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Review Paper on Second Order Statistics of Various Fading Channels

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ABSTRACT- Radio-wave propagation through wireless channel is a complicated phenomenon characterized by fading which is the result of multipath propagation. In wireless communication system, random process associated with fading channels can usually characterized by their PDF (Probability Density Function) and CDF (Cumulative Distribution Function). Signal fading can drastically affect the performance of terrestrial communication systems. Several statistical models are available for describing the fading envelope of the received signal in which Rayleigh, Rician and Nakagami are the most frequently applied models. Higher-order statistics such as Level Crossing Rate (LCR) & Average Fade Duration render (AFD) insight into signals which is not always available at lower orders.

KEYWORDS: PDF, CDF**,** Statistical models, Second order statistics, LCR, AFD, Fading Channels.

I. INTRODUCTION

The field of wireless communication has made significant progress in making high speed and broader telecommunication. By seeking such an ambitious goal, wireless communication technology is facing the ultimate technical challenge of achieving higher data exchange speeds. Since signal propagation takes place in the atmosphere & near the ground the most notable effect of signal degradation is multipath propagation and this leads to multipath fading. Researchers have shown that multiple propagation paths or multi-paths have both slow and fast aspects.

The wireless channel can be described as a function of time and space and the received signal is the combination of many replicas of the original signal impinging at receiver from many different paths. The signal on these different paths can constructively or destructively interfere with each other. This is referred as multipath. If either the transmitter or the receiver is moving, then this propagation phenomena will be time varying, and fading occurs. In particular the fading models can be divided into three classes by separating the received signal in three scale of spatial variation such as fast fading, slow fading or shadowing and path loss. Moreover, several models for small scale fading are considered such as Rayleigh, Rician, Nakagami and Weibull distributions [1].

II. USE AND THE EFFECT OF HIGHER ORDER STATISTICS ON FADING CHANNELS

The lower order statistics sometimes insufficient to analyse the signals in detail or describe, so higher order statistics such as LCR and AFD are more beneficial because they provide better analytical platform for fading channels. Additionally, Gaussian-distributed signals have the interesting characteristic of disappearing at higher orders. Because of the noise and interference environment is Gaussian-distributed, higher-order statistics thus offers an additional method of noise reduction & interference mitigation & can be used to generate a filtering algorithm.

LCR and AFD have found a variety of applications in the modelling & design of wireless communication systems. LCR is defined as the number of times per unit duration that the envelope of a fading channel crosses a given value in the negative direction. AFD corresponds to the average length of time the envelope remains under the threshold value once it crosses it in the negative direction. These quantities reflect correlation properties, and thus the second-order

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statistics, of a fading channel. LCR) and AFD of the signal envelope are two important second-order channel statistics, which convey useful information about the dynamic temporal behaviour of multipath fading channels.

In 2000 the Level Crossing Rate and Average Fade Duration of Rayleigh, Rice, and Nakagami Fading Models with Mobile Channel Data were compared. Visual comparison of the theoretical results with measured data reveals that all the models such as the simple Rayleigh model with isotropic scattering show reasonable fit in terms of LCR and AFD for most of the records, independent of the CDF fits. This implies that the goodness of fit for second-order statistics (LCR and AFD) do not appear to be dependent on the accuracy of fit for first-order statistics (CDF) [2].

Cyril-Daniel Iskander shown in 2002 that the level-crossing rates (LCRs) and average fade durations (AFDs) of a fading channel find diverse applications in the evaluation and design of wireless communication systems. Generalizations of expressions for the LCR of a diversity received signal in Rayleigh fading, in order to handle the more general Nakagami fading distribution are derived [3].

In 2003 it was analysed and simulated the statistical performances of Nakagami Fading Channel using MATLAB including the complex envelop of received signal, the Level Crossing Rates and Average Fade Durations on the Maximal-Ratio Combining diversity. By changes each parameters, a little change in the fading channel can be observed that it is useful to understand the basic concept of radio channel [4].

The second-order statistical signal properties at the output of the dual diversity selection combining (SC) system analysed and exposed in 2007 to the combined influence of the co-channel interference (CCI) and the thermal noise (AWGN) in Nakagami fading channel. The analytical results reduce to known solutions in the cases of an interference-limited system in Rayleigh fading and an AWGN-limited system in Nakagami fading. [5]

In 2008 Nikola Zlatanov described the novel exact expressions and accurate closed-form approximations for LCR and AFD of the Double Nakagami-m Random Process and these are useful in study of the second order statistics of multiple input multiple output (MIMO) keyhole fading channels with space-time block coding. [6]

Researchers described in 2012, the applications and novel analytical framework for the calculation of the higher Order Statistics LCR and AFD of Sampled Fading Channels in terms of CDF and its bivariate CDF. As a direct application, exact closed form expressions for the LCRs of the equivalent frequency domain sampled random process associated with a multipath Rayleigh fading channel are calculated. It demonstrates that as the sampling rate of the random process is reduced, the actual LCR is lower than the LCR of the associated continuous random process and consequently, the actual AFD is larger [7].

In 2013 the PDF of analytic Nakagami fading parameter in dependent noise channel using copula theory which analyzes the noise behaviour much better than other conventional procedures estimated. In this a more comprehensive situation about the noise destruction is in low signal to noise ratios and the parametric bootstrap method for the accuracy of the analytically estimated PDF considered. Thus simulation results give superior performance over conventional estimators. [8]

Vidhi Sharma provided a novel analytical platform for evaluating the essential second order statistical boundaries, as the average fade duration and level crossing rate of Rayleigh and Nakagami fading channels in 2014. An expression is derived for the average LCR and AFD for discrete fading channels. Modelling and simulation is done in the proposed work for Rayleigh, and Nakagami channel and then the LCR and AFD for each channel is calculated. Results for all the discrete channels showed that the actual values of LCR and AFD are much similar as calculated by using the proposed approach than the conventional theoretical formula. [9]

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III. OBJECTIVE OF RESEARCH

In this paper, comparison of the method of calculation such as theoretical and discrete second order statistic parameters i.e. LCR and AFD in the different types of fading channels such as Rayleigh, Rician & Nakagami is done. After comparison it is found that in discrete process LCR and AFD provide good response as compared to theoretical process.

IV. PROPOSED METHODOLOGY

In this paper Rayleigh, Rician and Nakagami multipath fading channel objects and the channel visualization tools are used to model a fading channel. These channels are useful models of real-world phenomena in wireless communication. A channel object is created that describes the channel that is desired to use. Properties of the channel object are adjusted, if necessary, to tailor it to channel's need. For example, change in the path delays or average path gains can be done. Then the channel object is applied to the signal using the filter function, which has been overloaded to work with channel objects. The characteristics of a channel can be plotted using the channel visualization tool.

V. CONCLUSION

This review paper shows that higher order statistics namely level crossing rate and average fade duration led to the evolution of fading channels mostly Rayleigh, Rician and Nakagami. Also these higher order statistics have been used in wide range of applications. So, there is scope that these parameters can be used to estimate the spectral characteristics of fading channels in real time applications. After comparison it is shown that Nakagami fading channel provides a better explanation to less and more severe conditions than the Rayleigh and Rician fading channels and provides a better fit to the mobile communication channel data because it has lowest level crossing rate and highest average fade duration corresponding to threshold value.

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BIOGRAPHY

Vidhi Sharma has received her B.E. Degree in Electronics & Communication Engineering 2009, from R.N.MODI, KOTA & now is M. Tech Scholar in Digital communication from Rajasthan College of Engineering for Women, Jaipur. Her current area of research includes fading channels in wireless communication and currently working on the project related to it.

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