow prediction methods.

Hybridizing Basic Variable Neighborhood Search With Particle Swarm Optimization for Solving Sustainable Ship Routing and Bunker Management Problem

A. De, J. Wang, and M. K. Tiwari

This article studies a novel sustainable ship routing problem considering a time window concept and bunker fuel management. Ship routing involves decisions corresponding to the deployment of vessels to multiple ports and time window concept helps to maintain the service level of the port. Reducing carbon emissions within the maritime transportation domain remains one of the most significant challenges as it addresses the sustainability aspect. Bunker fuel management deals with the fuel bunkering issues faced by different ships such as a selection of bunkering ports and total bunkered amount at a port. A novel mathematical model is developed capturing the intricacies of the problem. A hybrid particle swarm optimization with a basic variable neighborhood search algorithm is proposed to solve the model and compared with the exact solutions obtained using Cplex and other popular algorithms for several problem instances.

A Probability Occupancy Grid Based Approach for Real-Time LiDAR Ground Segmentation

Z. Luo, M. V. Mohrenschildt, and S. Habibi

Ground segmentation plays an important role in the sequence of data processing for autonomous vehicle application, as it can help to reduce the size of data to be processed and further decrease the overall computational time. This article presents a probability occupancy grid-based approach for real-time ground segmentation by using a single LiDAR sensor. The effectiveness and robustness of the proposed method in this article are evaluated and demonstrated by the real-time experiments which are spanning different traffic scenarios from heavy traffic to light traffic.

Modeling Curbside Parking as a Network of Finite Capacity Queues

C. P. Dowling, L. J. Ratliff, and B. Zhang

A network of finite capacity queues is derived and used to study the mean congestion effects of drivers searching for curbside parking with respect to surface topology and parking supply. Utilizing multiple sources of existing data, a case study of Seattle is presented with an eye toward costs to social welfare incurred by cruising. Results confirm long-standing estimates of the proportion of traffic actively searching for parking but with higher spatial and temporal resolution and without assuming the probabilistic independence of curbside parking availability. Furthermore, model assumptions are analyzed and results are placed in the context of recent related works.

Optimizing Mixed Pedestrian-Vehicle Evacuation via Adaptive Network Reconfiguration

Q. Li, S. Zhong, Z. Fang, L. Liu, W. Tu, and B. Chen

Insufficient network capacity and conflicts between pedestrians and vehicles at roadway intersections can be critical obstacles to the operational efficiency of evacuation activities. This article integrates two types of network reconfiguration strategies, namely, the use of contraflow lane reversal for road lanes and pedestrian walkways and time-dependent conflict point elimination by separating pedestrian and vehicle flows with physical barriers at road intersections, to strategize pedestrian and vehicle moving directions during a mass evacuation. A multiobjective optimization model is formulated to adaptively select the appropriate locations for barriers according to different evacuation phases. An experiment in the case of a toxic gas leak accident was carried out. The efficiency of the proposed approach is demonstrated by comparison with the uncontrolled plan.

Multipoint Relaying Versus Chain-Branch-Leaf Clustering Performance in Optimized Link State Routing-Based Vehicular Ad Hoc Networks

L. Rivoirard, M. Wahl, and P. Sondi

The multipoint relaying (MPR) technique has demonstrated its efficiency as a clustering scheme for the Optimized Link State Routing (OLSR) protocol. However, originally designed for open areas, MPR does not exploit the particular configuration of road sections which are intrinsically spatially constrained. In this article, MPR is compared with Chain-Branch-Leaf (CBL), a clustering scheme designed in order to enhance the flooding of broadcast traffic in vehicular networks. The simulation results over several road configurations and traffic scenarios show that CBL actually reduces the number of nodes acting as relays, thus decreasing the routing traffic related to flooding and retransmission of topology control (TC) messages. With CBL, the nodes chosen as relays remain longer in this role, thus favoring the overall network stability, and most of the nodes remain attached longer to the same relay than with the MPR technique.

