Scanning the Issue

A Mixed Path Size Logit-Based Taxi Customer-Search Model Considering Spatio-Temporal Factors in Route Choice

J. Tang, Y. Wang, W. Hao, F. Liu, H. Huang, and Y. Wang

A Mixed Path Size Logit (MPSL) model is proposed to analyze route choice behaviors in the process of taxi customer-searching through considering spatio-temporal features of the route, including customer generation rate, path travel time, cumulative intersection delay, path distance, and path size. The GPS data were collected from about 36 000 taxi vehicles in Beijing city at 30-s intervals for six months. In the model application, Xidan district in the center of Beijing city is selected to demonstrate the effectiveness of the proposed model. The results indicated that the MPSL model could effectively analyze the route choice behavior in the customer-searching process and express higher accuracy than the traditional Multinomial Logit model and basic PSL model.

Fuel-Optimal Multi-Impulse Orbit Transfer Using a Hybrid Optimization Method

H. Zhou, X. Wang, and N. Cui

For the N-impulse transfer between two earth orbits, this article introduces N–1 intermediate orbits to describe the orbit transfer scheme. Based on the patched conic theory, candidate solutions can be analytically derived, constraints are removed from the optimization model, and the original problem is converted to a parameter optimization problem. The only difficulty lies in the initialization because the number of optimization variables increases linearly with N, which can be very large. This is settled by a hybrid optimization algorithm that comprises two searching methods. The problem is solved first by an improved particle swarm optimization method and then by an adaptive conjugate gradient method. The authors' method is adaptive to problems with any finite N and can calculate the optimal N in any transfer scenarios.

Optimal Recourse Strategy for Battery Swapping Stations Considering Electric Vehicle Uncertainty

W. Infante, J. Ma, X. Han, and A. Liebman

To create comprehensive and resilient battery swapping stations, a two-stage optimization with recourse is proposed. In the planning stage, the investment for battery purchases is recommended even before the electric vehicle station visit uncertainties are made known. In the operation stage, the battery allocation decisions such as charging, discharging, and swapping are then coordinated. To apply the recourse strategy in creating representative scenarios, electric vehicle station visit distribution techniques are also proposed using a modified K-means clustering method. Aside from the sensitivity analysis made with swapping prices and charging intervals, the strategy comparisons with conventional strategies have also demonstrated the practicality of the proposed coordination to future electricity and transportation networks.

3D LiDAR-Based Global Localization Using Siamese Neural Network

H. Yin, Y. Wang, X. Ding, L. Tang, S. Huang, and R. Xiong

This article proposes a global localization system in 3D LiDAR maps, which can localize the vehicle without any prior knowledge of its pose. Siamese neural network is developed to model the environments in mapping, and then similarities can be measured to achieve place recognition for global localization. Finally, Monte Carlo localization is used to localize the vehicle from scratch based on a Gaussian mixture model. The observability analysis is also presented as the theoretical foundations and practice guidelines to the localization system. The experimental results show that the proposed system can achieve global localization in 3D point clouds with effectiveness and high efficiency.

Developing Robot Driver Etiquette Based on Naturalistic Human Driving Behavior

X. Huang, S. Zhang, and H. Peng

Automated vehicles can change the society by improved safety, mobility, and fuel efficiency. However, due to the higher cost and change in the business model, over the coming decades, the highly automated vehicles will likely continue to interact with many human-driven vehicles. In the past, the control/design of the highly automated (robotic) vehicles mainly considers safety and efficiency but failed to address the "driving culture" of the surrounding human-driven vehicles. Thus, the robotic vehicles may demonstrate behaviors very different from other vehicles. The authors study this "driving etiquette" problem in this article. As the first step, they report the key behavior parameters of human-driven vehicles, derived from a large naturalistic driving database. The results can be used to guide future algorithm design of highly automated vehicles or to develop realistic human-driven vehicle behavior model in simulations.

Moving Object Detection Through Image Bit-Planes Representation Without Thresholding

C.-Y. Lin, K. Muchtar, W.-Y. Lin, and Z.-Y. Jian

Background subtraction is an example of a moving object detection technique that uses machine vision systems. Conventional moving object detection methods need complicated thresholds for background modeling to address changes in illumination. This article proposes a novel background

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modeling approach without thresholding based on a bit-planes method, which fully utilizes color characteristics through spatial and temporal-based improvement. The proposed idea is effective, efficiently solving for shadow disturbance and brightness changes. The authors evaluate their proposed method using several challenging indoor and outdoor sequences from the CDNET 2014 dataset. The experiments show that the proposed idea typically achieves a higher rate of detection accuracy than those of the current state-of-the-art approaches.

