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COMPARATIVE STUDY ON PERFORMANCE OF VARIOUS CHANNELS MODELLING IN MIMO SYSTEMS

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Abstract

This paper proposes comparative study on the performance of various channel models. The channel model is also the factor which is considered in the network performance evaluation. As this channel model influences network performance their characteristic (modeling) should be well defined, but as in practical case it is not possible because of its indeterministic characteristics. That is why various channel models has been proposed for different environment such as Rayleigh fading channel for outdoor environment, Rician fading channel for indoor environment, deterministic channel model, stochastic channel model etc.This paper enlightens about the influence of correlation in channel model and the characteristics of channel models present so far.

Keyword**-- Rayleigh, channel model**

I. INTRODUCTION

Multi antenna at both end of the communication environment such as transmitter and receiver can significantly increases spectral efficiency [1].Also MIMO in rate gain is influenced by the correlation in channel matrix. In [2], MIMO channel model characteristics on land mobile system has revealed that rate is degraded by correlation and mutual coupling. However significant rate gain can be still achieved by employing cooperative form of transmitter/receiver antenna array, because

MIMO system has rate gain even without rich scattering. The difficulty of channel model is solved only by choosing proper geometrical parameters.

II. BASIC PARAMETERS IN CHANNEL MODEL

The parameter which is used to model the channel is used to control the correlation and their characteristic. There are many parameter associated with channel modeling they are

i. *Multipath*

The objects located around the path of the wireless signal reflect the signal. Some of these reflected waves are also received at the receiver.

Since each of these reflected signals takes a different path, it has a different amplitude and phase at the receiver. Even a slight change in position may result in a significant difference in phases of the signals and so in the total received power.

The power delay profile gives the statistical power distribution of the channel over time for a signal transmitted for just an instant.

ii. *Shadowing*

If there are any objects (such buildings or trees) along the path of the signal, some part of the transmitted signal is lost through absorption, reflection, scattering, and diffraction. This effect is called shadowing. As a result of shadowing, power received at the points that are at the same distance d from the transmitter may be different and have a lognormal distribution. This phenomenon is referred to as *lognormal shadowing.*

iii. *Projected distance*

It is the distance between $\overline{v_1}$ and $\overline{v_2}$, the projections of two transmit antennas unit length direction vectors $\overline{d_1}$ and $\overline{d_2}$ .As shown in figure 1(src: 3-D Channel Model for Distributed MIMO Satellite Systems).

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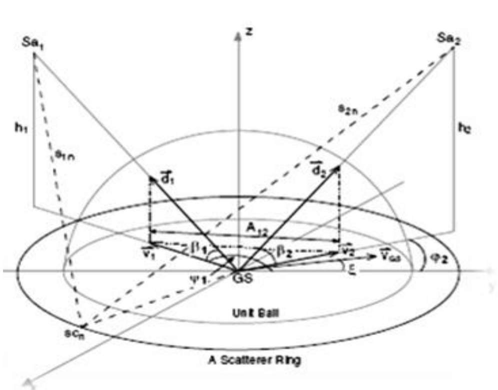


Figure 1: the 3-D channel model for the channel between satellite Antennas and ground station antennas with the projected distance A_{ij}

It indicate how close the directions of these two transmit antennas are. When projected distance is small, then correlation between two transmit antenna multipath components is high [1]

iv. Doppler spread

It occurs due to motion of the intermediate objects in the channel. Thus, if the transmitter, receiver, or the intermediate objects move very fast, the Doppler spread is large and the coherence time is small, i.e., the channel changes fast, requiring good channel estimation algorithms.

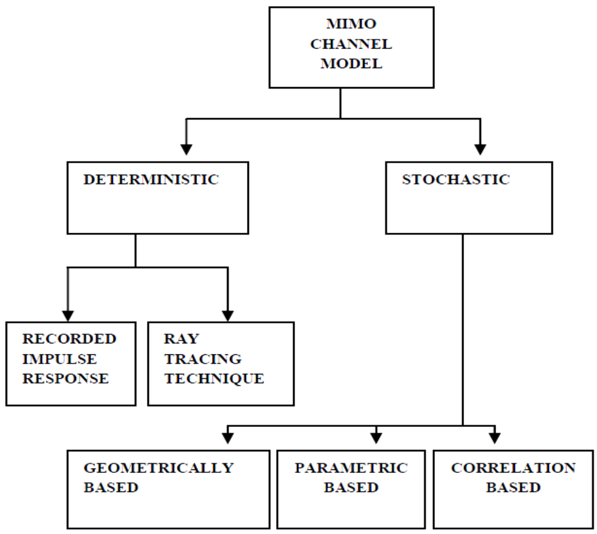
The Doppler power spectrum is nonzero for ($f-f_D$, $f+f_D$), where f_D is the maximum Doppler spread or Doppler spread.

v. Angle of arrival and departure

The relationship between these two can be used to derive cross correlation function, frequency correlation function, auto correlation function in 2D/3D cases [3].These parameter is used to control angular spread.

