LITERATURE SURVEY

Data-Driven Urban Traffic Accident Analysis and Prediction Using Logit and Machine Learning-Based Pattern Recognition Models

Authors:
Vahid Najafi Moghaddam Gilani, Seyed Mohsen Hosseinian, Meisam Ghasedi, Mohammad Nikookar

Abstract

Modeling the severity of accidents based on the most effective variables accounts for developing a high-precision model presenting the possibility of occurrence of each category of future accidents, and it could be utilized to prioritize the corrective measures for authorities. The purpose of this study is to identify the variables affecting the severity of the injury, fatal, and property damage only (PDO) accidents in Rasht city by collecting information on urban accidents from March 2019 to March 2020. In this regard, the multiple logistic regression and the pattern recognition type of artificial neural network (ANN) as a machine learning solution are used to recognize the most influential variables on the severity of accidents and the superior approach for accident prediction. Results show that the multiple logistic regression in the forward stepwise method has R^2 of 0.854 and an accuracy prediction power of 89.17%. It turns out that the accidents occurred between 18 and 24 and KIA Pride vehicle has the highest effect on increasing the severity of accidents, respectively. The most important result of the logit model accentuates the role of environmental variables, including poor lighting conditions alongside unfavorable weather and the dominant role of unsafe and poor quality of vehicles on increasing the severity of accidents. In addition, the machine learning model performs significantly better and has higher prediction accuracy (98.9%) than the logit model. In addition, the ANN model's greater power to predict and estimate future accidents is confirmed through performance and sensitivity analysis.

A Survey on Machine Learning-Based Mobile Big Data Analysis: Challenges and Applications

Authors:
Jiyang Xie Zeyu Song, Yupeng Li, Yanting Zhang, Hong Yu, Jinnan Zhan, Zhanyu Ma, Yuanyuan Qiao, Jianhua Zhang, Jun Guo

Abstract

This paper attempts to identify the requirement and the development of machine learning-based mobile big data (MBD) analysis through discussing the insights of challenges in the mobile big data. Furthermore, it reviews the state-of-the-art applications of data analysis in the

area of MBD. Firstly, we introduce the development of MBD. Secondly, the frequently applied data analysis methods are reviewed. Three typical applications of MBD analysis, namely, wireless channel modeling, human online and offline behavior analysis, and speech recognition in the Internet of Vehicles, are introduced, respectively. Finally, we summarize the main challenges and future development directions of mobile big data analysis.

Angle-of-Arrival Estimation for Vehicle-to-vehicle Communications based on Machine Learning

Authors:
Mi Yang; Bo Ai; Ruisi He; Huang Chen; Zhangfeng Ma; Zhangdui Zhong

Abstract:
For vehicular communications, angle-of-arrival (AOA) estimation plays an important role in smart antenna, beamforming, and assisted driving. Although there are a series of high-performance spectral- or parametric-based AOA estimation methods, they are difficult to realize real-time AOA estimation. In order to solve this problem, this paper proposes a machine-learning-based AOA estimation approach. The proposed method includes off-line training and on-line estimation processes. In the off-line training process, an estimation model is obtained by using the support vector machine (SVM) based on a large number of actual measurement data of vehicular communication scenarios. Then, in the on-line estimation process, the obtained model is used to realize AOA estimation in real-time according to the array snapshot data collected by the antenna array. Experimental results show that the proposed method can achieve real-time and accurate AOA estimation under reasonable configuration. This achievement has the potential for further application in vehicular communication systems.

Machine Learning Technologies for Secure Vehicular Communication in Internet of Vehicles: Recent Advances and Applications

Authors:
Elmustafa Sayed Ali,Mohammad Kamrul Hasan, Rosilah Hassan, Rashid A. Saeed, Mona Bakri Hassan, Shayla Islam, Nazmus Shaker Nafi, and Savitri Bevinakoppa

Abstract

Recently, interest in Internet of Vehicles' (IoV) technologies has significantly emerged due to the substantial development in the smart automobile industries. Internet of Vehicles' technology enables vehicles to communicate with public networks and interact with the surrounding environment. It also allows vehicles to exchange and collect information about other vehicles and roads. IoV is introduced to enhance road users' experience by reducing road congestion, improving traffic management, and ensuring the road safety. The promised

