IEEE Access Special Section Editorial: Big Data Technology and Applications in Intelligent Transportation

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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: BIG DATA TECHNOLOGY AND APPLICATIONS IN INTELLIGENT TRANSPORTATION

During the last few years, information technology and transportation industries, along with automotive manufacturers and academia, are focusing on leveraging intelligent transportation systems (ITS) to improve services related to driver experience, connected cars, Internet data plans for vehicles, traffic infrastructure, urban transportation systems, traffic collaborative management, road traffic accidents analysis, road traffic flow prediction, public transportation service plan, personal travel route plans, and the development of an effective ecosystem for vehicles, drivers, traffic controllers, city planners, and transportation applications. Moreover, the emerging technologies of the Internet of Things (IoT) and cloud computing have provided unprecedented opportunities for the development and realization of innovative intelligent transportation systems where sensors and mobile devices can gather information and cloud computing, allowing knowledge discovery, information sharing, and supported decision making. However, the development of such data-driven ITS requires the integration, processing, and analysis of plentiful information obtained from millions of vehicles, traffic infrastructures, smartphones, and other collaborative systems like weather stations and road safety and early warning systems. The huge amount of data generated by ITS devices is only of value if utilized in data analytics for decision-making such as accident prevention and detection, controlling road risks, reducing traffic carbon emissions, and other applications which bring big data analytics into the picture.

Big data can benefit ITS with added-value capabilities that contribute to the solutions of the envisioned innovative ITS systems. Such capabilities include [item 1) in the Appendix]–[item 3) in the Appendix]:

1. Collecting and processing a massive amount of data based on infrastructures utilizing Apache Hadoop and Spark, which are widely available in industry and academia.

2. Providing analysis of current and historical massive traffic data to a traffic management department to predict intrinsic traffic indicators, such as traffic flow efficiency and predicting traffic congestion in real time.

3. Improving the ITS safety level through identifying assets problems, such as pavement degradation, black ice, and other road conditions.

4. Enabling vehicular communication networks (VANETs) such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), or, more generally, vehicle-to-everything (V2X) communications.

5. Providing numerous applications in logistics and supply chain management for transportation industries.

Data for modern ITS comes from multiple heterogeneous sources that can be classified into the following ways:

- **GPS Data** for providing location-related information on vehicles, which can be used for navigation, traffic management, communication-routing optimization, vehicular content caching and sharing, and many other useful services.
- **Vehicle Sensing Data** (VSD) including location-based data (LB-VSD) such as location, speed and moving direction, and surrounding traffic data (ST-VSD) under Connected and Automated Vehicle (CAV) environment. Such vital information can enable a wide range of applications, such as online vehicle diagnosis, road safety improvement, smart charging planning, accident detection, and so on.
- **Self-Driving Data** for controlling self-driving cars. The artificial intelligence (AI) program for self-driving cars requires a continuous, uninterrupted stream of data and instructions in order to make real-time decisions based on complex data sets. The AI program learns from repeatedly driving the same route consistently over many days, where the details of the route and the generated high-resolution maps are the key parts of the self-navigation system.
- **Vehicular Mobile Service Data** provides in-vehicle services for improving both drivers and passengers, such as OnStar, Smartphone Interfaces, and automatic environment adjustments.
- **Advanced Driver-Assistance Data** is collected from the sensory input of more than one vehicle and enables instant reaction through automatic monitoring, alerting, braking, and steering activities.
- **Connected Cars Data** for empowering vehicle operations by allowing the car to share important information remotely. This comes in handy in a range of different situations, from making driving safer, to providing a less stressful and easier process to help track a car if it is stolen.

- **Transportation Logistic Data** for improving the performance and efficiency for companies in the transportation and logistics space. Based on this data, business intelligence solutions and dashboard analytics can easily analyze and find areas for improving the transportation logistics from distribution networks, carriers, and third-party logistics (3PL) to increase speed of goods distribution and reduce fuel and other shipping and transportation costs.

Over the past few years, unprecedented amounts of vehicular and transportation data are constantly being generated in many forms, several of which we have listed above. Based on the analytics of this big data, several useful applications are having significant impacts on various facets of the transportation industry. This Special Section in IEEE ACCESS aims to provide researchers and practitioners a platform to present innovative solutions for intelligent transportation systems based on big data technology and applications. This Special Section was extremely successful. By March 31, 2020, 290 article submissions were attracted, of which 111 were accepted and 167 were rejected. The success of this Special Section is attributed to the timely research issue, the popularity of IEEE ACCESS, and the unfailing efforts of the Guest Editors. There was one invited article by Dr. J. Fiaidhi of Lakehead University, which provided out-of-the-box ideas that are useful for future ITS based on the use of Thick Data for empowering big data analytics with more qualitative methods and techniques. The invited article also went through our stringent peer-review process. However, attempting to summarize the contributions of the 111 accepted articles was a challenge while compiling a short editorial for this Special Section. In general, the articles were distributed into five categories. Figure 1 illustrates the article distribution in these areas.

FIGURE 1. Big data application areas for ITS.

In the article "Scheduling of dynamic multi-objective flexible enterprise job-shop problem based on hybrid QPSO," by Chen *et al.*, the authors developed a hybrid quantum particle swarm optimization (QPSO) to ensure the scheduling job-shop efficiency using the notion fuzziness. For this purpose, they defined the dynamic multiobjective FJSP and constructed a mathematical model according to the features of dynamic multiobjective FJSP. To acquire the optimal solution of dynamic FJSP, the authors proposed a hybrid QPSO algorithm based on double chain coding.

In the article "Disruption management for vehicle routing problem based on consumer value and improved tree-seed algorithm," by Zhang and Zhu, the authors studied logistics distribution through consumer relationships, cloud model, and disruption management, in order to classify target consumers based on their values. On this basis, the authors set up a distribution management model for the vehicle routing problem (VRP) using a tree-seed algorithm (TSA), which was improved with the IA (immune algorithm) to provide valid results through simulation.

In the article "Short-term origin-destination forecasting in urban rail transit based on attraction degree," by Zhang *et al.*, the authors proposed an indicator called attraction degree (ODAD) to address solving the origin-destination (OD) forecasting problem. The ODAD introduced five levels to describe the attraction between OD pairs. Nine cases under different time granularities and different ODAD levels were thoroughly studied to explore their optimal combination. Based on this analysis, the authors recommended a time granularity of 30 min and an ODAD level of "low" for actual subway operation.

In the article "Construction and simulation of rear-end conflicts recognition model based on improved TTC algorithm," by Ge *et al.*, the authors proposed a WTTC model to evaluate collision risks in the freeway work zone. The results show that compared with TTC (traffic conflict measure time to collision), the accuracy of the recognition model increased by 30% based on WTTC, which can capture more potential rear-end conflicts in the freeway work zone.

In the article "Passenger behavior prediction with semantic and multi-pattern LSTM model," by Wang *et al.*, the authors proposed a two-level learning module to improve passenger behavior prediction based on the semantic sensing module that translates the raw traveling sequence into a semantic representation, and a multipattern learning module that constructs an exclusive prediction model for passengers with different traveling purposes. Moreover, a unifying learning framework was designed to incorporate the above two learning modules with the LSTM model.