III. Comparison Of Channel Model

There are several channel models for analog and digital communication.General classification in MIMO channel model are



i. *Deterministic channel model*

A deterministic channel depiction can be used to model the radio-wave propagation. With this description we can estimate some of the properties of the radio channel efficiently, if underlying assumptions are sufficiently accurate. Since either channel model concept does currently not provide all the information necessary for adaptive antennas.

a. Ray tracing model

Ray tracing is a technique based on Geometrical Optics (GO), an easily applied approximate method for estimating a high-frequency electromagnetic field. The dissipating energy is considered to be radiating in infinitesimally small tubes, often called rays. These rays are normal to the surface of equal signal power, lie in the direction of propagation, and travel in straight lines, provided that the refractive index is constant. [4]Their amplitude is governed by the conservation of energy flux in the ray tube. The purpose of these rays is to remove the field discontinuities and to introduce proper field corrections, especially in the zero field areas predicted by GO.

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In a wireless communication system, the signal arriving at the receiving antenna consists of several multipath components, each of which is the result of the interaction of the transmitted waves with the surrounding environment. It uses a technique called ray tracing, in the ray launching approach rays are sent out at various angles and their paths are traced until a certain power threshold is reached. The number of rays considered and the distance from the transmitter to the receiver location determined the available spatial resolution and the accuracy of the model

b. Recorded impulse response

The recorded impulse response is based on the electromagnetic theory of images and works by generating an image table for each BS location, considering all the various wall reflection, transmission and diffraction permutations that are possible in a given area. The image information is then stored and used to compute the channel characteristics at each mobile location [4].

Advantage of deterministic model:

The advantage of using deterministic predictions instead of field trial measurements is mainly that large data sets can be easily produced for many different test environments. Also, when using field trial results in order to produce a statistical model, the influence of the measurement antennas is included in the results and cannot be eliminated afterward.

ii. Stochastic channel model

A probabilistic approach addresses the time varying space and frequency selective fading properties of the received signals, which are usually described by stochastic processes exhibiting e.g. the well known Rice or Rayleigh probability density distribution [4] No detailed assumptions are made concerning scatterer locations. Therefore, these concepts cannot directly be applied to systems with multiple antennas, where directional knowledge is required.

a. Correlations and the Kronecker model

In the channel model characterized as Rayleigh it was assumed that all the matrix elements, the transmission coefficients, are identically distributed and uncorrelated. Where the scatterer richness decreases as the spacing decreases.

It is therefore important to understand the correlations between the transmission coefficients, and we take the simple (2, 2) case with two elements at each side [4]

$$H=\begin{bmatrix} a & b \\ c & d \end{bmatrix}, \qquad \text{---------- (1)}$$

For brevity and we consider in the full correlation matrix, a 4 x 4 matrix, between all transmission coefficients. It is possible to assume that the full matrix can be determined from the antenna correlations, the so-called Kronecker model. The Kronecker model is an approximation, shows that the error grows with the number of antenna elements. We can immediately see also that any internal correlations in the double-bounce model will not be covered by the Kronecker model.

a. Parametric based channel model

One of the main assumptions in the Clarke's classic channel model is isotropic scattering, i.e. uniform distribution for the angle of arrival of multipath components at the mobile station. However, in many mobile radio channels we encounter non-isotropic scattering, which strongly affects the correlation function and power spectrum of the complex envelope at the mobile receiver. In this contribution, we propose the use of the versatile von Mises angular distribution, which includes and/or closely approximates important distributions like uniform, impulse, cardioid, Gaussian, and wrapped Gaussian, for modeling the non-uniform angle of arrivals at the mobile.

Based on this distribution, associated correlation functions and power spectrum of the complex envelope at the mobile receiver are derived. The utility of the new results is demonstrated by comparison with the correlation function estimates of measured data. The utility of the model and new results have been verified by fitting the parametric model of the correlation function to the estimates of this function based on measured data.

b. Geometrically based channel models

A geometric approach starts from a given or assumed a priori spatial scatterer distribution with distinct reflector locations in order to derive the channel characteristics. However, the effects of continuously moving mobiles or scatterer which are important for analyzing the performance of beam-formers can hardly be handled with purely geometrical models.[4]

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A GBSM has the following important advantages

1. It can be applied to physical/real conditions; this is because important parameters (like the scatterer locations) can often be determined using simple geometrical considerations;

2. Many effects are implicitly reproduced; Small-scale fading is created by the superposition of waves from individual scatterers, DoA and delay drifts (from Doppler shifts) as a result of the MS movement are also taken into consideration;

3. All information is dependent on the distribution of the scatterers; therefore, dependencies of Power Delay Profile (PDP) and Angular Power spectrum (APS) do not lead to a complication of the model;

4. Tx/Rx and scatterer movement as well as shadowing and the (dis)appearance of propagation paths (e.g. due to blocking by obstacles) can be easily implemented; this allows us to include long-term channel correlations in a straightforward way.

