Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2015, 2(5): 108-111

Research Article ISSN: 2394 - 658X

Effect of Frame variation on Nakagami and Rayleigh Channel through M-FSK Modulation Technique

Hemant Dhabhai[1], Ravindra Prakash Gupta[2] and Anand Jain[3]

[1] Pacific University, Udaipur, Rajasthan, India
[2] MIT, Bikaner, Rajasthan, India
[3]Aravali Institute of Technical Studies, Udaipur, Rajasthan, India
hemant1_anu@rediff.com

ABSTRACT

The main objective of this research work is to analyze the effect on SNR over BER in Different Fading channel using various digital modulation techniques (i.e. BPSK and BFSK) using Single Frame and Multi Frame data transmission techniques. Nakagami fading channel gives better analysis of results as compared to Rayleigh and Rician fading Channels. We present a highly accurate closed-form approximation for the PDF of Nakagami-m Random Variables (RVs) with identical (integer) fading parameters.

Key words: Nakagami, Rayleigh, Rician Fading, Single Frame, Multi frame, SNR, BER

INTRODUCTION

Several statistical models have been used in the literature to describe the fading envelope of the received signal from a multipath fading channel. The most popular of these statistical models are Nakagami, Rayleigh and Rice, distribution statistics.

Nakagami Channel

Nakagami distribution model was shown to model adequately different propagation channels exhibiting greater flexibility and higher accuracy in setting experimental data than the commonly adopted Rayleigh, Rice and log-normal distributions [1]. More-over, Nakagami distribution model can be used in the field of land mobile radio to describe both indoor and outdoor propagation. This is especially appropriate for describing the urban radio multipath channel, when large area effects need to be accounted for, as well as the signal envelope fluctuations in suburban and open areas. Nakagami fading distribution is a central chi-distribution generalized to a non-integral number of degrees of freedom which includes the Rayleigh and the one-sided Gaussian fading distributions as special cases [2]. Also, it can approximate the Rician and log-normal fading distribution at certain conditions. Moreover, it can model fading conditions which are more or less severe than that of Rayleigh fading distribution.
The Nakagami fading distribution, is given by-

$$P_Z(Z) = \frac{2K^k Z^{2k-1}}{\Gamma(k) P_r^k} \exp\left[\frac{-kz^2}{P_r}\right], k \geq .5 \quad (1)$$

Thus, k is the ratio of the power in the LOS component to the power in the other (non-LOS) multipath components. The fading parameter k is therefore a measure of the severity of the fading: a small k implies severe fading; a large k implies more fading. Pr is the average received power and Γ (.) is the gamma function. The Nakagami distribution is parameterized by Pr and the fading parameter k [5].

Rayleigh Channel

The Rayleigh fading model is one of the most widely used fading channel model which assumes that there exist no direct line of sight path between the transmitter and the receiver and all the arriving signals at the receiver are due to reflected waves. This assumption is a typical characteristic of mobile communication scenario in urban areas.

The normalized Rayleigh distribution, its mean and variance are as given below [4]

$$p(a) = \begin{cases} 2a \exp\left(-a^2\right) & a \geq 0 \\ 0 & a < 0 \end{cases} \quad (2)$$

Rician Fading

In many propagation scenarios, there exist a line of sight component having constant amplitude and a number of reflected waves. The sum of direct path and the reflected components result in a signal having Rician envelope distribution. The normalized Rician distribution along with its mean and variance are shown in Eq. 3, 4 & 5 [6].

$$p(a) = \begin{cases} 2a(1+K)\exp\left[-K-(1+K)a^2\right] I_0\left(2a\sqrt{K(1+K)}\right) & a \geq 0 \\ 0 & a < 0 \end{cases} \quad (3)$$

$$m_a = \frac{1}{2}\sqrt{\frac{\pi}{1+K}}\exp\left(-\frac{K}{2}\right)\left[(1+K)I_0\left(\frac{K}{2}\right)+KI_1\left(\frac{K}{2}\right)\right] \quad (4)$$

$$\sigma_a^2 = 1 - m_a^2 \quad (5)$$

SYSTEM MODEL

We have presented overall functional block diagram of proposed system in this paper that is related to our work. Here, MFSK Communication link model is implemented using different MATLAB communication block set as shown in Fig. 1. This proposed system shows a new creation for causing the Nakagami Fading channel (NFC) which possess random and different fading Fig. m for each sub channel with Multiuser diversity to producing an acceptable average Signal to Noise Ratio(SNR) and best statistical reducing outage probability(Pout) or Bit Error Rate (BER) of multipath fading effect [8].