In the article "Collision-free path planning for intelligent vehicles based on Bézier curve," by Li *et al.*, the authors developed a path planning method for collision-free lane changing based on fifth-order Bézier curve. The planning included the use of a multiobjective optimization function. Simulation results showed that the proposed method worked well at different vehicle velocities and provided a desirable tool to plan a dynamic path in actual traffic environments.

In the article "A blockchain-based byzantine consensus algorithm for information authentication of the Internet of

vehicles,'' by Hu *et al.*, the authors proposed an architecture for solving the security problems in communication, consensus-making, and authentication of nodes in the Internet of Vehicles (IoVs) based on blockchain. They used the Byzantine consensus algorithm based on time sequence and gossip protocol to complete information communication and consensus authentication.

In the article ''Collaborative optimization of distributed scheduling based on blockchain consensus mechanism considering battery-swap stations of electric vehicles,'' by Hu *et al.*, the authors developed a collaborative optimization model for distributed scheduling for the power system of electric vehicles based on blockchain consensus mechanism, considering the battery-swap stations. The power system was divided into three levels. The objective functions were constructed to minimize the generation cost and daily load variance on each level, and the optimal scheduling plan for the power system was solved through multi-level collaborative optimization. The blockchain consensus mechanism was adopted to verify the accuracy of the transaction data.

In the article ''Cluster-based LSTM network for short-term passenger flow forecasting in urban rail transit,'' by Zhang *et al.*, the authors proposed a two-step K-means clustering model to capture passenger flow variation trends and ridership volume characteristics. Based on the clustering results and the recommended time granularity interval, a CB-LSTM model was developed to conduct short-term passenger flow forecasting. The results show that the prediction based on subway station clusters can not only avoid the complication of developing numerous models for each of the hundreds of stations but also improve the prediction performance, which makes it possible to predict short-term passenger flow on a network scale using a limited dataset.

In the article ''Short-term traffic flow prediction method for urban road sections based on space–time analysis and GRU,'' by Dai *et al.*, the authors proposed a short-term traffic flow prediction model that combined the spatio-temporal analysis with a Gated Recurrent Unit (GRU). The model proposed was compared with the convolutional neural network (CNN) model, and the results show that the proposed method outperforms both in accuracy and stability.

In the article ''Solving location problem for electric vehicle charging stations—A sharing charging model,'' by Gong *et al.*, the authors proposed a nondeterministic polynomial (NP) model aiming to minimize the total vehicle service distance for locating charging stations. They used an agent-based model to simulate the optimized charging station location based on Anylogic. The model optimizes the existing location by improving the constraint for the smallest number of charging stations.

In the article ''A bi-objective capacitated location-routing problem for multiple perishable commodities,'' by Li *et al.*, the authors proposed a bi-objective mathematical model and framework, which considers many aspects of logistics network design for big events. Aspects considered in this model include multi-commodity, perishability of goods, combined storage strategy, vehicle capacity limitation, multivehicle, and multipoint distribution. With this model, the shortest total distribution time and the lowest total cost are set up according to the sensitivity of different perishable commodities to time and cost.

In the article ''Adaptive separation thresholds for self-separation of unmanned aircraft system in dynamic airspace,'' by Du *et al.*, the authors proposed a model to sense and avoid (SAA) other aircrafts in airspace. The separation thresholds are defined quantitatively for the unmanned aircraft system (UAS) in a dynamic airspace full of aircrafts that differ in motion state and performance. Then, a ''sector-like'' dynamic collision-free region (CFR) is set up around the UAS. The size of the CRF can be adjusted adaptively according to the relative motion states of the surrounding intruders, the performance of the UAS, and the altitude of the airspace.

In the article ''Simulation of road capacity considering the influence of buses,'' by Shen *et al.*, the authors proposed a cellular automata model accounting for car-following and lane-changing behaviors to investigate the relationship between multilane road capacity and the proportion of buses. The parameters of the model were calibrated and verified using the data collected from a real word road with heterogeneous traffic flow. The calibration result indicates that the proposed model can accurately describe the evolution of traffic dynamics on multilane roads.

In the article ''An edge-assisted data distribution method for vehicular network services,'' by Wang *et al.*, the authors designed an edge-assisted service data distribution method for vehicular network services to satisfy the strict spatiotemporal constraints on the transmission of massive service data. The service data distribution was predicted by time series analysis through edge computing, based on the storage capacity of base stations. Then, a spatiotemporal constrained data sharing algorithm was proposed, which sets up a distribution tree to evaluate the importance of each vehicle in data transmission, and heuristically chooses the most important vehicles as seeds to speed up the vehicle-to-vehicle data sharing.

In the article ''A collaborative route optimization model for regional multi-airport system,'' by Zhang *et al.*, the authors proposed an index system for airport collaboration on the multiairport system (MAS), including the number of external routes, total cost of the route network, passenger volume of the MAS, airport primacy ratio, route repetition rate, capacity utilization, and the purpose matching rate of airports. Based on this index, a mathematical model was constructed for collaborative optimization of the route network of the MAS and was used to determine the transit airport and its passenger volume. The indices were transformed into constraints and optimization objectives.

In the article ''Prediction of passenger flow in urban rail transit based on big data analysis and deep learning,'' by Zhu *et al.*, the authors proposed a DL-SVM model for urban rail transit (URT) passenger flow prediction. The model combines deep learning (DL) theory and support vector machine (SVM). The deep belief network (DBN) is used to extract the

features and inherent variation of passenger flow data, and the SVM regression model is used to predict passenger flow. The proposed model was compared with three shallow prediction models through experiments on Qingdao Metro. The results show that the DL-SVM outperformed the other models in accuracy and stability.

In the article ''Operation mechanisms for intelligent logistics system: A blockchain perspective,'' by Fu and Zhu, the authors proposed a scheme for applying blockchain in intelligent logistics systems, which includes operation principle, consensus authentication mechanism, and data storage and access mechanism. The scheme provided thoughts for the application research of intelligent logistics systems based on blockchain.

In the article ''Multi-tasks discovery method based on the concept network for data mining,'' by Wang and Gao, the authors proposed an automatic data mining tasks discovery method (DMTD) by establishing the concept network (CN) model to represent human knowledge and experience in the problem-solving process. The method has been tested with two major mining tasks (clustering and classification) in a CN. Experiment results illustrated that the DMTD can discover all the potential mining tasks from a predefined concept network, filtered by important or interesting analysis subjects.

In the article ''Clustering of remote sensing data based on k-nearest neighbors sampling with non-evenly division,'' by Liu *et al.*, the authors proposed a method of remote sensing data based on k-nearest neighbors (KNN) sampling with nonevenly division. The experiments prove that the proposed method can not only precisely record the correspondence relations between samples and unsampled data by the KNN sampling with nonevenly division and ensure the accuracy of clustering results but also significantly reduce data traffic and effectively improve memory utilization. The result reveals that the proposed method can potentially contribute to the data analysis of remote sensing data and prediction of traffic jams with large-scale and high real-time performance.

In the article ''An improved multi-objective quantum-behaved particle swarm optimization for railway freight transportation routing design,'' by Zhang *et al.*, the authors proposed an improved multiobjective quantum-behaved particle swarm optimization algorithm (IMOQPSO) for railway freight transportation routing Design. The article also compared the performance of the improved multiobjective quantum-behaved particle swarm optimization algorithm with four other continuous multiobjective swarm intelligence algorithms. The results showed that the proposed algorithm obtained the best Pareto front, which is closer to the real Pareto front of railway freight transportation routing design.