Progressive Latent Models for Self-Learning Scene-Specific Pedestrian Detectors

Q. Ye, T. Zhang, and W. Ke

A self-learning approach is proposed toward specifying a pedestrian detector for each video scene without any human annotation involved. Object locations in video frames are treated as latent variables and a progressive latent model (PLM) is proposed to solve such latent variables. PLM is deployed as components of object discovery, object enforcement, and label propagation, which are used to learn the object locations in a progressive manner. With the difference of convex (DC) objective functions, PLM is optimized by a concave–convex programming algorithm. With specified network branches and loss functions, PLM is integrated with deep feature learning and optimized in an end-to-end manner. From the perspectives of convex regularization and error rate estimation, detailed optimization analysis and learning stability analysis of the proposed PLM are provided.

Deep Learning for Large-Scale Traffic-Sign Detection and Recognition

D. Tabernik and D. Skočaj

A Mask-RCNN-based deep-learning method for the detection of 200 traffic sign categories is presented that is suitable for automating traffic-sign inventory management. A vast majority of existing approaches perform well on traffic signs needed for advanced driver-assistance and autonomous systems, but this represents a relatively small number of all traffic signs. The proposed method addresses the detection of the remaining difficult classes and is evaluated on a new dataset termed the DFG Traffic-Sign Dataset with 200 traffic-sign categories, including a large number of highly challenging categories with large intra-category appearance variation. The proposed method is shown to achieve 3% error rates, which is sufficient for deployment in practical applications of traffic-sign inventory management.

Pedestrian Detection Using Pixel Difference Matrix Projection

X. Liu, K.-A. Toh, and J. P. Allebach

In this article, a set of lightweight features is proposed to enhance the pedestrian detection performance when a small–medium scale of training data with low-resolution images is available. To address this issue, a difference matrix projection (DMP) is developed to compute the aggregated multioriented pixel differences using global matrix operations. Both the pixel differences and the aggregation are computed using global matrix projection to avoid the laborious iterative operations. The authors have tested their method on the INRIA, Daimler Chrysler classification (Daimler-CB), NICTA, and Caltech pedestrian datasets. The experiments on these benchmark datasets show encouraging results in terms of detection performance, particularly for image datasets with low-resolution pedestrians.

A Dynamic Predictive Traffic Signal Control Framework in a Cross-Sectional Vehicle Infrastructure Integration Environment

Z. Yao, L. Shen, R. Liu, Y. Jiang, and X. Yang

This article proposes a dynamic predictive traffic signal control framework for isolated intersections in a cross-sectional VII environment. The framework includes a dynamic platoon dispersion model (DPDM) and a dynamic programming algorithm based on the exhaustive optimization of phases (EOP). The proposed dynamic predictive control framework is tested in a simulated cross-sectional VII environment and a case study based on a real road network is carried out. The results show that the proposed framework can reduce the average delay and queue length by up to 33% and 35%, respectively, compared with traditional full-actuated control.

Automatic Traffic Sign Detection and Recognition Using SegU-Net and a Modified Tversky Loss Function With L1-Constraint

U. Kamal, T. I. Tonmoy, S. Das, and M. K. Hasan

This article proposes a novel deep learning-based approach for automatic traffic sign detection and recognition. The authors used a segmentation architecture—the SegU-Net—for detecting traffic-signs from video sequences. The authors designed it by merging the properties of Seg-Net and U-Net, and trained it on the recently released CURE-TSD dataset. They used the Tversky Loss Function to train the network, appending it with an L1-Constraint term, to properly control the weighting of False–Positives and False–Negatives during training. For the recognition task, the authors used a VGG-16-like architecture. Adoption of these techniques during experiments demonstrated current state-of-the-art performance on the CURE-TSD dataset, beating standard object detection networks by a large margin.

Short-Term Prediction of Passenger Demand in Multi-Zone Level: Temporal Convolutional Neural Network With Multi-Task Learning

K. Zhang, Z. Liu, and L. Zheng

An end-to-end multitask learning temporal convolutional neural network (MTL-TCNN) is proposed to predict the short-term passenger demand in a multizone level. Along with one feature selector named spatiotemporal dynamic time warping (ST-DTW) algorithm, this proposed MTL-TCNN is quite qualified for the multitask prediction problem with the consideration of spatiotemporal correlations. Then, based on the car-calling demand data from Didi Chuxing in Chengdu city, China, and taxi demand data from New York City, the numerical results show the MTL-TCNN outperforms both the classic methods [i.e., historical average (HA), v-support vector machine (v-SVM), and XGBoost] and the state-of-the-art deep learning approaches [e.g., long short-term memory (LSTM) and convolutional LSTM (ConvLSTM)], in both single-task learning (STL) and multitask learning (MTL) scenarios. The proposed MTL-TCNN with the ST-DTW algorithm is a promising method for short-term passenger demand prediction in a multizone level.

