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Editorial

Channel Modeling and Simulation for Vehicular Communications

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The interest that exists globally around the so-called intelligent transportation systems (ITS) has fostered a large amount of research activities aimed at developing new wireless communication technologies for the information exchange among vehicles on the move. The design of such technology gained an important momentum when in 1999 the American Federal Communications Commission (FCC) allocated a 75 MHz bandwidth in the 5.9 GHz band for dedicated short-range communications (DSRC) systems. The technology has seen a continuous development and the achievement of several milestones ever since. However, while the future ahead looks promising, the design of radio transceivers for vehicular communications continues to be a complex task, because the high speed at which the vehicles can move poses several new challenges that are not a concern for conventional mobile communication systems. For example, due to the rapidly changing propagation conditions that are typically found in vehicular communication environments, the Doppler shift effects and the nonstationary characteristics of the wireless channel become exacerbated. These issues significantly affect the performance of transceivers that are not optimized to operate over highly dispersive nonstationary channels. Proper channel models are therefore needed that provide insights into the physics of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) radio reception and, at the same time, that lend themselves to mathematical and numerical system performance investigations.

This special issue aims to provide a global perspective on open problems, current research trends, new results and ideas, and hot topics in the area of channel modeling and simulation for vehicular communication systems. The special issue comprises a collection of four papers that were received from open call and accepted for publication after a thorough peer review.

In the paper entitled "Statistical Modeling, Simulation, and Experimental Verification of Wideband Indoor Mobile Radio Channels," Y. Ma et al. present a geometry-based stochastic model for wideband indoor mobile radio channels. The model assumes that the transmitted signal is scattered by objects that are exponentially distributed over the two-dimensional horizontal plane of a rectangular room. Departing from this model, the authors investigate the probability density function (PDF) of the angle of arrival (AOA), the PDF of the path length, the power delay profile (PDP), and the frequency correlation function (FCF). In addition, they present an efficient sum-of-cisoids (SOC) channel simulator based on the proposed nonrealizable wideband indoor channel model. The channel model and its SOC simulator have been validated experimentally by empirical data collected in different indoor scenarios at 2.4, 5, and 60 GHz.

The design of computer simulators for nonstationary Rice fading channels under nonisotropic scattering scenarios is the subject of research of the paper "A Novel Simulation Model for Nonstationary Rice Fading Channels," by K. Jiang et al. The authors of this paper present a simulation model based on sum-of-chirp signals that takes into account the smooth transition of fading phases between the adjacent channel states. They analyze the envelope and phase PDFs, autocorrelation function (ACF), and Doppler power spectrum density (DPSD) of the proposed simulator, and they also introduce a proper parameterization method for such simulator. Simulation results are presented to demonstrate the accuracy of the simulator in replicating the statistical properties of the reference Rice fading channel model under nonstationary and nonisotropic scenarios.

In the paper entitled "A Triply Selective MIMO Channel Simulator Using GPUs," R. Carrasco-Alvarez et al. present a novel methodology based on graphics processing units (GPUs) for the simulation of triply selective multiple-input multiple-output (MIMO) radio channels. Compared with sequential implementations, the proposed GPU-based channel simulator is shown to achieve a 650-fold computational time improvement for an 8×8 MIMO channel. In addition to the computational improvement, the proposed simulator offers flexibility for testing a variety of propagation scenarios in V2V and V2I communication systems.

Finally, the paper "Modelling and Analysis of Nonstationary Vehicle-to-Infrastructure Channels with Time-Variant Angles of Arrival," by M. Pätzold and C. A. Gutierrez, deals with the statistical modeling of fixed-to-mobile (F2M) multipath radio channels with time-varying angular statistics. In the state of the art, it is commonly assumed that the AOA statistics of the received multipath signal are time invariant. However, this assumption does not in general agree with real-world channels in which the AOAs vary with the position of a moving receiver. In their paper, the authors present a mathematical model for the time-varying AOAs. This model is then employed as a basis for the development of two nonstationary multipath fading channels models for V2I communications. The time-dependent ACF, time-dependent mean Doppler shift, time-dependent Doppler spread, and the Wigner-Ville spectrum of the proposed V2I channel models are analyzed. All in all, this paper provides a new view on the channel characteristics that go beyond ultrashort observation intervals over which the channel can be considered as wide-sense stationary.

Conflicts of Interest

I hereby declare that I and the other Guest Editors of the Special Issue have no conflicts of interest or private agreements with companies or organizations, as described in https://about.hindawi.com/managing-conflicts-of-interest/.

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