applications of smart vehicles and IoV systems face many challenges, such as big data collection in IoV and distribution to attractive vehicles and humans. Another challenge is achieving fast and efficient communication between many different vehicles and smart devices called Vehicle-to-Everything (V2X). One of the vital questions that the researchers need to address is how to effectively handle the privacy of large groups of data and vehicles in IoV systems. Artificial Intelligence technology offers many smart solutions that may help IoV networks address all these questions and issues. Machine learning (ML) is one of the highest efficient AI tools that have been extensively used to resolve all mentioned problematic issues. For example, ML can be used to avoid road accidents by analyzing the driving behavior and environment by sensing data of the surrounding environment. Machine learning mechanisms are characterized by the time change and are critical to channel modeling in-vehicle network scenarios. This paper aims to provide theoretical foundations for machine learning and the leading models and algorithms to resolve IoV applications' challenges. This paper has conducted a critical review with analytical modeling for offloading mobile edge-computing decisions based on machine learning and Deep Reinforcement Learning (DRL) approaches for the Internet of Vehicles (IoV). The paper has assumed a Secure IoV edge-computing offloading model with various data processing and traffic flow. The proposed analytical model considers the Markov decision process (MDP) and ML in offloading the decision process of different task flows of the IoV network control cycle. In the paper, we focused on buffer and energy aware in ML-enabled Quality of Experience (QoE) optimization, where many recent related research and methods were analyzed, compared, and discussed. The IoV edge computing and fog-based identity authentication and security mechanism were presented as well. Finally, future directions and potential solutions for secure ML IoV and V2X were highlighted.

Machine Learning-Based Vehicle Model Construction and Validation—Toward Optimal Control Strategy Development for Plug-In Hybrid Electric Vehicles

Authors:

Yuanjian Zhang; Zheng Chen; Guang Li; Yonggang Liu; Haibo Chen; Geoff Cunningham; Juliana Early

Abstract:

Advances in machine learning inspire novel solutions for the validation of complex vehicle models and spur an easy manner to promote energy management performance of complexly configured vehicles, such as plug-in hybrid electric vehicles (PHEVs). A constructed PHEV model, based on the four-wheel-drive passenger vehicle configuration, is validated through an efficient virtual test controller (VTC) developed in this article. The VTC is designed via a novel approach based on the least-square support vector machine and random forest with the inner-interim data filtered by the ReliefF algorithm to validate the vehicle model as necessary. This article discusses the process and highlights the accuracy improvements of the PHEV model that is achieved by implementing the VTC. The validity of the VTC is addressed by examining the PHEV model to mimic the characteristics of internal combustion

engine, motor, and generator behaviors observed through the benchmark test. Sufficient simulations and hardware-in-loop test are employed to demonstrate the capability of the novel VTC-based model validation method in practical applications. The major novelty of this article lies in the development of a VTC, by which the vehicle model can be efficiently developed, providing solid framework and enormous convenience for control strategy design.

Machine-Learning-Based Scenario Identification Using Channel Characteristics in Intelligent Vehicular Communications

Authors:
Mi Yang; Bo Ai; Ruisi He; Chao Shen; Miaowen Wen; Chen Huang; Jianzhi Li; Zhangfeng Ma; Liang Chen

Abstract:
Scenario identification plays an important role in improving communication system performance. Considering that the scenarios of vehicle communications are dynamic due to movements of vehicles, and there are obvious differences in channel characteristics, vehicle speeds, traffic densities between various scenarios, the requirement for real-time scenario identification of vehicular communications is increasingly urgent. Vehicular communication systems can select appropriate channel models and transmission mode by correctly identifying the current scenarios to maintain an effective and reliable operating state. This paper presents a machine-learning-based scenario identification model for intelligent vehicular communications. Channel characteristics extracted from channel measurements in different scenarios form the datasets used to training, then a back-propagation neural network (BPNN) is trained, and a scenario identification model is obtained. Furthermore, the model configuration scheme is explored and presented which can make the proposed identification model achieves optimal performance. Subsequently, identification accuracy is verified by using validation data of the corresponding scenarios. The results show that the identification accuracies are all above 98 % in four typical scenarios of urban areas, highways, tunnels, and vehicle obstructions, which indicates that the model proposed in this paper shows good performance in scenario identification for intelligent vehicular communications.