In the article ''Integrated inventory-transportation problem in vendor-managed inventory system,'' by Teng *et al.*, the authors proposed a two-echelon inventory–transportation problem in Vendor Managed Inventory (VMI) system. The objective was to minimize total logistics cost in the distribution network, including inventory cost, distribution cost, and time penalty cost. The upper echelon model focused on minimizing inventory cost, while the lower echelon model focused on vehicle routing problem. A mixed algorithm was designed to solve the problem with simulated annealing and ant colony with a local search.

In the article ''Simulation of evacuating crowd based on deep learning and social force model,'' by Li *et al.*, the authors proposed a pedestrian detection method based on the social force model (SFM) with deep learning for crowd evacuation applications. Several deep learning algorithms for pedestrian detection were compared, and the best ones for sparse and dense crowds were determined. The pedestrian positions in a real video were acquired by the selected algorithms and converted into actual coordinates in the scene. Then, the evacuation process was simulated with the proposed method and the SFM based on these coordinates.

In the article ''Resource-expandable railway freight transportation routing optimization,'' by Wang *et al.*, the authors proposed an improved algorithm of swarm intelligence for the design of door-to-door full-loaded transportation of railway goods. The improved algorithm was applied to solve the selected benchmark cases, and the comparison and analysis were conducted from both quantitative and qualitative aspects to verify their performance in solving continuous optimization problems.

In the article ''Short-term passenger flow prediction based on wavelet transform and kernel extreme learning machine,'' by Liu *et al.*, the authors proposed a hybrid forecasting model W-KELM, which combines wavelet transform (WT) and kernel extreme learning machine (KELM) to get a more accurate prediction of short-term passenger flow. The main idea of the model is to decompose passenger flow data into high-frequency and low-frequency sequences through WT and Mallat algorithms, and then use KELM approach to learn and forecast signals with different frequencies. Finally, different prediction sequences are reconstructed using WT.

In the article ''Preserving location privacy in spatial crowdsourcing under quality control,'' by Chu *et al.*, the authors proposed a scheme to protect workers' location privacy from the spatiotemporal information collected by the emerging spatial crowdsourcing (SC) of intelligent transportation systems. Two measures, location entropy and results accuracy, are used to evaluate the performance of location privacy protection.

In the article ''Triplet decoders neural network ensemble system and T-conversion for traffic speed sequence prediction,'' by Own *et al.*, the authors proposed a Triplet Decoders Neural Network (TDNN) model for traffic flow prediction. In addition, they proposed a data preprocessing model called T-Conversion, to help RNN capturing long-term dependencies.

In the article ''Environmental intelligent control of underground integrated pipe gallery based on equipment failure rate,'' by Xue *et al.*, the authors proposed an intelligent regulation algorithm for underground integrated pipe gallery based on equipment failure rate. The algorithm can

effectively reduce the probability of equipment failure by intelligent regulation of the environment and improve the safety and economy of the underground integrated pipe gallery.

In the article ''Feature recognition of urban road traffic accidents based on GA-XGBoost in the context of big data,'' by Qu *et al.*, the authors proposed a feature recognition model based on big data from traffic accidents. The model uses the XGBoost algorithm as a multi-classifier of traffic accident levels to identify the characteristics of urban road traffic accidents by a GA search for the optimal solution. The model was tested with big data from traffic accidents in a sub-provincial city in China and compared with the GA-RF, GA-GBDT, and GA-LightGBM models. The results show that the GA-XGBoost model can effectively identify the characteristics of urban road traffic accidents and that the algorithm has better performance.

In the article ''A multi-index fusion clustering strategy for traffic flow state identification,'' by Bao, the author proposed a multi-index fusion clustering strategy to improve the identification accuracy of traffic flow states and disclose the impacts of different evaluation indices on the identification results.

In the article ''A real-time collision avoidance strategy in dynamic airspace based on dynamic artificial potential field algorithm,'' by Du *et al.*, the authors proposed a real-time reactive path planning method for collision avoidance in dynamic airspace (DAPF), which generates a collision-free path according to the threat level of the moving obstacle. For a variety of encounter scenes and motion states of the obstacle, the DAPF can prevent the UAV from colliding into nearby unexpected moving obstacles and reduce the impact on nearby users of the airspace.

In the article ''A hidden Markov model-based map matching algorithm for low sampling rate Trajectory data,'' by Hu and Lu, the authors proposed a map-matching algorithm based on the hidden Markov model, where both position and direction information for calculating observation and transition probabilities have been used to solve the labeling problem with the Viterbi algorithm by maximizing the state sequence probabilities.

In the article ''A novel density peaks clustering Halo node assignment method based on k-nearest neighbor theory,'' by Wang *et al.*, the authors proposed a density peaks clustering halo node assignment algorithm based on the k-nearest neighbor theory (KNN-HDPC). KNN-HDPC can grasp the internal relations between outliers and cluster nodes more deeply, so as to dig out the deeper relationships between nodes.

In the article ''A novel self-adaptive affinity propagation clustering algorithm based on density peak theory and weighted similarity,'' by Wang *et al.*, the authors proposed a DPWSAP to solve both the similarity calculation method and parameter limits problems of the affinity propagation algorithm. Differing from the existing clustering algorithms, DPWSAP put forward the fusion of domain density and distance method to calculate the similarity more accurately.

In the article ''Solving vehicle routing problem: A big data analytic approach,'' by Zheng, the author put forward a dynamic VRP model based on big data analysis on traffic flow and solved it using the genetic algorithm (GA). It was assumed that the real-time traffic data were updated every 15 min in the transport network, and the customer demand was updated dynamically from time to time.

In the article ''Direction-decision learning based pedestrian flow behavior investigation,'' by Zhang and Jia, the authors proposed a microscopic simulation model to investigate the pedestrian flow behavior in corridors based on the desired-direction-decision learning and social force model. The proposed model is composed of two parts: direction-decision and walking behavior decision.

In the article ''Modeling and recognition of driving fatigue state based on R-R intervals of ECG data,'' by Wang *et al.*, the authors used the heart rate R-R interval sequence as an indicator to recognize the driving fatigue state. For the R-R interval sequence, it has the volatility cluster effect. Then, the AR(1)-GARCH(1,1) model is used to analyze the sequence. According to the case study based on field data, the developed model can recognize the driving fatigue state in a timely manner.

In the article ''Directional signage location optimization of subway station based on big data,'' by Tu *et al.*, the authors used big data to analyze the problem of signage in Beijing subways and proposed an optimization model for signage in subway stations based on the particle swarm optimization algorithm.

In the article ''A barrage sentiment analysis scheme based on expression and tone,'' by Cui *et al.*, the authors proposed a sentiment dictionary based on expression and tone to increase the effect of barrage sentiment analysis. The proposed sentiment calculation method was based on expression and tone to increase the accuracy.

In the article ''A research into the reliability of equipment-integrated system regarding high-speed train based on network model,'' by Li *et al.*, the authors put forward the principle of the division of the main body structure of the subsystem and the equipment unit, and combined network-related knowledge to establish the connection relationship between equipment units, and constructed the network model of equipment-integrated systems to solve the composition of equipment-integrated systems and the working mechanism of High-Speed Train Based on Network Model.