Safe Route Determination for First Responders in the Presence of Moving Obstacles

Z. Wang and S. Zlatanova

This article addresses the issue of determining safe and fast routes for first responders in passing through moving obstacles (e.g., toxic plumes, fires, and floods). A set of algorithms is proposed to deal with not only geometries but also the properties of moving obstacles to support route generation. Based on the Dijkstra algorithm, a new routing algorithm is designed and developed, aiming at minimizing the risk whilst constraining the travel time of routes. The developed algorithms have been tested with a set of navigation cases. The experimental results show promising algorithms in the generation of feasible and safe routes for first responders in the presence of moving obstacles.

Adaptive Neuro-Fuzzy Predictor-Based Control for Cooperative Adaptive Cruise Control System

Y.-C. Lin and H. L. T. Nguyen

The problem of the cooperative adaptive cruise control (CACC) system is addressed in this article. An adaptive neuro-fuzzy predictor-based control approach with integrated automotive radar and vehicle-to-vehicle (V2V) communication is designed to assist the vehicle of the platoon in maintaining a safe distance to improve traffic flow and enhances its fuel efficiency. By exploiting the application of the T-S fuzzy model and fuzzy neural networks (FNNs), an estimated model of the preceding vehicle is generated to predict the future state of the preceding vehicle so that the following vehicle control law is obtained based on an approximated cost function. Experimental results show that the proposed control strategy for the CACC system can significantly reduce fuel consumption while ensuring driving comfort and safety.

Multi-Vehicle Automated Driving as a Generalized Mixed-Integer Potential Game

F. Fabiani and S. Grammatico

This article considers the multivehicle automated driving coordination problem. A distributed, hybrid decision-making framework for safe and efficient autonomous driving of selfish vehicles on multilane highways is developed. Here, each dynamic is modeled as a mixed-logical-dynamical system. The coordination problem is then formalized as a generalized mixed-integer potential game, seeking an equilibrium solution that generates almost individually-optimal mixed-integer decisions, given the safety constraints. Finally, the proposed best response-based algorithms are embedded within distributed open- and closed-loop control policies.

The Outlier and Integrity Detection of Rail Profile Based on Profile Registration

Y. Li, X. Zhong, Z. Ma, and H. Liu

In the influence of the outlier and profile diversity, the actual rail measured profile becomes complex and cannot be matched with the standard one through the traditional rail waist double circle segment method (DCS). To solve the problem, a hybrid profile registration method is developed in this article. Compared with state-of-the-art methods, the proposed method makes full use of the comparative advantage between the measured profile and the standard one to detect the outlier and profile integrity, rather than the measured one itself. Thus, the detection effect is more precise and robust. Furthermore, the system can run at a speed of 21.95 km/h under their experimental setup, which is far higher than that of the rail maintenance train (up to 5 km/h).

Multi-Agent Deep Reinforcement Learning for Large-Scale Traffic Signal Control

T. Chu, J. Wang, L. Codecà, and Z. Li

A decentralized advantage actor critic algorithm is proposed for scalable traffic signal control, with its training procedure stabilized by a novel spatial discount factor and shared neighborhood policy. The algorithm is compared against state-of-the-art decentralized deep reinforcement learning algorithms in a 5 x 5 synthetic traffic grid and a 30-intersection Monaco city traffic network, with simulated peak-hour traffic dynamics.

Physical Features and Deep Learning-based Appearance Features for Vehicle Classification from Rear View Videos

R. Theagarajan, N. S. Thakoor, and B. Bhanu

Classification of vehicles from the rear view is challenging because vehicles have very subtle appearance differences and there are changing environmental conditions making it even more difficult. This article presents a novel multiclass vehicle classification system that uses the physical and visual features of the vehicle. For a given geometric setup of the camera on highways, physical measurements of the vehicle are estimated which include the Visual Rear Ground Clearance, height of the vehicle and the distance between the license plate and the rear bumper. These distances are called the physical features. The visual features are extracted by training convolutional neural networks. Experimental results empirically demonstrate the pros and cons of the physical and visual features sets and show how these feature sets complement each other in classifying vehicles from the rear view.