Machine Learning Based Channel Modeling for Vehicular Visible Light Communication

Abstract:
Vehicular Visible Light Communication (VVLC) is preferred as a vehicle to everything (V2X) communications scheme due to its highly secure, low complexity and radio frequency (RF) interference free characteristics, exploiting the line of sight (LoS) propagation of visible

light and usage of already existing vehicle light emitting diodes (LEDs). Current VVLC channel models based on deterministic and stochastic methods provide limited accuracy for path loss prediction since deterministic methods heavily depend on site-specific geometry and stochastic models average out the model parameters without considering environmental effects. Moreover, there exists no wireless channel model that can be adopted for channel frequency response (CFR) prediction. In this paper, we propose a novel framework for the machine learning (ML) based channel modeling of the VVLC with the goal of improving the model accuracy for path loss and building the CFR model through the consideration of multiple input variables related to vehicle mobility and environmental effects. The proposed framework incorporates multiple measurable input variables, e.g., distance, ambient light, receiver inclination angle, and optical turbulence, with the exploitation of feed forward neural network based multilayer perceptron neural network (MLP-NN), radial basis function neural network (RBF-NN) and decision tree based Random Forest learning methods. The framework also includes data pre-processing step, with synthetic minority over sampling technique (SMOTE) data balancing, and hyper-parameter tuning based on iterative grid search, to further improve the accuracy. The accuracy of the proposed ML based channel modeling is demonstrated on the real world VVLC vehicle-to-vehicle (V2V) communication channel data. The proposed MLP-NN, RBF-NN and Random Forest based channel models generate highly accurate path loss predictions with 3.53 dB, 3.81 dB, 3.95 dB root mean square error (RMSE), whereas the best performing stochastic model based on two-term exponential fitting provides prediction accuracy of 7 dB RMSE. Moreover, MLP-NN and RBF-NN models are demonstrated to predict VVLC CFR with 3.78 dB and 3.60 dB RMSE, respectively.

A General Active-Learning Framework for On-Road Vehicle Recognition and Tracking

Authors:

Sayanan Sivaraman; Mohan Manubhai Trivedi

Abstract:

This paper introduces a general active-learning framework for robust on-road vehicle recognition and tracking. This framework takes a novel active-learning approach to building vehicle-recognition and tracking systems. A passively trained recognition system is built using conventional supervised learning. Using the query and archiving interface for active learning (QUAIL), the passively trained vehicle-recognition system is evaluated on an independent real-world data set, and informative samples are queried and archived to perform selective sampling. A second round of learning is then performed to build an active-learning-based vehicle recognizer. Particle filter tracking is integrated to build a complete multiple-vehicle tracking system. The active-learning-based vehicle-recognition and tracking (ALVeRT) system has been thoroughly evaluated on static images and roadway video data captured in a variety of traffic, illumination, and weather conditions. Experimental results

show that this framework yields a robust efficient on-board vehicle recognition and tracking system with high precision, high recall, and good localization.

Impact of COVID-19 pandemic on low-carbon shared traffic scheduling under machine learning model

Authors:
Xin Liu & Shunlong Li

Abstract

The present work aims to expand the application of machine learning models in predicting and identifying traffic flow data and provide a reference for the scheduling and management of shared traffic against the Coronavirus Disease 2019 (COVID-19) pandemic. First, a time segmentation-based prediction model is proposed considering the classification superiority of Support Vector Machine (SVM) and combining the Optimal Segmentation Algorithm (OSA), denoted as OSA-SVM. Second, an algorithm for generating a shared traffic flow sequence is proposed based on the historical data of shared traffic flow. Finally, a shared traffic flow moment identification model is constructed based on the label propagation algorithm and the Random Forest (RF) model. Comparative analysis suggests that the OSA-SVM regression prediction model can accurately fit the fluctuations caused by the shared traffic flow data; however, its overall effect is not good, with deviation from the actual traffic sequence. Introducing historical data for weighting processing improves the goodness-of-fit of the regression prediction model significantly, maintaining at the level of 0.66–0.71 after one week. The stochastic gradient descent algorithm can provide a better weighted processing effect. The RF model shows the best recognition effect for the shared traffic data stream compared with other models, presenting an excellent performance in dealing with the imbalance and instability problems. The proposed model and algorithm have outstanding prediction and recognition accuracy in shared traffic scheduling, playing an active role in traffic control during COVID-19 prevention and control.

Autonomous Vehicle Assisted by Heads up Display (HUD) with Augmented Reality Based on Machine Learning Techniques

Authors:
S. Murugan, A. Sampathkumar, S. Kanaga Suba Raja, S. Ramesh, R. Manikandan & Deepak Gupta

Abstract

The safety in driving is improved and driving workload is minimized, the provided information is understandably and the cognitive load on the driver is low. For the autonomous vehicle, machine learning-based AR-HUD (augmented reality based Head-up display) is used. In this paper the machine learning-based AR-HUD has been used for autonomous vehicles. The process of object detection and collected HUD data classification has been done by the proposed model. Determining the present state of vehicle has been validated based on the AR environment. The process of test and validation is an integral portion of a development cycle. Machine learning and deep neural network are used in this

paper for lab & real-world T&V for ARHUD and autonomous vehicles. The results of simulation obtain the data gathered from the implementation of human and machine interface (HMI) to detect the object and to classify the objects in motion. Accuracy, precision, recall and F-1 score are the analyzed parameters for machine learning-based ARHUD. The simulation results obtained are accuracy of 98%, precision 94%, recall 92.3% and F-1 score 86% in comparison with CNN, ANN and SVM.

