Scanning the Issue

A Survey on Electric Buses—Energy Storage, Power Management, and Charging Scheduling

R. Deng, Y. Liu, W. Chen, and H. Liang

In recent years, aiming to reduce the metropolitan air pollution caused by fossil fuel-powered vehicles, the electrification of transportation, such as electric vehicles (EVs) and electric buses (EBs), has attracted great attention from the automobile industry, academia, and public transportation. EBs, driven by decarbonized electricity, can reduce the air pollution and noise level. Besides, they can also recover electricity from regenerative braking. This survey first introduces the important components of EBs, including energy storage systems, powertrains, interleaving elements and electric motors, and driving cycles. Then, it reviews the existing research topics of EBs, including the energy storage system sizing, power/energy management, range remedy methods, charging design/scheduling, and trial projects. Finally, extending from existing studies, it further proposes the future research opportunities and ongoing challenges, such as extending EV related research to EBs, EB charging demand modeling, and EB impact on power systems.

Overcoming Occlusion in the Automotive Environment—A Review

S. Gilroy, E. Jones, and M. Glavin

This research focuses on one of the most challenging outstanding issues in object detection and recognition: partial occlusion, where a sensor has only a partial view of the target object due to a foreground object that partially obscures the target. This article discusses the process of object detection in the human visual system, provides an overview of occlusion reasoning in computer vision, presents a summary of occlusion handling strategies in pedestrian, vehicle and object detection applications in the automotive environment, and discusses the remaining challenges to achieving the required level of object detection performance for safe autonomous driving.

A Novel Texture-Less Object Oriented Visual SLAM System

Y. Dong, S. Wang, J. Yue, C. Chen, S. He, H. Wang, and B. He

Traditional mapping modules in visual simultaneous localization and mapping systems can only estimate 3D information of isolated sparse or semi-dense feature points. However, utilizing high-dimensional features, such as object instances or structural lines in mapping and localization, can help the system understand its surroundings better. This article presents a novel visual SLAM method that can effectively utilize texture-less object instances for mapping and localization, which includes newly designed feature extraction, matching, localization and mapping modules, and can jointly use object features and point features to estimate camera 6-DOF poses and do richer map construction. The advantages of proposed visual SLAM method are demonstrated through experiments in this article conducted both on synthetic datasets and real-world datasets.

ReFOCUS+: Multi-Layers Real-Time Intelligent Route Guidance System With Congestion Detection and Avoidance

M. Rezaei, H. Noori, M. M. Razlighi, and M. Nickray

This article proposes a new dynamic multilayer and fog-cloud-based advance route guidance system architecture in order to detect and ease the road congestion. The architecture employs road sides units (RSUs) to calculate different traffic-related factors such as current and predicted road congestions, area congestions, traveling time, etc. Then, using a novel developed method, it detects congested roads and using a multimetric fitness function, applies re-routing to vehicles to ease the traffic congestion in the area, and avoids the traffic congestion in the other areas with smart and distributed re-routing system. A large-scale realistic simulation has been performed and the results demonstrate that the proposed system is able to dramatically improve traveling time, fuel consumption, and emissions.

A Control-Theoretic Approach for Scalable and Robust Traffic Density Estimation Using Convex Optimization

S. A. Nugroho, A. F. Taha, and C. G. Claudel

This article proposes a simple method for real-time monitoring of traffic networks via a robust observer design tailored for the estimation of traffic density on highways. To perform an accurate state estimation of unmeasured traffic, a generalized traffic model that considers arbitrary number of on- and off-ramps is constructed based on the Lighthill–Witham–Richards (LWR) model. In this model, Greenshield's fundamental diagram is used to represent the relation between traffic speed, density, and flow. The resulting model is then expressed as a nonlinear dynamic system. The authors show that the nonlinearities belong to Lipschitz's function set. Based on the Lipschitz property of traffic dynamics, a scalable robust observer design is developed using the notion of L-Infinity stability. The numerical simulations showcase the effectiveness of the author's approach in estimating traffic density with a limited number of traffic sensors. The presented method also outperforms other mainstream estimation methods from the literature in the quality of state estimation as well as the computational efficiency.