Characterizing the Connectivity of Railway Networks

Z. Xu, Q. Zhang, D. Chen, and Y. He

Network analysis is a highly intuitive and interpretable approach to characterizing the physical connectivity of railway systems. However, the physical connectivity is often limited in depicting transportation network dynamics due to the lack of traffic flow information. In this research, a comprehensive review of the physical connectivity metrics is presented. These metrics are applied to evaluate the connectivity of China's high-speed railway system. Then, the first data-driven research on comparing the physical connectivity with the logical connectivity of railway systems is carried out through integrating network topology and travel demand data. Experiments demonstrate that physical connectivity metrics cannot well represent the connectivity of railway systems due to the neglect of the heterogeneous distribution and temporal patterns of the passenger flows.

Operational Perspectives Into the Resilience of the U.S. Air Transportation Network Against Intelligent Attacks

K. H. Thompson and H. T. Tran

This article presents a defender–attacker–defender model to analyze potential impacts of intelligent attacks and worst-case disruptions on the U.S. air transportation network, as well as possible protection steps that could be taken to minimize the negative outcomes of such disruptions. Furthermore, to analyze the effects of intermodal connections on the resilience of the air network, a second-model layer representing a hypothetical bus network is added and studied. The authors use these models, supported by publicly available data, to identify air routes with the highest impact probabilities and those critical to the resilient operation of the air network in such scenarios. They also demonstrate the potential benefits of inter-modal linkages toward maintaining network operations and identify promising research directions for this type of integrated and intelligent transportation system.

Real-Time Semantic Segmentation-Based Stereo Reconstruction

V.-C. Miclea and S. Nedevschi

A novel real-time stereo reconstruction method is proposed. The solution follows the classic stereo pipeline, each step in the stereo workflow being enhanced by additional information from semantic segmentation. For this purpose, the computation, aggregation, and optimization steps are adapted by integrating additional surface information given by each semantic class. For cost computation and optimization, new genetic algorithms are introduced in order to incrementally adjust the parameters for better solutions. Furthermore, a new post-processing edge-aware filtering technique is proposed. The method relies on an improved convolutional neural network (CNN) architecture for disparity refinement. Competitive results are obtained at 30 frames/s (including segmentation).

Feature Pyramid and Hierarchical Boosting Network for Pavement Crack Detection

F. Yang, L. Zhang, S. Yu, D. Prokhorov, X. Mei, and H. Ling

A feature pyramid and hierarchical boosting network (FPHBN) is proposed for pavement crack detection. The feature pyramid module is introduced to enrich the low-level feature by integrating semantic information from high-level layers in a pyramid way. A hierarchical boosting module is proposed to deal with hard examples by reweighting samples in a hierarchical way. Incorporating the two components to Holistically-Nested Edge Detection (HED) results in the proposed FPHBN. A novel crack detection measurement, i.e., average intersection over union (AIU), has been proposed to evaluate crack detection methods. Extensive experiments are conducted to demonstrate the superiority and generalizability of the proposed FPHBN.

Development of a Microsimulation Model for Motorway Roadworks With Narrow Lanes

Z. Nassrullah and S. Yousif

The article presents a newly developed microsimulation model for motorway roadwork sections to evaluate the efficiency of different temporary traffic management schemes using offside/inside lane closures. A comparison has been made with narrow lanes schemes which, at present, are becoming more commonly used on U.K. motorways. The model was developed based on car-following, discretionary lane changing, mandatory lane changing, gap acceptance, and the newly developed narrow lanes rules. Several sources of data were used in the verification, calibration, and validation processes of the model. Observations from motorway roadwork sites with narrow lanes schemes suggested that the presence of heavy goods vehicles (HGVs) had a noticeable impact on reducing section capacity. Various parameters within the model have been tested, such as different percentage of HGVs, varied roadwork zone lengths, and variable speed limits.

Block Simplex Signal Recovery: Methods, Trade-Offs, and an Application to Routing

C. Wu, A. Pozdnukhov, and A. M. Bayen

The problem of block simplex constrained signal recovery is introduced and demonstrated to be a suitable formulation for estimation problems in networks, such as route flow estimation in traffic. There are several natural approaches to this problem: compressed sensing, Bayesian inference, and convex optimization. This article presents new methods within each framework and assess their respective abilities to reconstruct signals, with particular emphasis on sparse recovery, ability to incorporate prior information, and scalability. The authors then apply these methods to route flow estimation in traffic networks of various sizes and network topologies. They find that both compressed sensing and Bayesian inference approaches are appropriate for structured recovery but have scalability limitations. The convex optimization approach does not directly incorporate prior information, but scales well and has been shown to achieve 90% route flow accuracy on a full-scale network of over 10 000 links and 280 000 routes.