Design of a Machine Learning-Based Self-driving Car

Authors:

Abhishek Soni, Dharamvir Dharmacharya, Amrindra Pal, Vivek Kumar Srivastava, Rabindra Nath Shaw & Ankush Ghosh

Abstract

In this work, an algorithm of machine learning for self-driving car using udacity and unity self-driving car simulation software has been presented. Using the software, the car is driven on the simulated circuit having three cameras mounted on car hood which generate three images simultaneously and acceleration and de-acceleration of the car steering angle and brake. This method includes a behavior cloning approach and tries to replicate a behavior of human driver. For training the model, approximately, 18,000 training samples are required, and by using image augmentation technique, an increase in the data sample with few times is obtained, which leads to little robust simulated self-driving car.

Federated Learning With Blockchain for Autonomous Vehicles: Analysis and Design Challenges

Authors:

Shiva Raj Pokhrel; Jinho Choi

Abstract:

We propose an autonomous blockchain-based federated learning (BFL) design for privacy-aware and efficient vehicular communication networking, where local on-vehicle machine learning (oVML) model updates are exchanged and verified in a distributed fashion. BFL enables oVML without any centralized training data or coordination by utilizing the consensus mechanism of the blockchain. Relying on a renewal reward approach, we develop a mathematical framework that features the controllable network and BFL parameters (e.g., the retransmission limit, block size, block arrival rate, and the frame sizes) so as to capture their impact on the system-level performance. More importantly, our rigorous analysis of oVML system dynamics quantifies the end-to-end delay with BFL, which provides important insights into deriving optimal block arrival rate by considering communication and consensus delays. We present a variety of numerical and simulation results highlighting various non-trivial findings and insights for adaptive BFL design. In particular, based on analytical results, we minimize the system delay by exploiting the channel dynamics and demonstrate that the proposed idea of tuning the block arrival rate is provably online and

capable of driving the system dynamics to the desired operating point. It also identifies the improved dependency on other blockchain parameters for a given set of channel conditions, retransmission limits, and frame sizes. [1] However, a number of challenges (gaps in knowledge) need to be resolved in order to realise these changes. In particular, we identify key bottleneck challenges requiring further investigations, and provide potential future research directions. [1] An early version of this work has been accepted for presentation in IEEE WCNC Wksps 2020 [1].

Study on the Take-over Performance of Level 3 Autonomous Vehicles Based on Subjective Driving Tendency Questionnaires and Machine Learning Methods

Authors:
Hyunsuk Kim,Woojin Kim,Jungsook Kim,Seung-Jun Lee,Daesub Yoon,Oh-Cheon Kwon,Cheong Hee Park

Abstract:

Level 3 autonomous vehicles require conditional autonomous driving in which autonomous and manual driving are alternately performed; whether the driver can resume manual driving within a limited time should be examined. This study investigates whether the demographics and subjective driving tendencies of drivers affect the take-over performance. We measured and analyzed the reengagement and stabilization time after a take-over request from the autonomous driving system to manual driving using a vehicle simulator that supports the driver's take-over mechanism. We discovered that the driver's reengagement and stabilization time correlated with the speeding and wild driving tendency as well as driving workload questionnaires. To verify the efficiency of subjective questionnaire information, we tested whether the driver with slow or fast reengagement and stabilization time can be detected based on machine learning techniques and obtained results. We expect to apply these results to training programs for autonomous vehicles' users and personalized human–vehicle interfaces for future autonomous vehicles.

Looking at Vehicles on the Road: A Survey of Vision-Based Vehicle Detection, Tracking, and Behavior Analysis

Authors:
Sayanan Sivaraman; Mohan Manubhai Trivedi

Abstract:
This paper provides a review of the literature in on-road vision-based vehicle detection, tracking, and behavior understanding. Over the past decade, vision-based surround perception has progressed from its infancy into maturity. We provide a survey of recent works in the literature, placing vision-based vehicle detection in the context of sensor-based on-road surround analysis. We detail advances in vehicle detection, discussing monocular, stereo vision, and active sensor-vision fusion for on-road vehicle detection. We discuss

vision-based vehicle tracking in the monocular and stereo-vision domains, analyzing filtering, estimation, and dynamical models. We discuss the nascent branch of intelligent vehicles research concerned with utilizing spatiotemporal measurements, trajectories, and various features to characterize on-road behavior. We provide a discussion on the state of the art, detail common performance metrics and benchmarks, and provide perspective on future research directions in the field.