In the article ''Analysis of bus trip characteristic analysis and demand forecasting based on GA-NARX neural network model,'' by Sun *et al.*, the authors refined bus operation management using the IC card data from Qingdao buses. The model studied the distribution characteristics and regularity of bus passenger flow over time, and analyzed this data in terms of single-day passenger flow and subperiod passenger flow. The model used a genetic algorithm to improve the prediction accuracy of short-term public transport passenger flow prediction, providing theoretical and methodological support for the real-time scheduling and scheme

formulation of public transport operation management departments.

In the article "A spatiotemporal Apriori approach to capture dynamic associations of regional traffic congestion," by Xie *et al.*, the authors developed a data-driven approach based on the Apriori algorithm to explore the underlying inherent characteristics of regional congestion associations of a road network. The approach recognizes a regional traffic state based on a clustering algorithm that integrates the classical k-means++ and FCM algorithms.

In the article "Paving the way for evaluation of connected and autonomous vehicles in buses-preliminary analysis," by Xiao *et al.*, the authors proposed a safety study that paves the way for the implementation of CAVs in public buses from the injury severity perspective. The study considers the drivers' factors when replaced by CAVs using a CHAID decision tree model. The results showed that drivers' actions and the crash type were significant for the crash severity.

In the article "A day-to-day stochastic traffic flow assignment model based on mixed regulation," by Wu *et al.*, the authors proposed a DTD stochastic traffic flow assignment model based on mixed regulation to solve the stochastic travel time when the final path selection of travelers is not the shortest path. The proposed model was verified through simulation on a Nguyen–Dupuis road network. The results show that traffic flows and travel times of all paths reached the equilibrium state.

In the article "Preventive maintenance decision model of urban transportation system equipment based on multi-control units," by Li *et al.*, the authors proposed a joint equipment monitoring model for multi-equipment systems composed of intelligent control units. The network method predicts the faults of the equipment and gives the equipment fault prediction process. Combining the multiequipment system attributes of intelligent control units, aiming at minimizing the total maintenance cost of control unit systems, and taking the reliability of the whole system and the availability of equipment as constraints, a preventive maintenance decision model for joint equipment maintenance is established.

In the article "Bus scheduling of overlapping routes with multi-vehicle types based on passenger OD data," by Bie *et al.*, the authors proposed a multivehicle-type scheduling model to minimize the overall cost of passenger travel time. The model uses heuristic knowledge designed to tune the model. Three real bus routes were selected to validate the model.

In the article "Drowsy driving detection based on fused data and information granulation," by Wang *et al.*, the authors proposed a model to detect drowsy driving based on data fusion and information granulation. The drowsy driving mode was identified on a simulation platform for drivers' operating behavior and the vehicles' running state. The drowsy driving detection model was trained and tested by LIBSVM based on the fused information of the mean and standard deviation of composite factor scores in each subtime window. Experimental results showed that the model outperformed the contrastive models with an accuracy of 86.47% and an AUC of 0.911.

In the article "Seaport data space for improving logistic maritime operations," by Sarabia Jácome *et al.*, the authors proposed Seaport Data Space (SDS) architecture based on the Industrial Data Space (IDS) reference architecture model to enable a secure data sharing space and promote an intelligent transport multimodal terminal. Each seaport stakeholder implements the IDS connector to take part in the SDS and share their data. On top of SDS, a Big Data architecture is integrated to manage the massive data shared in the SDS and extract useful information to improve decision making.

In the article "Research on construction of crude set model of critical fault information for bus based on CAN-BUS data," by Li *et al.*, the authors studied the current situation of frequent faults in urban ground public transport vehicles in Beijing based on factors that include the vehicle situation, management status, and external traffic characteristics, and used the huge data set of CAN-BUS data, warranty data, rush repair data, and traffic scheduling data, to carry out predicting the key fault information of vehicles.

In the article "An expected utility-based optimization of slow steaming in sulphur emission control areas by applying big data analytics," by Zhao *et al.*, the authors analyzed the operator's risk-based decision (RBD) company for slow steaming and creates a sailing speed optimization model for slow steaming (SSOM-SS), aiming to balance the expected utility-based objectives (EUO) of fuel consumption, SOx emissions, and delivery delay. The analysis applies big data analytics (BDA) techniques like data fusion and feature selection to provide the SSOM-SS with accurate and suitable data on fuel consumption.

In the article "Research on lane occupancy rate forecasting based on the capsule network," by Tian *et al.*, the authors proposed a hybrid lane occupancy rate prediction model called 2LayersCapsNet, which combines the improved capsule network and convolutional neural networks (CNNs). The model uses CNNs to mine the spatial–temporal correlation characteristics of the lane occupancy rate and then uses an improved capsule network to mine the interrelationships in traffic data measured by sensors in continuous time intervals to predict the lane occupancy rate. The model can solve the problem of CNNs losing important spatiotemporal information caused by the maximum pooling operation and can obtain better prediction results.

In the article "RNN-based subway passenger flow rolling prediction," by Sha *et al.*, the authors proposed a subway station passenger flow prediction model to forecast passenger volume. The model helps to carry out safety warnings and evacuation passenger flow in advance. Based on data from Shanghai traffic cards, the passenger volume in all the time intervals is clustered into three different models for prediction.

In the article "Logistic optimization for multi depots loading capacitated electric vehicle routing problem from low

carbon perspective,'' by Zhu *et al.*, the authors investigated the 2L-MDEVRP (a multidepot-capacitated electric vehicle routing problem where client demand is composed of two-dimensional weighted items) algorithm, which is a variant of VRP. Since the 2L-MDEVRP is an NP-hard problem, a heuristic algorithm combining variable neighborhood search algorithm (VNS) and space-saving heuristic algorithm (SSH) was proposed. The VNS algorithm was used to solve the vehicle routing problem (VRP) sub-problem, and the SSH algorithm was used to solve the bin packing problem (BPP) subproblem.

In the article ''Economic system simulation with big data analytics approach,'' by Li *et al.*, the authors studied the common characteristics of economic and security issues with many source data and complex, wide-ranging, and complex behaviors, for the key technologies such as networked simulation support technology based on cloud computing concept, high-performance data processing and analysis method based on big data, and parallel system construction in the economic field, so as to realize simulation capability of economic dynamics, dynamic evaluation of economic development, and economic security prediction.

In the article ''The design of intelligent transportation video processing system in big data environment,'' by Hao and Qin, the authors suggested a high-performance computing architecture for large-scale transportation video data management based on cloud computing and designed a parallel computing model containing the distributed file system and distributed computing system to solve problems associated with flexible server increase or decrease, load balancing and flexible dynamic storage increase or decrease, computing power, and great improvement of storage efficiency. On the basis of this technical architecture, the system adopts BP neural network-related algorithms to extract the static transportation signs in road videos and uses the interframe difference algorithm and the Gaussian mixture model (GMM) fusion algorithm to extract the moving targets in road transportation videos.

In the article ''Route optimization for last-mile distribution of rural e-commerce logistics based on ant colony optimization,'' by Liu, the author proposed a route optimization model constructed for RECL's last-mile distribution to maximize the profit of the logistics enterprise. The model uses ant colony optimization (ACO) to improve the heuristic information and update rule of pheromone.

In the article ''Time series data mining: A case study with big data analytics approach,'' by Wang *et al.*, the authors proposed several time series autoregressive (AR) models, along with a moving average (MA) model and ARIMA model, for reliably predicting the future stock price trend based on the historical price.