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Timetable Optimization for Metro Lines Connecting to Intercity Railway Stations to Minimize Passenger Waiting Time

Y. Bai, Q. Hu, T. K. Ho, H. Guo, and B. Mao

A metro train timetable model is developed to optimize service headways at all stations of a metro line connecting to intercity railways. The objective is to minimize the total waiting time of passengers at platforms throughout the metro line, without changing the number of vehicle trips. To calculate the passenger waiting time accurately, a mathematical model is proposed to obtain the number of transfer passengers arriving at metro platform in each small-time interval, based on arrivals of intercity trains and transfer facilities at the station. A genetic algorithm, combined with interior-point algorithm, is developed to obtain the solution of the proposed timetable model. Case studies verify the performance of the optimized timetable in reducing the total passenger waiting time and the peak number of passengers congregating at metro platforms.

Cycle-Based Queue Length Estimation for Signalized Intersections Using Sparse Vehicle Trajectory Data

C. Tan, J. Yao, K. Tang, and J. Sun

In this article, a novel stochastic approach is proposed for cycle-based queue length estimation to address the challenge of low and unstable accuracy of queue length estimation with sparse probe vehicle trajectory data. By efficiently exploiting real-time and historical probe vehicle trajectory data, the queue length estimation problem is formulated as a parameter estimation problem in the proposed approach. Therefore, both the maximum queue length and back of queue with the maximum likelihood can be estimated. The proposed approach is verified by using both simulation and empirical data. Results indicate that the proposed approach can realize satisfactory estimations even with sparse vehicle trajectory data, where the penetration rate is usually no more than 5%.

Memory-Based Deep Reinforcement Learning for Obstacle Avoidance in UAV With Limited Environment Knowledge

A. Singla, S. Padakandla, and S. Bhatnagar

A deep reinforcement learning method for UAV obstacle avoidance is proposed, which enables a UAV quadrotor, equipped with a monocular camera, to autonomously avoid collisions with obstacles in unstructured and unknown indoor environments. This obstacle avoidance method relies on the crucial idea of partial observability. Using the author's method, UAVs can retain relevant information about the environment structure to make better future navigation decisions. Their obstacle avoidance technique uses recurrent neural networks with temporal attention and provides better results compared with prior works in terms of distance covered without collisions. Additionally, their technique has a high inference rate and reduces power wastage by minimizing oscillatory motion of UAV.

A Computational Approach to Quantify the Benefits of Ridesharing for Policy Makers and Travellers

F. Bistaffa, C. Blum, J. Cerquides, A. Farinelli, and J. A. Rodríguez-Aguilar

With the growing popularity of the shared economy, ridesharing services are called to transform urban mobility. Shared mobility is expected to have major environmental and economic impacts by reducing pollution, traffic congestion, and energy consumption. The authors propose a novel algorithm that makes large-scale, real-time ridesharing technologically feasible, and they quantify the impact of different ridesharing policies in terms of environmental benefits (reduction of CO2 emissions, noise pollution, and traffic congestion) and quality of service for the users. Their analysis on a real-world dataset (provided by the New York City Taxi Commission) shows that their approach yields a reduction of up to 107.18 Tons of CO2 emissions per day. Their approach provides the means to estimate the expected societal benefits of ridesharing from existing traveling data records. Policy makers can leverage on their approach in order to design action plans aimed at achieving target societal impacts within some time frame

A Direction-Constrained Space-Time Prism-Based Approach for Quantifying Possible Multi-Ship Collision Risks

H. Yu, Z. Fang, A. T. Murray, and G. Peng

Maritime collision risk prediction is crucial for the safety management of ocean transportation. Previous studies have primarily focused on near-miss collision risk of ship pairs, yet the risk due to congestion caused by multiple ships is significant. A novel space-time geographical approach named as the direction-constrained space-time prism has been proposed for addressing multiship near-miss collision risk based on vessel motion behavior. The advantage in analyzing ship movements is that it accounts for direction limitation thereby eliminating unreasonable estimation associated with the assumption of arbitrary changes in sailing direction through the classical space-time prism. In comparison to the fuzzy quaternion ship domain model and closest point of approach-based methods, the proposed approach is capable of identifying hierarchical near-miss collision risks for different ships to improve risk evaluation. This article supports maritime collision risk forecasting and ship path optimization, but also provides detailed insights for actionable steps to reduce risks.

