3-DIMENSIONAL SPATIAL CHANNEL MODEL FOR MULTI-STOREYED INDOOR ENVIRONMENTS

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Abstract

A three-dimensional (3-D) geometry-based stochastic model (GBSM) is presented for various types of multi-story indoor environments. The proposed model assumed that the scatterers are distributed within a spheroid, where the transmitter and the receiver are located at the focal points of the spheroid. The proposed model provides the probability density functions (PDFs) of the angle of arrival (AoA), the time of arrival (ToA) and the spatial correlation coefficients correspondence with several channel parameters of the channel.

By considering non-uniform scatterer distributions, the spheroid GBSM is extended for multistory indoor environments. Closed-form expressions are derived for the joint and marginal PDFs of the AoA in both the elevation and azimuth planes and the ToA. The analytically-derived PDFs of the AoA and ToA obtained for Gaussian and Rayleigh scatterer distributions are compared against those obtained from the ray-tracing simulation of typical indoor environments. The standard deviation values of Gaussian and Rayleigh scatterer distributions are chosen to provide the best possible approximation to the PDFs of the AoA and the ToA obtained from simulation. Our results clearly indicate that the analytically-derived PDFs of the AOA and the TOA for Gaussian and Rayleigh scatterer distributions are in much closer agreement with those obtained from ray-tracing simulation than for uniform scatterer distribution. However, analytically-derived PDFs of the AOA and the TOA for Gaussian scatterer distribution show closest agreement with those PDFs obtained from the simulations.

A generalized 3D channel model with an arbitrator scatterer distribution point is proposed based on the spheroid GBMS. The proposed channel model is assumed that the scatterers to be distributed according to the Gaussian distribution about an arbitrary point within the spheroid. Closed-form expressions are derived for the joint PDFs of the AoA, marginal PDFs in both the elevation and azimuth planes, as well as for the marginal PDF of the ToA. Numerical results are utilized for the verification of the derived-closed form mathematical expressions. More-

over, the obtained marginal PDFs of AoA and TOA are compared against PDFs obtained from the simulation of an indoor environment using ray-tracing tool. By choosing a proper scatterer distribution center point based on the actual indoor propagation environment and a suitable value for the standard deviation of the scatterer region, the proposed 3-D model of the channel can be exploit the performance of the wireless communication technologies and systems in indoor environments.

The spheroid GBSM is extended to a 3D geometry-based spatial correlation model for multiple-input multiple-output (MIMO) communication environments. Approximated closed-form expressions are obtained for the normalized spatial correlation coefficients of frequency non-selective Rician fading channels. As a special case, the normalized spatial coefficients are derived for Gaussian scatterer distribution. Closed-form expressions developed are verified by the simulation results obtained using the WINNER Phase II channel model (WIM2). Furthermore, the capacity performance of MIMO channels is investigated using the proposed geometry-based correlation model. Our results have clearly demonstrated that the proposed 3D spatial correlation model can be used to investigate the performance of the frequency non-selective Rician or Rayleigh fading MIMO channels with different antenna configurations accurately.

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