In the article ''Research trends in enterprise service bus (ESB) applications: A systematic mapping study,'' by Aziz *et al.*, the authors conducted a systematic study with the goal of understanding the applicability of enterprise service bus (ESB). The study selected papers according to their features such as contribution-type and ESB applications. The systematic study identified a total of twenty-two papers and provided suggestions on possible directions for future research.

In the article ''Financial big data analysis and early warning platform: A case study,'' by Liang *et al.*, the authors investigated multi-source heterogeneous data fusion algorithms and cleaning technologies to establish a suitable style for data analysis and big data computation frame. Based on this investigation, a method has been proposed to provide the basis for early analysis of economic security by embedding risk early-warning methods and building a risk monitoring and early-warning platform to achieve scientific economic decision making.

In the article ''Clarifying origin–destination flows using force-directed edge bundling layout,'' by Luo *et al.*, the authors proposed an approach to visualize origin–destination (OD) flows and identify the main corridors in a city based on the force-directed edge bundling (FDEB) algorithm. The approach reduces the chaos of OD flows through vertex clustering and then uses a modified FDEB algorithm to clarify the OD flows.

In the article ''Multi-lane short-term traffic forecasting with convolutional LSTM network,'' by Ma *et al.*, the authors proposed a convolutional long short-term memory (LSTM) neural network architecture for multi-lane short-term traffic prediction. The model applies multiple features to characterize traffic conditions, explicitly considering the routing between neighboring lanes and downstream/upstream traffic, as well as predicting multiple time-step traffic in a rolling-prediction manner.

In the article ''Copula-based travel time distribution estimation considering channelization section spillover,'' by Yu *et al.*, the authors proposed an approach to estimate travel time under uncertainty by incorporating the correlation of turning movements in the travel time distribution (TTD) model by considering section spillover (CSS), copula-based link-level, and path-level.

In the article ''Disruption recovery for urban public tram system: An analysis of replacement service selection,'' by Fang *et al.*, the authors proposed an approach to provide replacement services for stranded passengers during short-term unplanned events for the tram system. A decision support tool to dispatch appropriate replacement services by taxis or buses was investigated.

In the article ''A deep adaptive traffic signal controller with long-term planning horizon and spatial–temporal state definition under dynamic traffic fluctuations,'' by Li *et al.*, the authors proposed an adaptive traffic signal control scheme to effectively manage dynamically fluctuating traffic flow through intersections. A spatial–temporal representation of the traffic state at an intersection was designed to efficiently identify traffic patterns from complex intersection environments, and a deep neural network (long short-term memory network, LSTM) was used to determine look-ahead signal

control decisions based on the estimated long-term feedback from a given traffic state.

In the article "A high-precision collaborative control algorithm for multi-agent system based on enhanced depth image fusion positioning," by Deng *et al.*, the authors proposed an approach to collaboratively control a multi-agent system (MAS) with multiple under-driven automated guided vehicles (AGVs) based on flexible sampling periods and changing communication topology. A first-order collaborative control algorithm (CSRR) was proposed for the under-driven AGVs, which guaranteed the convergence of system states.

In the article "Neural network-based prediction model for passenger flow in a large passenger station: An exploratory study," by Jing and Yin, the authors proposed a neural network model to predict passenger flow. First, the key factors affecting the change of passenger flow are selected and analyzed as the input of the neural network. Second, the learning and rate updating of variable step size was adopted to estimate the number people entering the station during a certain time interval, which is then weighted with the historical data to derive the prediction of passenger flow during the next time interval.

In the article "Exploring dynamic characteristics of multistate air traffic flow: A time series approach," by Li *et al.*, the authors investigated the dynamic evolution and fluctuation characteristics of multistate air traffic time series from a complex network perspective, which is essential for understanding the nature of an air traffic system. The fundamental diagram (FD) approach identified three key variables for interpreting the arrival traffic flow states of the Xiamen Gaoqi International Airport: the relative velocity, flight distance, and trajectory similarity.

In the article "Mixed scheduling strategy for high frequency bus routes with common stops," by Bie *et al.*, the authors proposed a mixed scheduling method combining the all-stop service and the stop-skipping service for overlapping bus routes. The proposed method optimizes scheduling strategies for multiple routes by minimizing total passenger travel time. The optimization variables are binary variables reflecting whether the stops in the overlapping area are skipped.

In the article "Short-term passenger flow prediction of a passageway in a subway station using time space correlations between multi sites," by Li *et al.*, the authors proposed a method for a multi-sites prediction (MSP) of passenger flow in a subway station. Real-time passenger flow data collected from multisites in a subway station were used as inputs, and a delay parameter was introduced to identify the correlation between measurements at multiple sites.

In the article "A vehicle routing problem model with multiple fuzzy windows based on time-varying traffic flow," by Zheng, the authors proposed a vehicle routing problem (VRP) model with multiple fuzzy time windows, based on time-varying traffic flow to minimize the total distribution cost and mean consumer dissatisfaction. The Ito algorithm was improved based on time-varying traffic flow. The model and algorithm were verified through example simulation, in comparison with ant colony optimization (ACO).

In the article "Design and simulation of an intelligent current monitoring system for urban rail transit," by Yao *et al.*, the authors explored the different resistances in each power supply section under unilateral and bilateral power supplies in urban rail transit (URT) systems that cause great safety hazards to the metal structures in and near the URT system. To identify the defects, a back propagation neural network (BPNN) has been proposed to build a discharge flow prediction model.

In the article "Enabling serverless deployment of large-scale AI workloads," by Christidis, *et al.*, the authors proposed a set of optimization techniques for transforming a generic AI codebase so that it can be successfully deployed to a restricted serverless environment without compromising capability or performance. The techniques involve slimming the libraries and frameworks, dynamically loading pretrained AI/ML models into local temporary storage, using separate frameworks for training and inference, and performance-oriented tuning for data storage and lookup.

In the article "Traffic data imputation and prediction: An efficient realization of deep learning," by Zhao *et al.*, the authors studied the prediction of traffic flow in the presence of missing information from data sets. Three different patterns were used to model the missing data structure, and two types of approaches for the imputation were proposed. The resulted forecasting model uses deep-learning-based methods to predict the traffic flow from the recovered data set.

In the article "Integration of train-set circulation and adding train paths problem based on an existing cyclic timetable," by Tan *et al.*, the authors investigated the additional train paths problem for tactical and short-term planning applications with multiple objectives for scheduling a hybrid cyclic timetable and adapting traffic needs. The proposed a mixed-integer programming model and multiobjective adding train paths (ATPs) to simultaneously decide initial trains' modifications, additional trains' schedules, and train-set circulation. The tolerance of disruption for initial trains, including allowed adjustment and periodic structure, is taken into account in light of the practical concerns.

In the article "Object recognition based interpolation with 3D LIDAR and vision for autonomous driving of an intelligent vehicle," by Weon, *et al.*, the authors proposed an algorithm for fusing 3-D LIDAR (Light Detection and Ranging) systems that receive objects detected in deep-learning-based image sensors and object data in the form of 3-D point clouds. The 3-D LIDAR represents 3-D point data in a planar rectangular coordinate system with a 360° representation of the detected object surface, including the front face. However, only the direction and distance data of the object can be obtained, and point cloud data cannot be used to create a specific definition of the object.