IV. PERFORMANCE EVALUATION

Depending upon the number of antenna implemented at transmitter and receiver, this section evaluates the performance of above channel models between capacity, and SNR.

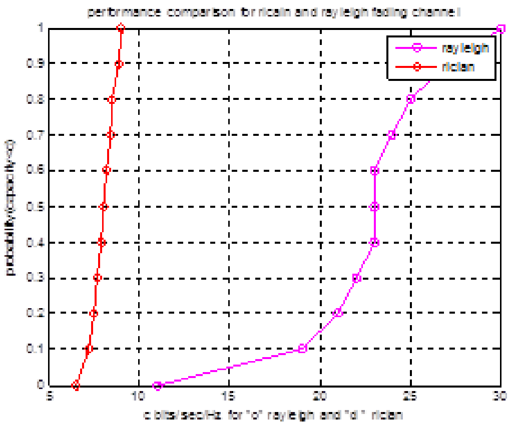

Figure 2: comparison between rician and Rayleigh fading channel at d=0.5λ

Above figure 2 shows the effect of correlation on MIMO Rayleigh channel. It reveals that uncorrelated channel d=0.5λ offers high capacity performance .

Hence distance between antenna elements decreases, capacity decreases too, this is due to coupling or correlation effect between antenna elements, there by leading to degradation in transmitted signals .In case of Rician channel, capacity decreases due to fixed component reaching receiver and can be compensated by deploying more elements [4].In Figure 3 One can see that the decorrelated situation provides more capacity than the correlated one at the same SNR and generally the total capacity increases with the SNR in stochastic channel.

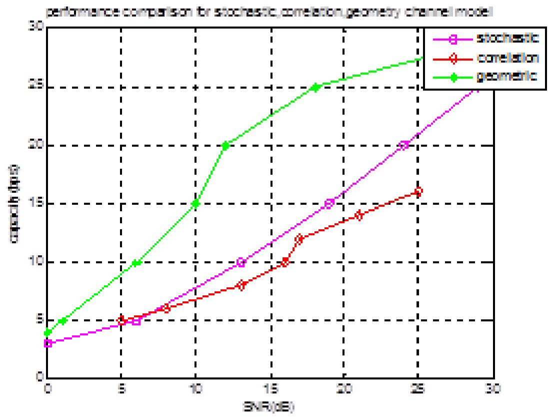

Figure3: performance comparison for stochastic, correlation, geometry channel model.

The performance in correlation is analyzed; using the goodness of the estimation degrades with increasing SNR, which is consistent with the Kronecker model [5]. This graph also provide the model verifications and agreed with the fact that for uniform scatterers distribution in 3D space, an antenna elements spacing of λ /2 is optimal for full decorrelation of the received multipath fading signals. The geometry channel model provides good performance to enhance the capacity by taking into account of angular spread information [6].

V. CONCLUSION

One advantage of geometrical channel models is ability to have an analytical form of the AOA distributions, for the systems are based on utilizing the space domain. This function has been derived in terms of some of the channel's physical parameters, such as: displacement and orientation of the antenna arrays and the delay spread in the azimuth and the elevation angles.

This will provide better prediction for the performance of MIMO wireless systems in order to provide guidelines for efficient designs of MIMO antenna array for different wireless communication environments.

REFERENCES

[1] Xing Li, Youjian (Eugene) Liu, Dept. of ECEE, University of Colorado at Boulder , "A 3-D Channel Model for Distributed MIMO Satellite Systems," IEEE Trans, Globecom 2010

[2] P. King and S. Stavrou, “Characteristics of the Land Mobile Satellite MIMO Channel,” Vehicular Technology Conference, 2006. VTC-2006 Fall. 2006 IEEE 64th, pp. 1 –4, sept. 2006.

[3] Matthias Patzold and Bj0rn Olav Hogstad Faculty of Engineering and Science, Agder University College," A Wideband MIMO Channel Model Derived From the Geometric Elliptical Scattering Model", IEEE Transactions on communications 2006.

[4] MIMO system technology for wireless communications Edited by George Tsoulos

[5] Accurate Estimation of Correlation and Capacity for Hybrid Spatial-Angular MIMO Systems Juan F. Valenzuela-Valdés, Antonio M. Martínez-González, and David A. Sánchez-Hernández, Senior Member, IEEE

[6] Generalized Three Dimensional Geometrical Scattering Channel Model for Indoor and Outdoor Propagation Environments By Mohammad A. S. Alsehaili A