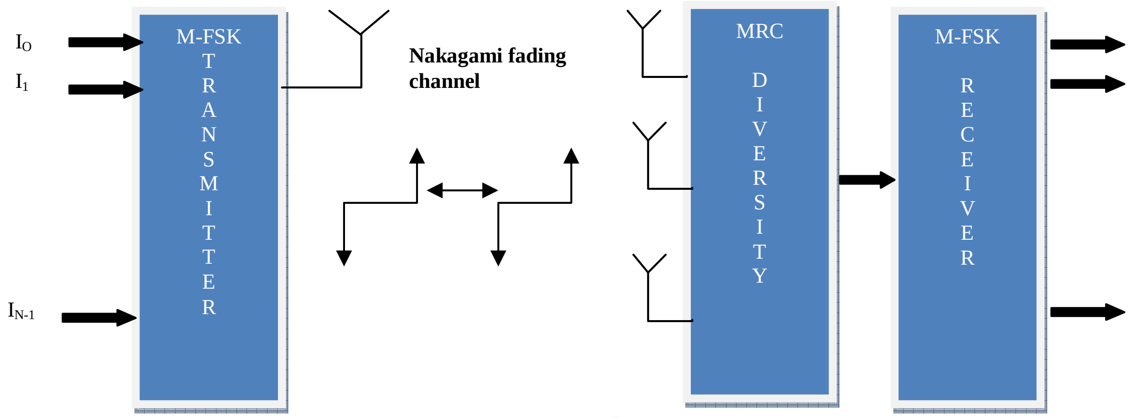

Fig. 1 Model to Calculate BER for Fading Channel

FADING IN MATLAB

Three different fading Channels i.e. Rayleigh, Rician and Nakagami-m have been analyzed using MATLAB. The following subsection shows algorithm used to generate these channel distributions based on their description in theory.

Rayleigh Distribution

```
Sigma = sqrt (10.^(-SNR/10)); % Noise variants
H = (randn (frLen, M) + 1i*randn (frLen, M))/sqrt (2);
```

Rician Distribution

```
my=0.5;
sigma=1;
a=mx+sigma.*(randn(frLen, M) + 1i*randn (frLen, M));
b=my+sigma.*(randn(frLen, M) + 1i*randn (frLen, M));
```

Nakagami-M Distribution

```
Ω=1; %Scale parameter
mu=.5; %Shape parameter
H=sqrt(gamrnd(mu, w./mu, frLen, M));
```

The data was transmitted by the transmitter, channel fading and noise was added to the signal. At the receiver, the same signal was detected, dividing it by the same channel response that was added to it. Numbers of errors are calculated by comparing the transmitted and the received data [9]. Signal and Noise power are calculated which then help calculating the signal to noise ratio for the system. As a result BER versus SNR graph was plotted.

SIMULATION RESULTS

Single Frame Transmission

In single frame data transmission technique each frame is sent one by one from transmit to receive antenna. Single frame data transmission may be preferred when channel is stationary for the complete data transmission time [10].

Table -1 Effect of SNR over BER in different fading channel in BPSK

SNR (dB)	Rayleigh	Nakagami-m	Rician
0	0.0520	0.1010	0.0020
2	0.0350	0.0630	0.0010
4	0.0140	0.0500	0.0000
6	0.0090	0.0300	0.0000
8	0.0020	0.0130	0.0000
10	0.0000	0.0150	0.0000
12	0.0000	0.0100	0.0000
14	0.0000	0.0060	0.0000
16	0.0000	0.0040	0.0000
18	0.0000	0.0000	0.0000
20	0.0000	0.0010	0.0000