Subway Passenger Flow Prediction for Special Events Using Smart Card Data

E. Chen, Z. Ye, C. Wang, and M. Xu

Considering the dynamic uncertainty and volatility of subway travel demands during special events, this article proposes a generic framework to predict short-term passenger flow at the station level. It is shown that the volatility of passenger flow has significant nonlinear and asymmetric features during special events. Based on the measures of effectiveness, the proposed approach can effectively capture the mean and volatility of passenger flow, and outperform the previous methods in terms of accuracy and reliability. The article can help transit agencies better understand the deterministic and stochastic changes of the passenger flow, and implement precautionary countermeasures for large crowds in a subway station before and after special events.

Cooperative Position Prediction: Beyond Vehicle-to-Vehicle Relative Positioning

K. Ansari

The issue of cooperative vehicle-to-vehicle position prediction is investigated considering DSRC-enabled vehicles may not necessarily know the latest positioning data of their neighboring vehicles. The article, at first, studies the benefits of a terrestrial communications system complementing DSRC-based V2V real-time relative positioning and then considers position prediction techniques suitable for V2V real-time relative positioning and examines a few existing solutions and makes a detailed comparison based on a set of required positioning performance parameters for vehicle safety application.

Multi-Target State Estimation Using Interactive Kalman Filter for Multi-Vehicle Tracking

M. Baradaran Khalkhali, A. Vahedian, and H. S. Yazdi

Vehicle tracking is an attractive application in the field of object tracking and public transportation. In this article, a variant of Kalman filter called "Interactive Kalman filter" (IKF) is proposed that models interactions between adjacent vehicles. A network of IKF nodes is constructed in which each node is associated with every other target. Interactions between nodes are represented by time-variant weights. Experiments show impressive improvement in estimation accuracy as well as in RMSE, MOTP, MOTA, and MSE metrics.

An Innovative Multi-Sensor Fusion Algorithm to Enhance Positioning Accuracy of an Instrumented Bicycle

S. Miah, E. Milonidis, I. Kaparias, and N. Karcanias

Cycling is an increasingly popular mode of travel in cities, but its poor safety record currently acts as a hurdle to its wider adoption as a real alternative to the private car. A particular source of hazard appears to originate from the interaction of cyclists with motorized traffic at low speeds in urban areas. However, while technological advances in recent years have resulted in numerous attempts at systems for preventing cyclist-vehicle collisions, these have generally encountered the challenge of accurate cyclist localization. This article addresses this challenge by introducing an innovative bicycle localization algorithm. The capabilities of the algorithm are demonstrated through a real-world field experiment using an instrumented bicycle in an urban environment. The results show that the proposed algorithm achieves considerably lower positioning errors, which makes the algorithm a credible basis for the development of future collision warning and avoidance systems.

Reliable Emergency Message Dissemination Scheme for Urban Vehicular Networks

W. Benrhaiem, A. Hafid, and P. K. Sahu

A novel reliable emergency message dissemination scheme is proposed to achieve a predefined reliability while satisfying delay requirements for DSRC/802.11p-based vehicular safety applications in various channel conditions. The article aims to guarantee very high reliability (e.g., 99%) in each hop, with low control overhead while keeping low end-to-end latency for time critical applications. To combat hidden terminal problem, the authors employ zero-correlated unipolar orthogonal codes (UPOC). The article exploits periodic beacons to accurately estimate reception quality of 802.11p wireless link in each cell; then, it uses this information to determine optimal number of broadcast repetitions in each hop. In addition, the article utilizes cooperative communication to ensure reliability in multihop.

A Multiobjective Optimization Approach for COLREGs-Compliant Path Planning of Autonomous Surface Vehicles Verified on Networked Bridge Simulators

L. Hu, W. Naeem, E. Rajabally, G. Watson, T. Mills, Z. Bhuiyan, C. Raeburn, I. Salter, and C. Pekcan

This article presents a multiobjective optimization approach for path planning of autonomous surface vehicles. A unique feature of the technique is the unification of the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs) with good seamanship's practice along with hierarchical (rather than simultaneous) inclusion of objectives. The requirements of collision avoidance are considered in the optimization framework and thus collision-free maneuvers and COLREGs-compliant behaviors are provided in a seafarer-like way. For example, good seamanship reveals that if allowed, an evasive maneuver with course changes is always preferred over one with speed changes in practical maritime navigation. As a result, a hierarchical sorting rule is designed to prioritize the objective of course/speed change preference over other objectives such as path length and path smoothness, and then incorporated into a specific evolutionary algorithm. The effectiveness of the proposed algorithm is demonstrated through both desktop and high-fidelity networked bridge simulations.