Machine Learning-Based Target Classification for MMW Radar in Autonomous Driving

Authors:
Xiuzhang Cai; Michael Giallorenzo; Kamal Sarabandi

Abstract:
Millimeter-wave (MMW) radar sensors are considered key components of autonomous vehicles. Because of the performance degeneration of cameras and lidars under inclement weather conditions, robust autonomy must rely on radar sensors to perform target detection and classification. Unlike basic target classifier methods in literature that make use of target velocity, the proposed approach is far more comprehensive and can be applied to targets with zero-Doppler. Depending on the radar type and target range, this paper presents four target classification models based on four different types of radar data: statistical RCS, distributed (time-domain) RCS, range-azimuth angle radar images and 3D radar images. The classification models are implemented by machine learning approaches artificial neural network (ANN) and convolutional neural network (CNN) with a comprehensive simulated dataset. Good classification accuracies are demonstrated, and the proposed model is validated with measured data. Different radar target classification approaches are compared, which clearly reveals the trade-off between classification performance and system complexity. The proposed radar target classification methods can be applied effectively to both static and dynamic targets, at near or far ranges, using traditional or imaging radars, resulting in improved safety for autonomous vehicles in a wide variety of complex environments.

A Reliable Sensor Network Infrastructure for Electric Vehicles to Enable Dynamic Wireless Charging Based on Machine Learning Technique

Authors:

Muhammad Adil; Jehad Ali; Qui Thanh Hoai Ta; Muhammad Attique; Tae-Sun Chung

Abstract:
In this paper, a hybrid scheme of Dynamic wireless charging (DWC) for electric vehicles EV(s) is proposed to resolve this issue in a network topological infrastructure. The proposed hybrid scheme uses different parameters to allow DWC in EVs. The network infrastructure was established through an enhanced destination sequential distance vector (Enhanced-

DSDV) protocol for participating EVs. The DWC charge between paired EV(s) was enabled by magnetic coupling, where the Charge State Estimator (CSE) was used as an unsupervised machine learning technique to learn the current charging status of each EV. Similarly, the captured data of CSE is shared via embedded wireless nodes in the network following enhanced-DSDV routing protocol. Moreover, the proposed model enables each participating EV to transfer charge to another EV participating in the network in DWC environment. To allow, the drivers to monitor the participating EVs in close proximity with their current charge status, location, and distance information, we have have used a dashboard screen in each EV. In addition, each EV uses a generator to produce a magnetic field for magnetic coupling between paired EV(s) to exchange power in wireless environment. The feasibility of the proposed model was thoroughly examined in the real environment of DWC. The results show that the proposed scheme is reliable in terms of DWC in both static and dynamic. Moreover, the enhanced-DSDV routing protocol performed significantly well than existing schemes particularly in terms of throughput, packet lost ratio and latency.

Machine Learning Aided Path Loss Estimator and Jammer Detector for Heterogeneous Vehicular Networks

Authors:

Bugra Turan; Ali Uyrus; O. Nuri Koc; Emrah Kar; Sinem Coleri

Abstract:

Heterogeneous vehicular communications aim to improve the reliability, security and delay performance of vehicle-to-vehicle (V2V) communications, by utilizing multiple communication technologies. Predicting the path loss through conventional fitting based models and radio frequency (RF) jamming detection through rule based models of different communication schemes fail to address comprehensive mobility and jamming scenarios. In this paper, we propose a machine learning based adaptive link quality estimation and jamming detection scheme for the optimum selection and aggregation of IEEE 802.11p and Vehicular Visible Light Communications (V-VLC) technologies targeting reliable V2V communications. We propose to use Random Forest regression and classifier based algorithms, where multiple individual learners with diversity are trained by using measurement data and the final result is obtained by averaging outputs of all learners. We test our framework on real-world road measurement data, demonstrating up to 2.34 dB and 0.56 dB Mean Absolute Error (MAE) improvement for V-VLC and IEEE 802.11p path loss prediction compared to fitting based models, respectively. The proposed jamming presence detection scheme yields 88.3% accuracy to detect noise interference injection for IEEE 802.11p links, yielding 3% better prediction performance than previously proposed deep convolutional neural network (DCNN) based scheme.