In the article "Study on delay propagation relations among airports based on transfer entropy," by Xiao *et al.*, the authors

proposed a low-dimensional approximation of conditional mutual information (CMI) for transfer entropy (LTE) to address the delay propagation from the perspective of multiple airports and the constructing delay propagation relation (DPR) networks among airports.

In the article ''Hierarchical multimodal Hub location with time restriction for China railway (CR) express network,'' by Ma *et al.*, the authors proposed a hierarchical multimodal for the hub location problem with time restriction for China railway (CR) express network to balance cargo flow and improve transport efficiency. A mixed integer programming is formulated and derived, and some results are concluded.

In the article ''Intelligent application protection mechanism for transportation in V2C environment,'' by Kim *et al.*, the authors proposed an intelligent application protection mechanism for smart vehicle services in a V2C environment that detects abnormal behavior through image-based system resource monitoring using artificial intelligence (ISRM-AI) to improve cloud vehicle service security. The ISRM-AI generates images about system information such as CPU, network, and memory on V2C cloud services.

In the article ''Intersection traffic control based on multi-objective optimization,'' by Mou, the author proposed a signal timing control model to optimize road capacity, delay time, and the number of stops at intersections, under the constraints of cycle time, effective green light time, and the maximum number of vehicles in each intersection direction. The dragonfly algorithm (DA) was improved to help in solving the optimization problem by a hybrid mutation operator to ensure the diversity of solution set.

In the article ''Prediction of vessel traffic volume in ports based on improved fuzzy neural network,'' by Su *et al.*, the authors proposed an improved fuzzy neural network (FNN) model with a quantum genetic algorithm (QGA) for accurate prediction of vessel traffic volume (VTV). The established model was applied to predict the VTV in an actual port of China, in comparison with several classic NNs. The VTV data were collected based on the length and gross tonnage of vessels. The results showed that the improved FNN outperformed the contrastive methods in the accuracy of VTV prediction.

In the article ''A cellular-automaton agent-hybrid model for emergency evacuation of people in public places,'' by Chang *et al.*, the authors studied the role of people and the evacuation environment as factors that influence emergency evacuations. An evacuation model is established using cellular automata and agent-hybrid theory.

In the article ''Dynamic path planning for unmanned vehicles based on fuzzy logic and improved ant colony optimization,'' by Song *et al.*, the authors proposed a dynamic path planning strategy based on fuzzy logic (FL) and improved ant colony optimization (ACO) for unmanned vehicles. The classic ACO was improved into the rank-based ant system. The improved ACO was integrated with the FL into the fuzzy logic ant colony optimization (FLACO) to find the optimal path for unmanned vehicles.

In the article ''Path planning for intelligent parking system based on improved ant colony optimization,'' by Wang *et al.*, the authors proposed a fallback strategy to improve ant colony optimization (ACO) for path planning in AGV-based intelligent parking systems. The adopted valuation function was used to optimize the calculation process of the heuristic information, and a reward/penalty mechanism was employed to the pheromone update strategy.

In the article ''A spatio-temporal structured LSTM model for short-term prediction of origin–destination matrix in rail transit with multisource data,'' by Li *et al.*, the authors proposed a combined multisource data with deep learning method to improve prediction of dynamic origin and destination demand (OD) matrix accuracy. The method improved the structure of long short-term memory network (LSTM) by redesigning the hidden layer and neuron, in view of the spatio-temporal characteristics of spatio-temporal long short-term memory network (STLSTM) of rail transit passenger flow.

In the article ''Travel mode choice prediction using deep neural networks with entity embeddings,'' by Ma and Zhang, the authors proposed an approach for optimizing data-driven prediction models for travel mode choice prediction with handling categorical data. The approach uses neural networks to efficiently learn dense vector representations of the categorical data. This feature representation process can be jointly trained by combining the entity embedding network with the downstream prediction network using a standard gradient-based optimization method.

In the article ''A modified post encroachment time model of urban road merging area based on lane-change characteristics,'' by Qi *et al.*, the authors proposed a modified post encroachment time (PET) model to estimate the safety level of some risky areas, especially for the merging areas of urban roads. The model considers the lane-change characteristics and accurately forecasts the traffic safety of the merging area.

In the article ''Short-term road speed forecasting based on hybrid RBF neural network with the aid of fuzzy system-based techniques in urban traffic flow,'' by Ai *et al.*, the authors proposed a hybrid radial basis function (RBF) neural network algorithm for forecasting road speed. The algorithm uses a fuzzy RBF neural network structure by combining the fuzzy logic system with the RBF neural network. It also incorporates factors such as weather, holidays, and road grades into the input layer.

In the article ''Free parking space prediction and reliability analysis based on big data analysis,'' by Zhang *et al.*, the authors investigated the distribution of free parking spaces (FPSs) in parking lots to predict the number of FPSs. The proposed model was subjected to big data analysis, revealing that the hourly number of FPSs obeys similar trends on different weekdays. The model was tested for effectiveness, and the algorithm was verified through simulation.

In the article ''A ramp metering method based on congestion status in the urban freeway,'' by Liu *et al.*, the authors

proposed an improved ALINEA algorithm for ramp metering, named CS-ALINEA. In this algorithm, the traffic flow is used to replace the occupancy as the control parameter, where the control rate can be selected according to the congestion status reclassified adaptively.

In the article ''Cause analysis of traffic accidents on urban roads based on an improved association rule mining algorithm,'' by Cai, the author proposed an improved Apriori algorithm to mine the association rules between risk factors, and probe deeply into the causes of traffic accidents on urban roads. According to the layer and dimension of specific attributes, the parameters such as support, confidence, and lift were adjusted to find the qualified association rules between risk factors. The results were further screened to obtain a series of meaningful association rules.

In the article ''Sign optimization model for rail transit: A big data approach,'' by Jing and Bai, the authors proposed an optimal model for placement of guide signs from multiple candidate positions. The model can theoretically reduce guidance errors caused by the guidance marks. The model considers the complaint data of Beijing Metro and uses Word2vec methods to effectively prove the phenomenon of subway-oriented sign identification. Next, it builds an MIP model for the subway-oriented identification system based on the optimization theory and analyzes the model.

In the article ''SADANet: Integrating scale-aware and domain adaptive for traffic sign detection,'' by Liu *et al.*, the authors proposed a traffic sign detection framework using a scale-aware and domain adaptive network (SADANet), which seamlessly combines a multiscale prediction network (MSPN) with a domain adaptive network (DAN) in a tightly coupled manner in order to tackle traffic sign detection in real environments.

In the article ''Human motion target recognition using convolutional neural network and global constraint block matching,'' by Liu and Li, the authors proposed a human motion target recognition algorithm based on convolutional neural network (CNN) and global constraint block matching to recognize the spatial constraint problem of feature blocks, which leads to good recognition effect and high correct rate. The algorithm considers the key frames of the human motion video and the local feature and global feature of key frames. The CNN model is used to perform feature fusion, and then, according to the result of the feature fusion, a feature block was formed and the closest matching feature block was obtained

In the article ''Automatic road survey by using vehicle mounted laser for road asset management,'' by Li *et al.*, the authors proposed a vehicle-mounted point laser system for the automated, rapid, and inexpensive measurement of a major mode of local road deterioration, namely fretting. Compared to other technologies such as Ground Penetrating Radar (GPR), visual sensors, and the Mobile Laser Scanning (MLS) system, the point laser requires less computational power, is less sensitive to the surrounding environment, and is of comparatively lower cost.