Travelers' Compliance With Social Routing Advice: Impacts on Road Network Performance and Equity

M. van Essen, O. Eikenbroek, T. Thomas, and E. van Berkum

Information-based demand measures using social routing direct travelers toward routes that benefit the road network instead of the individual traveler. Hence, some travelers need to take a detour. This study explores impacts on network performance and equity that result from the application of social routing services on a large-scale real-world road network. The authors discuss their findings in light of observed compliance. Their results show how time savings vary with assumed compliance rate, how social travelers need to compensate for the selfish behavior of others, and that impacts highly depend on the spatial distribution of social travelers among origins and destinations.

Fundamental Limits of Missing Traffic Data Estimation in Urban Networks

S. Wang and G. Mao

Fundamental limits of missing traffic data estimation accuracy are investigated with spatial-temporal random effects model. Squared flow error bound (SFEB) is derived for the cases of the Fisher matrix being a singular and non-singular matrix, respectively. The sufficient and necessary condition of the existence of an unbiased estimator is shown. An optimal spatial-temporal Kriging estimator is developed. The numerical results validate the effectiveness of the author's proposed theoretical findings.

A Real Time Simulation Optimization Framework for Vessel Collision Avoidance and the Case of Singapore Strait

G. Pedrielli, Y. Xing, J. H. Peh, K. W. Koh, and S. H. Ng

Safety is a primary concern for sea transport, including human safety at sea and at port, environmental safety and sustainability, and guaranteeing it is incredibly challenging in heavy-traffic regions. The authors exploit the rich information transmitted through the automatic identification system and propose, for the first time, an integrated simulation-optimization approach for real-time collision avoidance. An agent-based model is developed based on behavioral learning in a real-environment, and incorporated into a fast collision avoidance optimization algorithm to provide robust collision avoidance that accounts for future stochastic consequences of the actions taken. To illustrate the feasibility of the approach, they use the case of the Singapore strait, one of the busiest straits in the world.

A Pedestrian Detection System Accelerated by Kernelized Proposals

J. Baek, J. Hyun, and E. Kim

When pedestrian detection (PD) is implemented on a central processing unit (CPU), performing real-time processing using a classical sliding window is difficult. Therefore, an efficient proposal generation method is required. A new generation method, named additive kernel binarized normed gradient (AKBING), is proposed herein, and this method is applied to PD for real-time implementation on a CPU. AKBING is based on an additive kernel–support vector machine (AKSVM) and is implemented using the binarized normed gradient. The proposed PD can operate in real time because all AKSVM computations are approximated via simple atomic operations. In the suggested kernelized proposal method, the popular features and a classifier are combined, and the method is tested on a Caltech Pedestrian data set and KITTI data set. Experimental results show that the detection system with the proposed method improved the speed with minor degradation in detection accuracy.

Geometry-Based Multi-Link Channel Modeling for High-Speed Train Communication Networks

T. Zhou, C. Tao, S. Salous, and L. Liu

The performance of distributed communication systems is commonly subject to the cross correlation characteristics of multilink channels. In this article, the authors concentrate on the modeling of multilink small-scale fading (SSF) channels in high-speed train (HST) communication networks with distributed base stations, according to the classical geometry-based stochastic model (GBSM). To appropriately describe a multilink propagation scenario in the HST communication network, a novel geometrical model considering a line of sight component, a single-bounced one-ring model, and a double-bounced ellipse ring model is proposed. Based on the proposed GBSM, the expression of multilink channel impulse responses (CIRs) is obtained, and multilink cross correlation functions are derived and used for numerical analysis. In addition, realistic channel measurements are conducted in existing HST long-term evolution (LTE) networks and multilink CIRs are acquired using a time delay window-based partitioning scheme. Finally, the SSF cross correlation coefficient is extracted by the multilink channel data and used to validate the utility of the proposed model.

