

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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Contents

1	Introduction	1
1.1	Multipath Propagation Environment	1
1.2	Channel Models	2
1.3	Geometry Based Stochastic Channel Models	3
1.3.1	Major Assumptions of GBSMs	4
1.4	Multiple-Input Multiple-Output Wireless Systems	4
1.5	Statement of the Research Problem and Motivation	6
1.6	Objectives and Scope	6
1.7	Methodology	7
1.8	Contributions	7
1.9	Organization of the Thesis	8
2	Literature Review	9
2.1	SISO GBSMs	9
2.2	MIMO Geometry-Based Stochastic Channel Models	14
3	3-D GBSMs with Different Scatterer Distributions	15
3.1	3D Spheroid Model's Description	15
3.2	PDFs of the AoA	17
3.2.1	Uniform Scatterer Distribution	17
3.2.2	Gaussian Scatterer Distribution	18
3.2.3	Rayleigh Scatterer Distribution	19
3.3	PDFs of the ToA	20
3.3.1	Uniform Scatterer Distribution	21
3.3.2	Gaussian Scatterer Distribution	21
3.3.3	Rayleigh Scatterer Distribution	21
3.4	Results and Discussion	21

3.4.1	Obtaining Standard Deviation values of Scatterer Distributions	24
3.4.2	Comparison of Analytically-derived PDFs and Simulated PDFs	26
4	A GBSM with an Arbitrary Center Point of Gaussian Scatterer Distribution	30
4.1	System Model and General Formulations	30
4.1.1	AoA Statistics	33
4.1.2	ToA Statistics	34
4.2	AoA and ToA Statistics for the Gaussian Scatterer Distribution	35
4.2.1	Joint PDF of AOA	36
4.2.2	Marginal PDFs of Azimuth and Elevation Angles	37
4.2.3	Marginal PDF of ToA	38
4.3	Results and Discussion	39
4.3.1	PDFs of Azimuth and Elevation Angles and ToA	39
4.3.2	Validation of Proposed 3-D Channel Model	42
5	A 3D Spatial Correlation Functions for MIMO Channels	48
5.1	3D Spheroid Model for MIMO Channels	48
5.2	The Normalized Spatial Correlation Coefficient for MIMO Channels	50
5.2.1	Cross-Correlation Coefficients for the non LOS Components	51
5.2.2	Cross-Correlation Coefficients for the LOS Component	53
5.3	Normalized Spatial Correlation Coefficients for MIMO Channels with Gaussian Scatterer Distribution	54
5.3.1	Generation of MIMO Channel Coefficients	55
5.3.2	Ergodic Capacity of MIMO Channels	56
5.4	Results and Discussion	57
6	Conclusions and Further Work	61
6.1	Conclusions	61
6.2	Further Work	62

List of Figures

1.1	Wireless communication environments: a) Outdoor propagation environment: b) Indoor propagation environment.	2
1.2	A MIMO wireless communication system.	5
2.1	2-D GBSM for microcell and picocell environments: a) 2-D elliptical GBSM, b) 2-D rectangle GBSM.	10
2.2	2-D GBSM for microcell and picocell environments with non uniform scatterer distribution: a) 2-D circular GBSM, b) 2-D elliptical GBSM.	11
2.3	Geometry of the 3-D ellipsoid GBSM, where the transmitter and the receiver are located at the focal points with a separation distance D	12
2.4	Geometry of the 3-D spheroid GBSM, where the transmitter and the receiver are located at the focal points with a separation distance D	13
3.1	3D Spheroid model, in which the transmitter and the receiver are located at the focal points with a separation distance of D	16
3.2	Second floor of a three story office complex (E1) modeled using Wireless InSite software.	22
3.3	First floor of a two story building with lecture halls and class rooms (E2) modeled using Wireless InSite software.	22
3.4	A single story industrial zone (E3) modeled using Wireless InSite software.	23
3.5	A single story home (E4) modeled using Wireless InSite software.	23

3.6	Comparison of the analytically-derived marginal PDFs of the elevation AoA for uniform, Gaussian and Rayleigh scatterer distributions with the PDF obtained from simulation of different indoor environments a) A three story office complex (E1), b) A two story building with lecture halls and classrooms (E2), c) A single story industrial zone (E3), d) A single story home (E4).	27
3.7	Comparison of the analytically-derived marginal PDFs of the azimuth AoA for uniform, Gaussian and Rayleigh scatterer distributions with the PDF obtained from simulation of different indoor environments a) A three story office complex (E1), b) A two story building with lecture halls and classrooms (E2), c) A single story industrial zone (E3), d) A single story home (E4).	28
3.8	Comparison of the analytically-derived marginal PDFs of the ToA for uniform, Gaussian and Rayleigh scatterer distributions with the PDF obtained from simulation of different indoor environments a) A three story office complex (E1), b) A two story building with lecture halls and classrooms (E2), c) A single story industrial zone (E3), d) A single story home (E4).	29
4.1	3-D Spheroid model, in which the transmitter and the receiver are located at the focal points with a separation distance of D	31
4.2	The geometry of the scatterer region.	32
4.3	Analytically-derived marginal PDFs of the elevation AoA with different $\sigma_s = 4, 5, 6, 8$ for different Scenarios.	40
4.4	Analytically-derived marginal PDFs of the azimuth AoA with different $\sigma_s = 4, 5, 6, 8$ for different Scenarios.	41
4.5	Analytically-derived marginal PDFs of the ToA with different $\sigma_s = 4, 5, 6, 8$ for different Scenarios.	42
4.6	Indoor environment modeled using Wireless InSite software for Scenario 1.	43
4.7	Comparison of the analytically-derived marginal PDFs of the elevation AoA with the PDFs obtained from MATLAB simulation for different Scenarios.	44
4.8	Comparison of the analytically-derived marginal PDFs of the azimuth AoA with the PDFs obtained from MATLAB simulation for different Scenarios.	45

4.9	Comparison of the analytically-derived marginal PDFs of ToA with the PDFs obtained from MATLAB simulation for different Scenarios.	46
5.1	Geometry of the 3D spheroid GBSM, where the transmitter and the receiver are located at the focal points with a separation distance D (LOS paths are not shown in this figure).	49
5.2	Geometry of the 3D spheroid model only with LOS paths.	50
5.3	Comparison of the CDFs of the ergodic capacity for 2×2 MIMO channel, obtained from the developed 3D model and using WINNER phase II channel model.	58
5.4	Ergodic capacity of a 2×2 MIMO system: a) For different δ_{ll} values, b) different α_{ll} values with $\beta_{ll} = \pi/2$, c) For different α_{ll} with $\beta_{ll} = 0$, d) For different β_{ll} values.	59
5.5	Ergodic capacity of the system vs spatial correction coefficient for different SNR values.	60

List of Tables

2.1	Geometry of the scatterer region and scatterer distributions applied to the GBSMs.	13
3.1	Obtained values for σ_θ , σ_ϕ , and σ_τ from the simulation.	26
3.2	Calculated values for $\sigma_{s(gau)}$, and $\sigma_{s(ray)}$ for typical indoor environments.	26
4.1	Four different specific scenarios and parameter values.	39
4.2	Arrangements of the scatterers in each scenarios modeled in the Wireless InSite software.	43
5.1	The parameters used in the WINNER phase II model.	57