Effect of SNR over BER using BPSK

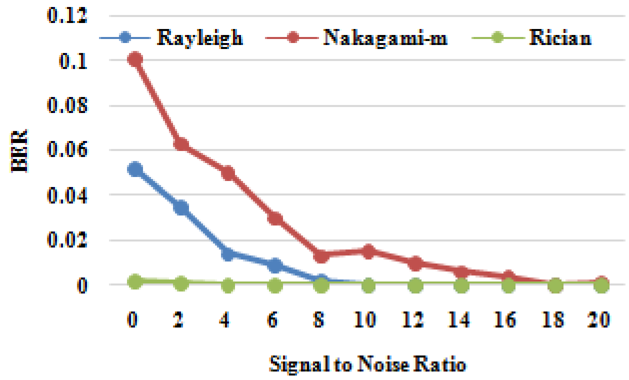

Fig. 2 Comparison for Different Fading Channel using Single Frame for BPSK

Table -2 Effect of SNR over BER in Different Fading Channel in FSK

SNR (dB)	Rayleigh	Nakagami-m	Rician
0	0.09814	0.0070	0.042
2	0.09023	0.0065	0.021
4	0.05134	0.0054	0.018
6	0.08535	0.00094	0.016
8	0.00091	0.00009	0.012
10	0.00045	0.00005	0.009
12	0.00012	0.00003	0.005
14	0.00005	0.00001	0.0001
16	0.00004	0.00001	0.00003
18	0.0000	0.0000	0.000035
20	0.0000	0.0000	0.000025

Effect of SNR over BER in BFSK

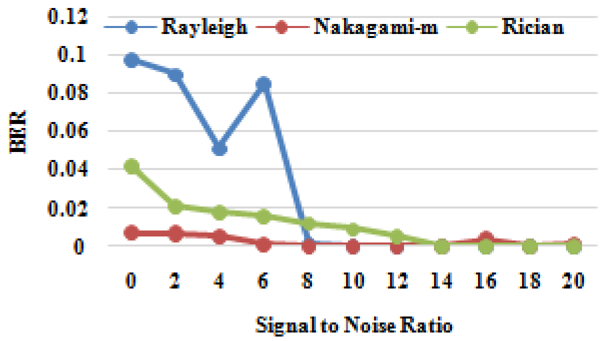

Fig. 3 Effect of SNR over BER in Different Fading Channel in FSK

Multi Frame Transmission

In Multi Frame Transmission technique, data is divided into blocks of certain frames and a block is sent for the time in which channel is considered to be stationary. Thus, in this way every block undergoes an independent fading and only a part of transmitted data is corrupted even if the channel is in a deep fade [9].

Table -3 Effect of SNR over BER in Different Fading Channel in BPSK

SNR (dB)	Rayleigh	Nakagami-m	Rician
0	0.0589	0.0909	0.0042
2	0.0333	0.0647	0.0013
4	0.0174	0.0432	0.0003
6	0.0080	0.0287	0.0001
8	0.0035	0.0189	0.0000
10	0.0015	0.0124	0.0000
12	0.0007	0.0083	0.0000
14	0.0003	0.0046	0.0000
16	0.0001	0.0032	0.0000
18	0.0000	0.0020	0.0000
20	0.0000	0.0012	0.0000

Effect of SNR over BER using BPSK

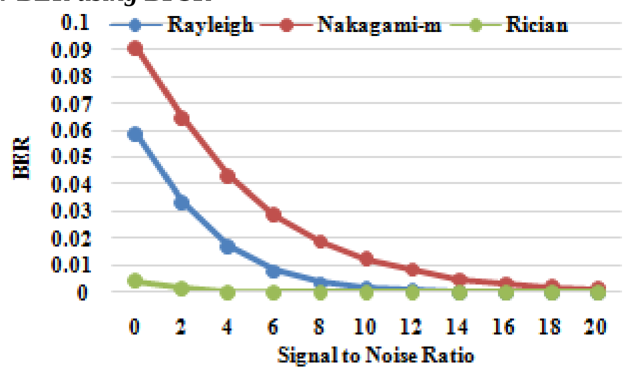

Fig. 4 Comparison for different fading channel using Multi frame for BPSK

Table -4 Effect of SNR over BER in Different Fading Channel in BFSK

SNR (dB)	Rayleigh	Nakagami-m	Rician
0	0.1240	0.0100	0.01258
2	0.0978	0.0071	0.0038
4	0.0563	0.0045	0.0156
6	0.0028	0.0026	0.0098
8	0.0013	0.0009	0.0052
10	0.00058	0.0005	0.0018
12	0.00026	0.00012	0.0007
14	0.00008	0.00001	0.00023
16	0.00003	0.000012	0.000012
18	0.00001	0.000006	0.000008
20	0.00000	0.000005	0.000006