In the article ''Automated pavement distress detection and deterioration analysis using street view map,'' by Lei *et al.*, the authors proposed a deep learning method based on a pretrained neural network architecture to identify and locate pavement distress in real time. About 20,000 street view images were collected and labeled as the training dataset using the Baidu e-map. Eight types of distress are notated using Yolov3 deep learning architecture.

In the article ''Traffic flow forecast through time series analysis based on deep learning,'' by Zheng and Huang, the authors proposed a model based on deep learning (DL) to forecast traffic flow through time series analysis. The model uses the long short-term memory (LSTM) network. The model was compared with two classic forecast models, namely the autoregressive integrated moving average (ARIMA) model and the back propagation neural network (BPNN) model, through long-term traffic flow forecast experiments, using an actual traffic flow time series from OpenITS.

In the article ''Road anomaly detection through deep learning approaches,'' by Luo *et al.*, the authors addressed road anomaly detection by formulating it as a classification problem and applying deep learning approaches to solve it. Besides conventional road anomalies, additional ones are introduced from the perspective of a vehicle to facilitate the learning process. Three deep learning approaches were used to detect the anomaly: Deep Feedforward Network (DFN), Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN), in order to tackle the classification problem. The detectors, with respect to the three deep learning approaches, were trained and evaluated through data collected from a test vehicle driven on various road anomaly conditions.

In the article ''A new hybrid algorithm for cold chain logistics distribution center location problem,'' by Dou *et al.*, the authors proposed a mathematical optimization model of cold chain logistics distribution center model to solve the problem associated with perishable characteristics of refrigerated food. An immune wolf colony hybrid algorithm is proposed to solve the location problem of the distribution center.

In the article ''Big data analysis of Beijing urban rail transit fares based on passenger flow,'' by Gao *et al.*, the authors proposed an improved measure for the shortest path fare scheme for urban rail transit. The authors simulated Beijing rail transit using Anylogic simulation technology and shortest path algorithm, and investigated the travel time between any originations and destinations. They used big data analysis technology to obtain the actual travel time distribution between any originations and destinations by processing basic data from passengers entering and leaving the station.

In the article ''Lane work-schedule of toll station based on queuing theory and PSO-LSTM model,'' by Wang *et al.*, the authors proposed a solution for lane work plans. First, the average queue length was selected as a good index for measuring the congestion of toll stations. Then, based on the

queuing theory, the service level of toll stations was divided into four levels according to the relationship between the average queue length and traffic capacity. Secondly based on the toll data, a toll station congestion prediction model was established with the long short-term memory (LSTM) model and the particle swarm optimization (PSO) algorithm.

In the article ''An improved LSTM model for behavior recognition of intelligent vehicles,'' by Xiao *et al.*, the authors applied LSTM to the vehicle behavior recognition problem to identify the left turn, right turn, and straight behavior of vehicles at intersections. The improved model can make full use of the input information and reduce unnecessary calculations, and the output of a single LSTM cell model can filter out interference information and retain important information, so it has better classification effect and faster training speed.

In the article ''Envisioning insight-driven learning based on thick data analytics with focus on healthcare,'' by Fiaidhi, the author proposed the use of Thick Data analytics to draw more specific insights from social media to enable healthcare givers to better understand what patients want and also to identify their pain points. Healthcare institutions cannot neglect the need to monitor and analyze popular social media outlets such as Twitter and Facebook, as patients often post their pain points. Thick data analytics were applied to healthcare information and can also be applied to other paradigms such as transportation systems.

In the article ''Scheduling extra train paths into cyclic timetable based on the genetic algorithm,'' by Tan *et al.*, the authors proposed a solution to the problem of inserting additional non-cyclic train paths into existing cyclic timetables. A multiobjective model for minimizing both the travel time of additional trains and the variation of existing trains has been proposed. The model considers both general constraints and some additional practical constraints, such as the overtaking priority constraint, reasonable adjustment of initial schedules, and the scheduled connections. A heuristic algorithm was introduced to find high-quality solutions for large-scale cases within reasonable computing time.

In the article ''A zero-inflated ordered probit model to analyze Hazmat truck drivers' violation behavior and associated risk factors,'' by Wu *et al.*, the authors investigated hazmat truck drivers' violation behavior and identified associated risk factors. Different data sources in intelligent transportation system (ITS), including hazmat transportation management system and traffic safety management system, are extracted and emerged together.

In the article ''An ineffective transport-focused, causality-based approach to station-to-station railway freight network design,'' by Yuan *et al.*, the authors investigated the notion of ineffective transport among rail stations. Based on defining the concept of ineffective transportation, their approach analyzed the ineffective transport volume and ineffective transport propagation on each station, which helped to more efficiently seek the core ineffective transport stations in the rail freight network.

In the article ''Optimization of time and power resources allocation in communication systems under the Industrial Internet of Things,'' by Yang and Wang, the authors proposed a dynamic allocation model for time and power resources in the Industrial Internet of Things (IIoT). Based on the proposed model, a dynamic resource allocation algorithm was designed to reduce energy consumption. In addition, a power and time allocation algorithm was developed to maximize the energy efficiency of the system.

In the article ''Improving bus transit services for disabled individuals: Demand clustering, bus assignment, and route optimization,'' by Du *et al.*, the authors proposed a four-module based methodology for the planning of bus transit, including demand information collection, demand clustering, transit bus assignment, and a linear programming-based route planning with different objective functions. Houston MetroLift bus transit service was employed as an example to illustrate the proposed method.

In the article ''Road scene segmentation based on deep learning,'' by Zheng and Naji, the authors investigated the semantic recognition of traffic scenes using a deep learning network model. A semantic recognition algorithm of road scenes based on image data was proposed. It was found that the proposed method can quickly capture the perceptual road scene, performs better than traditional methods, and demonstrates great potential to be used in a road scene applications.

In the article ''Method for identifying truck traffic site clustering using weigh-in-motion (WIM) data,'' by Liu *et al.*, the authors proposed an approach integrating two complementary data, weigh-in-motion (WIM) weigh data and telemetric traffic monitoring sites (TTMSs) volume data, to produce truck traffic site clustering. An improved k-means clustering with three attributes, the distances to the WIM sites (WIMSs), truck volumes in TTMS, and vehicle class distribution, was fitted to the TTMS.

In the article ''Mobility prediction based multi-directional broadcasting for both highway and urban vehicular sensor networks,'' by Ryu and Cha, the authors proposed a mobility prediction based multi-directional broadcasting (MPMB) protocol for both highway and urban Vehicular Sensor Networks (VSNs). VSNs have to ensure the prompt dissemination of critical sensing data to all vehicles within the Region of Interest (ROI) to avoid various road dangers.

In the article ''Behavioral feature description method based on the vector module ratio and vector angle of human body structure,'' by Hu *et al.*, the authors proposed a behavior description method from which the characteristics of bone joint points are extracted as behavior information. It is found that the direct use of joint coordinate information collected by depth camera for behavior recognition is easily affected by individual differences in behavior and changes in shooting distance. Considering the position information of

human joints, as well as the angle and length information of hidden limbs based on skeleton data, a behavior feature description method based on the ratio of vector angle and vector mode of human structure is proposed. This proposed method solves the above problems perfectly and obtains ideal results on the self-built data set, which is suitable for simple daily behavior recognition.

