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Editorial

Channel Characterization and Modeling for 5G and Future Wireless System Based on Big Data

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Big Data is attracting more and more attention in various fields nowadays, changing the way we live greatly, and proving to be one of the hottest research topics. The base of big data lies in the huge volume and scale of data, hence making it better for us to make decisions if we can extract more useful information from the huge amount of data.

The tremendous development of 5G, especially with the combination of Internet and Internet-of-Thing (IoT), boosts the amount and type of wireless data dramatically. Compared with the 4G, the bandwidth (over hundreds of MHz), central frequency (centimeter and millimeter wave band), amount of antennas (3-dimensional and massive MIMO), number of sensors (IoT), and application scenarios expand enormously, leading to the rapid growth in the amount of data. To be more specific, as for the IoT, the density of sensors is increasing rapidly in 5G systems and sensors are distributed everywhere in a typical scenario which is leading to the exponential growth in wireless links, making it difficult for conventional channel characterization methods to handle it .

It is crucial to characterize the wireless channel accurately to guarantee the demand of 5G system. The preliminary performance of big data provides a promising prospect in various fields. By using big data, we can mine the characteristic of wireless channel deeply and parameterize the channel more precisely, which has never been studied. In this special issue, we cordially invite some researchers to contribute papers that discuss the channel modeling and simulation for 5G systems using big data and machine learning, as well as other artificial intelligence theories. And this special issue provides the state-of-art research in this field.

The paper "A Survey on Machine Learning-Based Mobile Big Data Analysis: Challenges and Applications" investigates how to identify the requirement and the development of machine learning-based mobile big data (MBD) analysis through discussing the insights of challenges in the MBD and reviewing state-of-the-art application of data analysis in the area of MBD. The paper introduced the development of MBD and reviewed the frequently applied data analysis methods. Three typical applications of MBD analysis, namely, wireless channel modeling, human online and offline behavior analysis, and speech recognition and verification in the Internet of vehicles, are introduced, respectively. Finally the paper proposed five main challenges including large-scale and high-speed-M-Internet, overfitting and underfitting problems, generalization problem, cross-modal learning, and extended channel dimensions.

The paper "A Full Duplex D2D Clustering Resource Allocation Scheme Based on a K-means Algorithm" talks about the Device-to-Device (D2D) technology problem of resource allocation and control in a single-cell scene. The concept of a restricted D2D communication area and a restricted D2D user-reusage area is put forward to reduce the complexity and interference intensity of resource allocation. And under the premise of satisfying the QoS (Quality of Service) demands of every system user, the resource allocation algorithm is improved, the optimal allocation of resources is carried

out, and the algorithm's processes are given in detail. The simulation result shows a good performance in eliminating interference and improving the spectrum efficiency and the system fairness.

As the unmanned aerial vehicle (UAV) plays an important role in many applications due to its high flexibility and low cost, more and more research is implemented to explore the channel characterization of Air-to-Air (AA) scenario. The paper titled "Air-to-Air Path Loss Prediction Based on Machine Learning Methods in Urban Environments" proposes path loss models for the UAV AA scenario based on machine learning. A ray-tracing software has been utilized to generate the data for an urban AA scenario. And the models have been learned by two machine learning algorithms, Random Forest and k-Nearest Neighbor (KNN). The test data have been used to evaluate the accuracy performance of these machine-learning based models and two empirical models, SUI model and COST231-W-I model. It has been demonstrated that machine learning provides a flexible modeling approach based on the training data for such complex environment, and Random Forest has the best prediction performance. In addition, the importance of five input features for the path loss in the AA scenario is analyzed. Results have confirmed that the path visibility is the dominant factor. Propagation distance and elevation angle have also shown great influences.

The paper "Predicting Wireless MmWave Massive MIMO Channel Characteristics Using Machine Learning Algorithms" deals with the topic of the prediction of channel statistical characteristics based on the well-known machine learning algorithm, convolutional neural network (CNN), for three dimensional millimeter wave massive multiple-input multiple output indoor channels. The ray tracing software, Wireless InSite, is used in this paper to build the measurement datasets. A complete description of the process for creating and training a CNN-based model is presented with special emphasis on the training process. The results show good fittings between the predicted channel statistical characteristics and the real channel statistical characteristics.

As we know, tunnel scenario is a major and significant communication scenario attracting more and more attention with the rapid development of high-speed railway. The paper titled "Channel Characteristics of Rail Traffic Tunnel Scenarios Based on Ray-Tracing Simulator" provides a good understanding of channel characterization of tunnel scenarios based on ray-tracing. The channel characteristics in different carrier frequencies and tunnel cross sections were analyzed and some important conclusions are drawn: the channel experiences a severe and stable fading in long arched tunnels compared to other tunnel scenarios. The presence of the vehicle body introduces additional 35 dB of the path loss, which leads to the fluctuation and instability of the channel. K-factor changes severely when the distance between Tx and Rx is smaller than 100m and then decrease smoothly in far region.

The paper "Analysis of Nonstationary Characteristics for High-Speed Railway Scenarios" presents the analysis of nonstationary characteristics in typical high-speed railway (HSR) scenarios involving rural, station, and suburban, according to passive long-term evolution (LTE) based channel measurements. Additionally, a four-state Markvo chain model (MCM) is established to characterize the birth-death (B-D) process of multipath components (MPCs), and the corresponding state transition probability matrix and steady-state probability are provided. The results provide helpful information for nonstationary channel modeling of HSR communication systems.

The paper titled "A Request-Based Handover Strategy Using NDN for 5G" explores the small cell base stations (SBS) handover problem in ultra-dense networks (UDN) for 5G. Request-Based Handover Strategy (RBHS) is presented to improve the user experience in performance and obtain the optimal allocation of resources, and a caching mechanism based on the users' requests is introduced for it. The proposed caching mechanism and access network selection mechanism were validated utilizing ndnSim. The simulation results demonstrate that the proposed strategy achieves around 30% higher cache hit rate and 20% more traffic reduction, compared with the access network selection base on SINR.

The paper "MU-MIMO Downlink Capacity Analysis and Optimum Code Weight Vector Design for 5G Big Data Massive Antenna Millimeter Wave Communication" discusses the design of the optimum beam-vector for each user to minimize interference from other users in multiuser multiple input multiple output (MU-MIMO) wireless communication system. The nonlinear sum-rate analysis using dirty paper coding (DPC) in Ricean fading channels based on signal-to-leakage plus noise ratio (SLNR) was undertaken. And a new method is proposed to find an optimum beam weight vector by exploring the power iteration method using eigenvector approximation. The proposed method achieves higher performance regarding mean achievable sum-rate capacity per user, proving to provide significant system capacity enhancement compared with the SVD method.

In conclusion, this special issue brings new insights into the intricate characterization and modeling of wireless channel based on big data. We hope that this information will be helpful to the development of 5G and provide some novel methods to resolve some wireless channel problems.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this Special Issue.

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