Risk Assessment of an Electrical Power System Considering the Influence of Traffic Congestion on a Hypothetical Scenario of Electrified Transportation System in New York State

H. Wang, Y.-P. Fang, and E. Zio

The authors proposed an integrated risk assessment framework for coupled transportation-power systems considering real-time traffic conditions. The results show that certain characteristics of traffic congestion would lead to relatively higher impacts on the power system in the studies case. This article could bring forward their understanding of how to optimize and update the existing power and transport infrastructures facing the challenge of increasing electric vehicles.

Fast Depth Prediction and Obstacle Avoidance on a Monocular Drone Using Probabilistic Convolutional Neural Network

X. Yang, J. Chen, Y. Dang, H. Luo, Y. Tang, C. Liao, P. Chen, and K.-T. Cheng

This article presents a real-time onboard approach for monocular depth prediction and obstacle avoidance with a lightweight probabilistic CNN (pCNN), which will be ideal for use in a lightweight energy-efficient drone. The key of their pCNN is to concurrently predict both depth map and the corresponding confidence. The accuracy of their lightweight pCNN is greatly boosted by integrating sparse depth estimation from a visual odometry into the network for guiding dense depth and confidence inference. The extensive experimental results on public datasets demonstrate superior performance to the state-of-the-art methods in terms of efficiency and accuracy.

Target Vehicle Motion Prediction-Based Motion Planning Framework for Autonomous Driving in Uncontrolled Intersection

Y. Jeong and K. Yi

A motion-planning framework for urban autonomous driving at uncontrolled intersections have been developed, implemented, and evaluated with an autonomous vehicle. In order to decide the driving mode and desired motion, the future motion of the target vehicle is predicted by intelligent driver model-based interacting multiple model filter. The driving mode is realized as a state machine consisting of two phases, approach and risk management. The required deceleration determination for the approach phase is proposed to consider the occluded region to prevent inevitable collisions caused by fast approaches. The model predictive controller for the risk management phase is designed to determine the desired acceleration to guarantee safety and prevent unnecessary deceleration simultaneously. Both computer simulation studies and vehicle tests are conducted to evaluate the proposed framework. The results indicate that the proposed framework ensures the safety at uncontrolled intersections with a driving pattern similar to that of a driver.

Pedestrian-Safety-Aware Traffic Light Control Strategy for Urban Traffic Congestion Alleviation

Y. Zhang, Y. Zhang, and R. Su

Pedestrian flashing GREEN (FG) may fail to clear the crosswalk in the allotted time due to the large number of non-compliant pedestrians, which leads to a common safety issue at signalized intersections. In this article, the authors present a traffic signal control strategy for urban traffic networks with the aim to minimize both vehicle traveling delay and pedestrian crossing risk by adaptively tuning an additional RED phase at the end of each FG period according to the number of non-compliant pedestrians. An evolutionary algorithm with repairing mechanism (EARM) is proposed to solve the problem. Case studies finally illustrate the potential impact of the pedestrian movement to the vehicle traffic networks when pedestrian safety is considered, as well as the efficacy of the proposed traffic light control strategy for pedestrians and vehicles on risk reduction.

Combining Machine Learning and Dynamic Time Wrapping for Vehicle Driving Event Detection Using Smartphones

R. Sun, Q. Cheng, F. Xie, W. Zhang, T. Lin, and W. Y. Ochieng

This article proposes a novel bagging tree and dynamic time warping integrated algorithm for the detection of driving events by employing acceleration and orientation data from a smartphone's low-cost three-axis accelerometers and gyroscopes. The bagging tree-based machine learning algorithm provides the initial maneuver detection results, as well as the location of the event start and end points. Event detection is then achieved by calculating the similarity of the results predicted through the bagging tree algorithm with the corresponding templates extracted from the experience datasets, while also applying a number of constraints to verify the calculated results. The experimental results show that the proposed algorithm delivers an overall correct detection rate of 97.5% based on the designed scenarios.

Real-Time Embedded Vision System for the Watchfulness Analysis of Train Drivers

C. A. Avizzano, P. Tripicchio, E. Ruffaldi, A. Filippeschi, and J. M. Jacinto-Villegas

Railways safety regulations require the drivers acting on a pedal to signal that they are awake and vigilant. In this article, the authors propose an embedded computer-vision system that, using a single camera placed on the cockpit of a train, analyzes the driver's watchfulness by monitoring gaze and eyelid blinking. The proposed system provides a consensus to the control logic of the train. The system copes with the peculiar conditions of a train's cabin, such as variable illumination, the variability of the driver's face image, and the presence of other people in the cabin while accounting for international regulations, which poses limitations on the hardware selection. The system was tested in real operating conditions. The results show that it detects the driver's watchfulness correctly without false positives. As such, it can be used to avoid the driver's action on the pedal thus reducing the biomechanical load.