In conclusion, the Guest Editors would like to thank all the authors who submitted their research articles to our Special Section. They highly appreciate the contributions of the reviewers for their constructive comments and suggestions. The would also like to acknowledge the guidance from the IEEE Access Editor-in-Chief and staff members.

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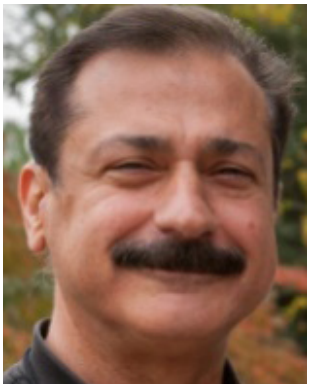
APPENDIX
RELATED WORK

1) L. Zhu, F. R. Yu, Y. Wang, B. Ning, and T. Tang, "Big data analytics in intelligent transportation systems: A survey," *IEEE Trans. Intell. Transp. Syst.*, vol. 20, no. 1, pp. 383–398, Jan. 2019.
2) N. Cheng, F. Lyu, J. Chen, W. Xu, H. Zhou, S. Zhang, and X. Shen, "Big data driven vehicular networks," *IEEE Netw.*, vol. 32, no. 6, pp. 160–167, Nov./Dec. 2018.
3) S. Mohammed, J. Fiaidhi, and M. Tang, "Towards using microservices for transportation management: The new TMS development trend," in *IEEE TechRxIv Preprint Paper LISS 2020: IEEE Int. Conf. Logistics, Inform. Service Sci.*, Budapest, Hungary, Jul. 2020, pp. 1–5. [Online]. Available: https://www.techrxiv.org/articles/preprint/Towards_using_Microservices_for_Transportation_Management_The_New_TMS_Development_Trend/11728965/1

SABAH MOHAMMED's (Senior Member, IEEE) research interests include intelligent systems that have to operate in large, nondeterministic, cooperative, highly connected, survivable, and adaptive or partially known domains. His continuous research is inspired by his Ph.D. work at Brunel University, U.K., in 1981, on the employment of the Brain Activity Structures for decision making (planning and learning) that enable processes (e.g., agents and mobile objects) and collaborative processes to act intelligently in their environments for timely achievement of the required goals. Having trained in medicine with a computer science Ph.D. in artificial intelligence (AI), he has been a Full Professor with the Department of Computer Science, Lakehead University, Thunder Bay, ON, Canada, since 2002, and a Core Professor for the BioTechnology Program, Lakehead University. With a research background in industry and academia, he has a strong international research reputation for his work on clinical decision support systems supporting remote areas, ubiquitous and extreme environments. Prior to his work at Lakehead University, he was the Chair of three computer science departments, HCT, Philadelphia, and Applied Science Universities. He is currently the Supervisor of the Smart Health FabLab, Lakehead University, and also the Chair of the special interest group on smart and connected health with the IEEE ComSoc eHealth TC. He is also a Professional Engineer of Ontario, Information Processing Professional, with CIPS. He was awarded Outstanding Associate Editor by IEEE Access and has research supported by major grant organizations, such as NSERC and CFI.



HAMID R. ARABNIA received the Ph.D. degree in computer science from the University of Kent, U.K., in 1987. He is currently a Professor Emeritus of computer science with the University of Georgia, Athens, GA, USA, where he has been since October 1987. He has about 280 peer-reviewed research publications, as well as 250 edited research books in his areas of expertise. Some of these books and journal special issues have received the top 25% downloads in their respective fields. He has been a PI/Co-PI on externally funded projects/initiatives of about $12 million. During his tenure as a Graduate Coordinator/Director, he secured the largest level of funding in the history of the department for supporting the research and education of graduate students (M.S. and Ph.D.). He has delivered a number of keynote and plenary lectures at international conferences, most recently at IEEE ICPADS, IEEE HPCC, ACM IMCOM, and others. He has also delivered a number of distinguished lectures at various universities and research units and centers. As of 2020, he has 11 Ph.D. students working under his supervision. His research interests include HPC/supercomputing, data science, deep learning, imaging science, and other compute intensive problems. His most recent activities include studying ways to promote legislation that would prevent cyber-stalking, cyber-harassment, and cyber-bullying. He is also an senior adviser to a number of corporations. He is also a Fellow and an Adviser of the Center of Excellence in Terrorism, Resilience, Intelligence & Organized Crime Research (CENTRIC). He has served as a member of the National Science Foundation (NSF) Site Visitation evaluation committee for ten years. He also received numerous distinguished awards from BIBE IEEE/SMC, ACM SIGAPP IMCOM, and others. He is the Editor-in-Chief of *The Journal of Supercomputing* (Springer). He is the book series Editor-in-Chief of *Transactions of Computational Science and Computational Intelligence* (Springer). He is also the Editor of *Annual Proceedings of Computational Science and Computational Intelligence* (Publisher: IEEE CPS). He has been an Associate/Guest Co-Editor of IEEE ACCESS journal since 2019.

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DALIN ZHANG received the Ph.D. degree in computer science from the Beijing University of Posts and Telecommunications, in 2014. In 2017, he was a Postdoctoral Researcher with the School of Electronics and Computer Engineering, Purdue University, USA. He is currently an Associate Professor of computer science and software engineering with Beijing Jiaotong University. At the same time, he led the Railway Software and Information Security Laboratory, National Research Center of Railway Safety Assessment (NRC-RSA), which is affiliated with Beijing Jiaotong University. His current research interests include railway information technology, software engineering, and information security. In the field of railway information technology, he mainly applies technologies, such as temporal action (video) detection, data mining, text recognition, and business flow management to improve the efficiency of railway operation and maintenance and monitoring. His research results have been successfully deployed in China's high-speed railway operations. In the field of software engineering, his research focuses on developing applications of program analysis and software testing for improving software reliability and security, as well as multimedia technologies and applications. He has been appointed as a Guest Editor of respected journals, such as IEEE ACCESS and *Cybernetics and Information Technologies*. He has published articles in *International Journal of Computers Communications and Control*, IEEE ACCESS, *Technical Gazette*, and so on.

TAI-HOON KIM (Member, IEEE) received the M.S. and Ph.D. degrees in electrical, electronics and computer engineering from Sungkyunkwan University, South Korea, and the Ph.D. degree in computer engineering from Bristol University, U.K. After working with the Technical Institute of Shindoricoh for two years as an Researcher, and working with the Korea Information Security Agency as a Senior Researcher for two years and six months, he worked with the Defense Security Command (DSC) about two years. After working with E-wha Woman University a half year as an Research Professor, he is currently a Professor with Sungshin W. University, South Korea, and a Visiting Scholar of UTAS, Australia. He wrote 17 books about software development, OS such as Linux and Windows 2000, and computer hacking and security. He has published about 200 articles in 2011. He is also a member of ACM, KIIT, and SERSC. He researched biometrics, bio-image processing, bio-medical system design, security engineering, the evaluation of information security products or systems with Common Criteria, process improvement for security enhancement, and some approaches and methods to make IT systems more secure. In these days, his research interests include biometric authentication, pattern recognition, and security and medical imaging. He is also the Vice-Chair of Science and Engineering Research Support soCiety (SERSC) and a Visiting Professor with Beijing Jiaotong University. He was the General Chair or the Program Committee Chair for more than 20 international conferences.

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