Robust Obstacle Detection and Recognition for Driver Assistance Systems

J. Leng, Y. Liu, D. Du, T. Zhang, and P. Quan

This article proposes a robust obstacle detection and recognition method for driver assistance systems. Different from the existing methods, the authors' method aims to detect and recognize obstacles on the road rather than all the obstacles in the view. The proposed method involves two stages aiming at an increased quality of the results. The first stage is to locate the positions of obstacles on the road. In order to accurately locate the on-road obstacles, the authors propose an obstacle detection method based on the U-V disparity map generated from a stereo vision system. Second, the detection results of their proposed U-V disparity algorithm are put into a context-aware Faster-RCNN that combines the interior and contextual features to improve the recognition accuracy of small and occluded obstacles. Specifically, they propose a context-aware module and apply it into the architecture of Faster-RCNN. The experimental results on two public datasets show that their proposed method achieves state-of-the-art performance under various driving conditions.

Enhanced Object Detection With Deep Convolutional Neural Networks for Advanced Driving Assistance

J. Wei, J. He, Y. Zhou, K. Chen, Z. Tang, and Z. Xiong

In this article, the authors propose three enhancements for CNN-based visual object detection for ADAS. To address the large object scale variation challenge, deconvolution and fusion of CNN feature maps are proposed to add context and deeper features for better object detection at low feature map scales. In addition, soft non-maximal suppression (NMS) is applied across object proposals at different feature scales to address the object occlusion challenge. As the cars and pedestrians have distinct aspect ratio features, the authors measure their aspect ratio statistics and exploit them to set anchor boxes properly for better object matching and localization. The proposed CNN enhancements are evaluated with various image input sizes by experiments over the KITTI dataset. The experiment results demonstrate the effectiveness of the proposed enhancements with good detection performance over KITTI test set.

Naturalistic Driver Intention and Path Prediction Using Recurrent Neural Networks

A. Zyner, S. Worrall, and E. Nebot

Understanding the intentions of drivers at intersections is a critical component for autonomous vehicles. Urban intersections that do not have traffic signals are a common epicenter of highly variable vehicle movement and interactions. The authors present a method for predicting driver intent at urban intersections through multimodal trajectory prediction with uncertainty. Their method is based on recurrent neural networks combined with a mixture density network output layer. To consolidate the multimodal nature of the output probability distribution, they introduce a clustering algorithm that extracts the set of possible paths that exist in the prediction output and ranks them according to probability. To verify the method's performance and generalizability, they present a real-world dataset that consists of over 23 000 vehicles traversing five different intersections, collected using a vehicle-mounted LiDAR-based tracking system. An array of metrics is used to demonstrate the performance of the model against several baselines.

Network Capacity Maximization Using Route Choice and Signal Control With Multiple OD Pairs

S. Wang, C. Li, W. Yue, and G. Mao

This article introduces a hybrid dynamical system which incorporates flow swap process, green-time proportion swap process, and flow divergence for a general network with multiple OD pairs and multiple routes. A novel control policy is proposed to fill the gap that bottleneck delays need to be intentionally constructed to yield the equilibrium flow vector and green-time proportion vector. This article derives the condition of unique equilibrium for fixed green-time proportion vector and shows that with varying green-time proportion vector, the set of equilibria is a compact, non-convex set, and with the same partial derivative of travel constfunction with respect to the flow and green-time proportion vectors. A sufficient condition for the existence of equilibrium the dynamical is derived under the mild constraints. The stability of the proposed dynamical system is proven by using Lyapunov stability analysis.

Manifold Siamese Network: A Novel Visual Tracking ConvNet for Autonomous Vehicles

M. Gao, L. Jin, Y. Jiang, and B. Guo

A novel manifold Siamese network visual tracking method is proposed and expected to enhance autonomous vehicles perception system. In order to utilize semantic and geometric information simultaneously, a deep convolutional architecture based on correlation filter network with a manifold feature branch is presented. A triplet occlusion score function is established to prevent occlusions. The experimental results on benchmarks show the competitive performance of the proposed algorithm.

Traffic Flow Imputation Using Parallel Data and Generative Adversarial Networks

Y. Chen, Y. Lv, and F.-Y. Wang

A novel approach using parallel data and generative adversarial networks (GANs) is proposed to enhance traffic data imputation. Parallel data paradigm uses synthetic data and real data for data mining and data-driven processes, which helps to reduce the cost of collecting a large amount of data in physical space. To generate synthetic traffic data which can effectively augment real traffic data, the authors apply GANs to train a data generator. As it is difficult for the standard GAN algorithm to generate time-dependent traffic flow data, they made twofold modifications: 1) Using the real data or the corrupted ones instead of random vectors as latent codes to generator within GANs and 2) Introducing a representation loss to measure discrepancy between synthetic data and real data. The experimental results demonstrate that their method can significantly improve the performance of traffic data imputation.

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