A Novel Approach for Big Data Classification and Transportation in Rail Networks

M. Saki, M. Abolhasan, and J. Lipman

This article introduces a new framework into future data-driven railway condition monitoring systems (RCM). For this purpose, the authors have proposed an edge-processing unit that includes two main parts: a data classification model that classifies IoT data into maintenance-critical data (MCD) and maintenance-non-critical data (MNCD); a data transmission unit that based on the class of data, employs appropriate communication methods to transmit data to railway control centers. For the transmission of MNCD, they propose a travel pattern method that employs train stations as points of data offloading so that trains can deliver data as well as passengers at stations. The performance of their proposed solution is successfully validated via three various data sets under different operating conditions.

Improving the RISS/GNSS Land-Vehicles Integrated Navigation System Using Magnetic Azimuth Updates

A. Abosekeen, A. Noureldin, and M. J. Korenberg

Navigation of land or self-driving vehicles is essential for safe and accurate travel. Global Navigation Satellite Systems (GNSS) such as Global Positioning System (GPS) are the prime sources of navigation information for such purpose. However, high-rise buildings in urban canyons block the GPS satellites signals. Alternatively, Inertial Navigation System (INS) is typically working as a backup. A Reduced Inertial Sensor System (RISS) is used instead of the full INS to achieve the same purpose in land vehicles navigation with fewer sensors and computations. Unfortunately, the RISS solution drifts over time, but this can be mitigated when integrated with GPS. However, the integration solution drifts in the case of GPS signal loss (outages). Therefore, the position errors grow especially during extended periods of GPS outages. Azimuth/heading angle is critical to keep the vehicle on the route. In this article, an azimuth update estimated from a calibrated magnetometer is introduced to improve the accuracy of the overall system. A new approach is proposed for pre-processing the magnetometer data utilizing a discrete-cosine-transform (DCT)-based pre-filtering stage. The obtained azimuth is utilized in updating the RISS system during the whole trajectory and mainly during GPS outage periods. The proposed approach significantly decreases both the azimuth error and the position error growth rate when driving in urban canyons where GPS signals are blocked. Finally, the proposed system was tested on a real road trajectory data for a metropolitan area. The results demonstrate that the accuracy of the whole system improved, especially during the GPS outage periods.

Real-Time Sensor Anomaly Detection and Identification in Automated Vehicles

F. van Wyk, Y. Wang, A. Khojandi, and N. Masoud

Anomalous sensor readings caused by either malicious cyber-attacks or faulty vehicle sensors can result in disruptive consequences for connected and automated vehicles (CAVs). This article presents a real-time anomaly detection approach by combining a deep learning method, namely convolutional neural network (CNN), with a well-established anomaly detection method, Kalman filtering with a chi-square detector, to detect and identify anomalous sensor readings in CAVs. The numerical experiments demonstrate that the developed approach can detect anomalies and identify their sources with high performance. In addition, the approach outperforms the anomaly detection and identification capabilities of both CNN and Kalman filtering with a chi-square detector method alone.

Benchmark Revision for HOG-SVM Pedestrian Detector Through Reinvigorated Training and Evaluation Methodologies

M. Bilal and M. S. Hanif

HOG-Linear SVM detector is still widely reported as a de facto standard benchmark to evaluate state-of-the-art pedestrian detectors. The results of this study, however, show that the true working potential of this detector has been hitherto grossly underestimated. An improved SVM training methodology has been proposed that makes this important detector yield up to 14% lower miss rates than being currently reported on standard data sets, e.g., INRIA, ETH, and Caltech. The proposed method accomplishes this by considering a small set of the most relevant training examples and mitigating the class imbalance problem. Second, kernel SVM classification has also been implemented through a fast lookup table (LUT) and a nonlinear quantization scheme. This leads to 4% further reduction in miss rates without incurring additional computational cost. The retrained models have been publicly released and provide a much better replacement for those currently being shipped with OpenCV and MATLAB computer vision libraries.