TrafficGAN: Network-Scale Deep Traffic Prediction With Generative Adversarial Nets

Y. Zhang, S. Wang, B. Chen, J. Cao, and Z. Huang

In this article, the authors propose a network-scale deep traffic prediction model called TrafficGAN, in which convolutional neural nets (CNN) and long-short term memory (LSTM) models are embedded into a generative adversarial nets (GAN) framework by considering the input traffic network data as images. GAN is utilized to predict traffic flow data in an adversarial way to address the blurry prediction issue. TrafficGAN captures the spatial–temporal correlations among the road links through the proposed deformable convolution kernel and captures the temporal correlations through LSTM model.

The performance of TrafficGAN is evaluated by comparison with various baseline models on a large GPS traffic data of the arterial transportation network of downtown Chicago. The results show that TrafficGAN significantly outperforms both traditional statistical models and state-of-the-art deep learning models in traffic congestion prediction.

Development and Testing of a Novel Game Theoretic De-Centralized Traffic Signal Controller

H. M. Abdelghaffar and H. A. Rakha

The research develops and evaluates a Nash bargaining de-centralized flexible phasing cycle-free traffic signal controller (DNB-controller) that models each phase as a player in a game, where players cooperate to reach a mutually agreeable outcome. The DNB-controller was implemented in the INTEGRATION microscopic traffic simulation software and tested on an isolated intersection and an arterial corridor. The performance of the DNB-controller was evaluated by comparing to an optimum fixed-time coordinated plan, an actuated controller, a centralized adaptive phase split controller, a decentralized phase split and cycle length controller, and a fully coordinated adaptive phase split, cycle length, and offset optimization controller. For the isolated intersection, reductions in queue length, delay, and vehicle emissions of 77%, 64%, and 17% were observed. On the arterial network, the DNB-controller produced statistically significant reductions in total delay ranging between 36% and 67% and vehicle emission reductions ranging between 6% and 13%.

Motion Analysis and Performance Improved Method for 3D LiDAR Sensor Data Compression

C. Tu, E. Takeuchi, A. Carballo, C. Miyajima, and K. Takeda

Continuous point cloud data are being used more and more widely in practical applications but due to the huge volume of data involved, sharing, and storing this data are expensive and difficult. Other researchers have proposed converting 3D point cloud data into 2D images, or using tree structures to compress the data. In a previous study, targeting streaming point cloud data, the authors proposed an MPEG-like compression method which simulates LiDAR's operating process. In this article, instead of imitating MPEG, they propose a new strategy for more efficient reference frame distribution and more natural frame prediction, and use a different algorithm to encode the residual, greatly improving the algorithm's performance and its stability in different scenarios. Using their proposed method, streaming point cloud data collected by LiDAR sensors can be compressed to 1/50th of its original size, with only 2 cm of root-mean-square error for each detected point.

Modeling Time-Varying Variability and Reliability of Freeway Travel Time Using Functional Principal Component Analysis

J.-M. Chiou, H.-T. Liou, and W.-H. Chen

This article presents an approach for modeling travel time variability and reliability that accounts for time-of-day effects on travel time variations. The proposed functional travel time density model uses functional principal component analysis in kernel density estimates for modeling and depicting the travel time variability that is varied with the departure time of day. The resulting quantile functions are used to obtain time-varying reliability that considers the addition of extra time to the average or the median. This article uses linked travel time data of an electronic toll collection system to estimate route travel times in the Taiwan Freeway system. The approach effectively captures the time-varying feature of travel time variability and reliability, and the reliability indicators identify the unreliable departure time of day of a route.