Accurate Classification for Automatic Vehicle-Type Recognition Based on Ensemble Classifiers

N. Shvai, A. Hasnat, A. Meicler, and A. Nakib

In this article, the optimal control of connected automated vehicles at roadway intersections is introduced. This optimization problem is solved considering dynamical constraints (i.e., ordinary differential equations governing the motion of a vehicle) and static constraints (i.e., maximum achievable velocities). By virtue of Pontryagin's minimum principle, the solution that minimizes the trip time is obtained. Given the problem parameters, the solution to the formulated problem is expected to be the true optimum and delivers the lowest possible delay that satisfies the previously mentioned constraints. This logic is simulated and compared to the operation of a roundabout, a stop sign and a traffic signal controlled intersection. The results demonstrate that an 80% reduction in delay is achievable compared to the best of these three intersection control strategies, on average. An interesting byproduct of this new logic is a reduction in vehicular fuel consumption and CO2 emissions by 42.5% and 40%, respectively.

A Survey of Intrusion Detection for In-Vehicle Networks

W. Wu, R. Li, G. Xie, J. An, Y. Bai, J. Zhou, and K. Li

This article conducts a survey of intrusion detection methods for in-vehicle networks (IVNs), highlighting the constraints and characteristics of intrusion detection methods for in-vehicle networks and its corresponding drawbacks. In this article, the different vehicle attacks are divided into different layers according to the source of the attack. An IVN environment is introduced, and the constraints and characteristics of an intrusion detection system (IDS) design for IVNs are presented. Various optimization objectives are considered and comprehensively compared. Finally, the trend, open issues, and emerging research directions are described.

Bus Arrival Time Prediction: A Spatial Kalman Filter Approach

A. Achar, D. Bharathi, B. A. Kumar, and L. Vanajakshi

This study proposes a new methodology for bus arrival time prediction in real-time by explicitly learning the spatial (and temporal) correlations/patterns of traffic in a novel fashion. It first detects the unknown order of spatial dependence and then learns the nonstationary spatial correlations for this detected order. It learns temporal correlations between successive trips as a function of their time difference. To make optimal prediction feasible, the learned predictive model is rewritten in a suitable linear state-space form and then an appropriate Kalman Filter (KF) is applied. The performance was evaluated with real field data and compared with existing methods.

Learning Probabilistic Awareness Models for Detecting Abnormalities in Vehicle Motions

D. Campo, M. Baydoun, P. Marin, D. Martin, L. Marcenaro, A. de la Escalera, and C. Regazzoni

A novel method for improving the self-awareness in intelligent systems is proposed. The employed method is based on a decomposition of Gaussian processes that describe trajectory data from a vehicle. Meaningful semantic regions are obtained and employed for prediction and abnormality detection purposes.

Discrete-Event Systems Modeling and the Model Predictive Allocation Algorithm for Integrated Berth and Quay Crane Allocation

R. T. Cahyono, E. J. Flonk, and B. Jayawardhana

The authors study the problem of integrated berth and quay crane allocation (I-BCAP) in general seaport container terminals. They propose a dynamical modeling framework based on discrete-event systems (DES) that describes the operation of complex berthing process. They also propose a model predictive allocation (MPA) algorithm and preconditioning for solving I-BCAP with a rolling event horizon. The validation and performance evaluation of the method is done using extensive Monte-Carlo simulations, real data sets and real life field experiments at a container terminal. The numerical simulation results show that their proposed algorithm can improve the efficiency of the terminal. The real life field experiment shows an improvement in comparison to the existing allocation method used in the terminal.

An Improved Bayesian Combination Model for Short-Term Traffic Prediction With Deep Learning

Y. Gu, W. Lu, X. Xu, L. Qin, Z. Shao, and H. Zhang

Considering error magnification phenomena in traditional combination methods, this article proposes an improved Bayesian combination model with deep learning (IBCM-DL) for short-term traffic flow prediction. The IBCM-DL model fuses gated recurrent unit neural network (GRUNN), autoregressive integrated moving average (ARIMA), and radial basis function neural network (RBFNN) to take advantage of each method. The real-world traffic volume data captured by microwave sensors located on the expressways of Beijing was used to validate the proposed model in multiple scenarios. The overall results illustrate that the IBCM-DL model shows superior prediction performance in terms of accuracy and stability.

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