Robust Distributed Cruise Control of Multiple High-Speed Trains Based on Disturbance Observer

X. Wang, L. Zhu, H. Wang, T. Tang, and K. Li

This article investigates the robust distributed cruise control problem of multiple high-speed trains under external disturbances. First, by modeling each train as a cascade of point masses connected by spring-like couplers, the longitudinal interaction between adjacent cars is represented by the connected topological graph. Then, under the framework of the communication-based train control technology, the interaction of desirable speed information among trains and the wayside control center is described by the directed topological graph. Next, a distributed cruise controller is designed by taking advantages of the graphic theory such that the multiple trains track different target speeds, and both the distance of neighboring cars and the headway of successive trains are kept in appropriate ranges. Finally, the authors adopt the disturbance observer to approximate the perturbations, and present a sufficient condition for the existence of the distributed control strategy and the observer gain parameter in form of the linear matrix inequality (LMI).

ViFi-MobiScanner: Observe Human Mobility via Vehicular Internet Service

L. Tu, S. Wang, D. Zhang, F. Zhang, and T. He

Exploring human mobility is essential for urban applications. While single-source data usually provide limited observability, this article investigates methods of observing human mobility through multisource data in the public bus system. By fusing data from the onboard WiFi devices and the automatic fare collection (AFC) system, and the bus GPS information, the authors develop a novel system called ViFi-MobiScanner, which is deployed on 4800 mobile routers distributed in a city with 1992 km^2 urban area. With both field tests and collected datasets evaluation, they show that ViFi-MobiScanner increases the observability on the passengers and trips by about 53.9% and 48.1% over the smartcard observations and helps to estimate the passenger' destination that cannot be observed by current smartcard systems. Thus, ViFi-MobiScanner expands the observability of mobility in object, temporal, and spatial dimensions.

Last-Mile School Shuttle Planning With Crowdsensed Student Trajectories

P. Tong, W. Du, M. Li, J. Huang, W. Wang, and Z. Qin

This article presents a more efficient last-mile shuttle bus planning system with consideration of multiple pickup locations of each individual. To achieve system-wise optimal school shuttle routes, a set of techniques—trip profiling from trajectory data, a novel graph-based data structure for embedding travel demands, as well as a graph-based Tabu expansion algorithm—are designed. The extensive experiments with large-scale real-world crowd sensed trajectory data show that the proposed system has a good performance and properly balances between the savings of individual commute time and the total operation cost.

A Novel Processing Methodology for Traffic-Speed Road Surveys Using Point Lasers

W. Li, M. Burrow, N. Metje, Y. Tao, and G. Ghataora

A robust vehicle-mounted point laser system has been proposed for the rapid assessment of a measure of road condition known as fretting. The road fretting is treated as a peak detection problem and together with a filter process for sensor noise and vehicle dynamic removal. The experimental results show that, with the proposed concepts, a point laser system that scans the road surface in the longitudinal direction is comparable to visual inspection which is able to provide data at IQL 3.

Platoon Definitions and Analysis of Correlation Between Number of Platoons and Jamming in Traffic System

P. Kasture and H. Nishimura

Using an agent-based traffic models, the authors analyze the manner in which the number of platoons within a traffic system is correlated with the appearance of traffic jams. Two definitions of a platoon are proposed and verified using agent-based simulations to find the one that provides the most realistic representation of traffic behavior in a stochastic model. They observe that traffic jams are closely related to the convergence of multiple platoons into a single platoon containing all the agents in the model. They also observed that at high-density, traffic system maintains a metastable state when it has multiple platoons in it. A traffic jam occurs when these multiple platoons are merged into a single platoon, which is equivalent to the concept of an infinite cluster in percolation theory.

Quantitative Driver Acceptance Modeling for Merging Car at Highway Junction and Its Application to the Design of Merging Behavior Control

H. Okuda, T. Suzuki, K. Harada, S. Saigo, and S. Inoue

This article models the decision-making characteristics of a driver regarding whether the driver accepts cut-in by merging car at a highway junction and the application of the model for the design of merging speed control is proposed. At first, the driver's state of decision (SOD) which represents the acceptance for merging a car coming from the merging lane is observed in a driving simulator, and the driver's SOD is modeled using a logistic regression model. Second, the speed controller of the merging car is designed to minimize the vagueness of SOD (decision entropy) of the cars on the main lane. The minimization problem of decision entropy is quantitatively formulated using an identified decision-making model and addressed by applying a randomized approach to the optimization. The numerical experiments are performed to demonstrate the usefulness of the proposed design scheme.

Hybrid Trajectory Planning for Autonomous Driving in On-Road Dynamic Scenarios

W. Lim, S. Lee, M. Sunwoo, and K. Jo

A safe trajectory planning for on-road autonomous driving is a challenging problem owing to the variety and complexity of driving environments. Furthermore, dynamically changing movements of surrounding vehicles make the problem more challenging. It requires the planner's ability to react to the changes in the driving environments in real time. To solve this problem, this article proposes a hybrid trajectory planning scheme to integrate the strength of the sampling and optimization methods. With the sampling method for a lateral movement, the planner can deal with various trajectories with multiple maneuvers. This helps the planner to generate a reactive trajectory in a dynamically changing environment. The numerical optimization of a longitudinal movement enables the planner to adapt to diverse situations without the restriction of predefined patterns for specific driving purposes. Its performance was evaluated through simulation and real driving tests in various on-road dynamic scenario.

A High-Integrity and Low-Cost Navigation System for Autonomous Vehicles

S. Bijjahalli and R. Sabatini

A new integrated navigation system architecture is proposed, which utilizes global navigation satellite systems (GNSS), low-cost inertial navigation systems (INS), visual odometry, and vehicle dynamic models (VDM). The system design is based on various navigation modes, each with independent failure mechanisms and fault-detection capabilities. A two-step data fusion approach is adopted to optimize the system accuracy and integrity performance. This includes a knowledge-based module (KBM) which performs a detailed sensor integrity analysis followed by a conventional extended Kalman filter (EKF). CAV navigation integrity requirements (i.e., alert limits and time-to-alert) are considered in the KBM. A simulation case study is executed to verify the performance of each navigation mode in the presence of faults affecting the individual navigation sensors.

An Evaluation Method for Emergency Procedures in Automatic Metro Based on Complexity

K. Niu, W. Fang, Q. Song, B. Guo, Y. Du, and Y. Chen

Considering the problem of automation influence on task complexity during emergency situations, a quantitative and qualitative method of the cognitive work analysis (CWA) combined with network topology analysis is proposed. The network model of emergency procedure is developed by connecting all events in the procedure through cognitive interactive behavior as information clues, and then characteristic analysis is used to obtain the mechanism that led to variation in network complexity. Case studies are performed under the same and different grades of automation. The results show the effectiveness to explain relationship between system design change and operation procedures complexity.

Understanding Preferences of Delhi Metro Users Using Choice-Based Conjoint Analysis

G. Bajaj and P. Singh

Delhi, the capital city of India, has been dealing with the problem of pollution for a long time now. Even though the government introduced metro trains to provide sustainable transportation solutions, these metro trains are still underutilized. In this article, the authors correlate this underutilization with customer needs and expectations in Delhi metro. They begin their work with a brief background of the Delhi metro ecosystem. They then introduce the notion of convenience in public transport and determine the factors that affect user convenience. They pose their research questions to analyze these factors using their research methodology—choice-based conjoint analysis. To answer their research questions, they correlate the different convenience factors identified with customer expectations using quantitative and qualitative analysis. Finally, they propose some design guidelines that can be adopted by the Delhi Metro Rail Corporation to offer improved user convenience to its citizens.

KISS+ for Rapid and Accurate Pedestrian Re-Identification

H. Han, M.C. Zhou, X. Shang, W. Cao, and A. Abusorrah

This work studies a small sample size (S3) problem that many metric learning methods, e.g., Keep It Simple and Straightforward (KISS) MEtric learning (KISSME), would encounter. Due to its low computational cost and fast computing speed, KISSME has broad application prospects in the field of pedestrian re-identification. Yet it faces the S3 problem that causes too small eigenvalues of its covariance matrix, thus resulting in an instability issue. Its large eigenvalues are overestimated; while its small ones are underestimated. In order to solve such problem, the authors use an orthogonal basis vector to generate virtual samples. The resulting algorithm named KISS+ is experimentally shown to have the eigenvalues of its covariance matrix significantly larger than KISSM's. The extensive experimental results show that the proposed method has a great advantage in running time while maintaining highly acceptable matching rate.

Using Reinforcement Learning With Partial Vehicle Detection for Intelligent Traffic Signal Control

R. Zhang, A. Ishikawa, W. Wang, B. Striner, and O. K. Tonguz

Intelligent transportation systems (ITS) have attracted the attention of researchers and the general public alike as a means to alleviate traffic congestion. Recently, the maturity of wireless technology has enabled a cost-efficient way to achieve ITS by detecting vehicles using vehicle-to-infrastructure (V2I) communications. Traditional ITS algorithms, in most cases, assume that every vehicle is observed, such as by a camera or a loop detector, but a V2I implementation would detect only those vehicles with wireless communications capability. The authors examine a family of transportation systems, which they will refer to as "partially detected intelligent transportation systems." An algorithm that can act well under a small detection rate is highly desirable due to gradual penetration rates of the underlying wireless technologies such as dedicated short-range communications (DSRC) technology. Artificial intelligence (AI) techniques for reinforcement learning (RL) are suitable tools for finding such an algorithm due to utilizing varied inputs and not requiring explicit analytic understanding or modeling of the underlying system dynamics. In this article, the authors report an RL algorithm for partially observable ITS based on DSRC. The performance of this system is studied under different car flows, detection rates, and topologies of the road network. The author's system is able to efficiently reduce the average waiting time of vehicles at an intersection, even with a low detection rate.

RadChat: Spectrum Sharing for Automotive Radar Interference Mitigation

C. Aydogdu, M. F. Keskin, N. Garcia, H. Wymeersch, and D. W. Bliss

In the automotive sector, both radars and wireless communication are susceptible to interference. However, combining the radar and communication systems, i.e., radio frequency (RF) communications and sensing convergence, has the potential to mitigate interference in both systems. This article analyses the mutual interference of spectrally coexistent frequency modulated continuous wave (FMCW) radar and communication systems in terms of occurrence probability and impact, and introduces RadChat, a distributed networking protocol for mitigation of interference among FMCW-based automotive radars, including self-interference, using radar and communication cooperation. The results show that RadChat can significantly reduce radar mutual interference in single-hop vehicular networks in less than 80 ms.

Multiobjective Mission Route Planning Problem: A Neural Network-Based Forecasting Model for Mission Planning

S. Biswas, S. G. Anavatti, and M. A. Garratt

A three-layered approach for the mission route planning problems for a multivehicle system is proposed in this article, where the autonomous vehicles have to collectively navigate to a number of target locations in a dynamic environment. The three-layered approaches are: path planning with task assignment in the presence of both static and dynamic obstacles, multiobjective optimization with user defined constraints, and a data driven neural network-based forecasting model to predict the outcome of a mission. The results show that for different circumstances, the predictions are fairly accurate. The significant contribution of this work is that without going through the total process, for a mission, a planner can easily apply the forecasting model and predict the optimal result based on current scenarios.

Adjacent Channel Interference Aware Joint Scheduling and Power Control for V2V Broadcast Communication

A. Hisham, D. Yuan, E. G. Ström, and F. Brännström

This article proposes scheduling and power control schemes to mitigate the impact of both co-channel interference (CCI) and adjacent channel interference (ACI) on direct vehicle-to-vehicle broadcast communication. The objective is to maximize the number of vehicles that can communicate with the prescribed requirement on latency and reliability. The joint scheduling and power control problem is formulated as a mixed Boolean linear programming (MBLP) problem. A column generation method is proposed to reduce the computational complexity of the joint problem. From the joint problem, the authors formulate a scheduling-alone problem (given a power allocation) as a Boolean linear programming (BLP) problem and a power control-alone problem (given a schedule) as an MBLP problem. The scheduling problem is numerically sensitive due to the high dynamic range of channel values and adjacent channel interference ratio (ACIR) values. Therefore, a novel sensitivity reduction technique, which can compute a numerically stable optimal solution at the price of increased computational complexity, is proposed. The numerical results show that ACI, just as CCI, is a serious problem in direct \gls{V2V} communication due to near-far situations and hence should not be ignored, and its impact can be reduced by proper scheduling and power control.

ARTS: Automotive Repository of Traffic Signs for the United States

F. Almutairy, T. Alshaabi, J. Nelson, and S. Wshah

A new large-scale open-sourced dataset for traffic signs recognition in the U.S. Arts is developed. The researchers used deep learning methods that can learn features automatically without the need for hand-crafting them, allowing for the recognition of a higher number of classes. Traditional non-deep learning methods developed on Europe are not scalable to accurately recognize a large subset of traffic signs, such as those that exist in the United States. Therefore, this dataset was crafted for use in the United States and includes a wide range of sign types, including regulatory, guide, warning, and temporary signs.

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