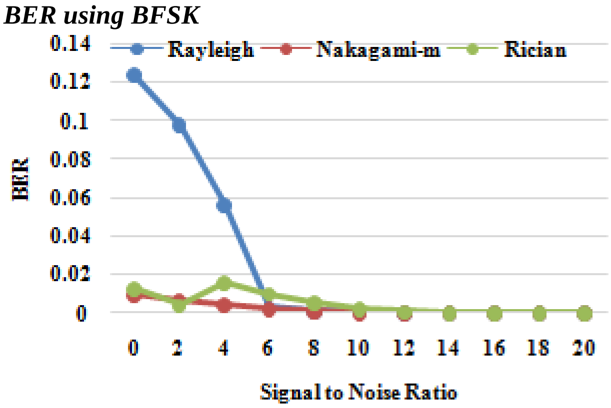

Fig. 5 Comparison for Different Fading Channel using Multi Frame for BFSK

RESULTS ANALYSIS

It can be inferred from tables that Nakagami channel gives the less BER for a given SNR using Single and Multi frame simulation techniques as compared to Rayleigh and Rician Channel. So, Nakagami channel is the best channel for wireless communication.

CONCLUSION

As per the Scope of this paper, the Nakagami-m fading channel simulation model is first developed in MATLAB/Simulink. It is concluded that Nakagami fading channel is having better error performance as compared to Rayleigh and other multipath fading channels. The simulated results also shows that when data is send from transmitter to receiver by Multi Frame simulation technique using BFSK modulation and MRC in Nakagami fading channel, then data experience less BER as the number of receivers increases. The simulated results also shows that data communication experience less BER in Nakagami fading channel by Multi Frame simulation technique using BPSK and BFSK modulation as compared to Rayleigh and Rician fading channels.

REFERENCES

[1] Anam Inlays, Ejaz A Ansari and Saleem Akhtar, Accurate BER / SER Analysis and Performance of Different Modulation Schemes over Wireless Fading Channels, *CODEN:SINTE 8 Sci. Int.(lahore)*, **2013**, 25(2), 367-374,.
[2] QT Zhang, Maximal-Ratio Combining Over Nakagami Fading Channels with an Arbitrary Branch Covariance Matrix, *IEEE Transactions on Vehicular Technology*, **1999**, 48, 1141- 1150.
[3] Li Tang and Zhu Hongbo, Analysis and Simulation of Nakagami Fading Channel with MATLAB, *Asia Pacific Conference on Environmental Electromagnetics (CEEM)*, Hangzhou, China, **2003**, 490-494.
[4] Marvin K Simon and Mohamed Slim Alouini, *Digital Communication over Fading Channels: A Unified Approach to Performance Analysis*, Wiley-Interscience Publication, John Wiley & Sons, Inc, **2000**.
[5] Jianxia Luo, Performance Analysis of Compact Antenna Arrays with MRC in Correlated Nakagami Fading Channels, *IEEE Transactions on Vehicular Technology*, **2001**, 50, 267 277.
[6] J G Proakis, *Digirul Communicurions*, New York: McGraw-Hill, 3rd Edition, **1995**.
[7] Marvin K Simon and Mohamed Alouini, *Digital Communication over Fading Channels*, Wiley series in Telecommunications and Signal Processing, Second Edition, **2004**.
[8] Goldsmith, *Wireless Communications*, Cambridge University Press, **2005**.
[9] Hemant Dhabhai and Ravindra Prakash Gupta, Analysis of BER in FSK Modulation With AWGN Fading Channel, *VSRD International Journal of Electrical, Electronics & Communication Engg.*, **2014**, 4 (10), 201-204.
[10] Hemant Dhabhai, Ravindra Prakash Gupta and Anand Jain, Parametric Comparison of various Fading Channels using MATLAB Simulation, *International Journal of Advanced Engg. Research and Science*, **2014**, 1 (5), 91-96.
[11] Hemant Dhabhai and Ravindra Prakash Gupta, A Performance Analysis of Digital Modulation Techniques under Simulation Environment, *Journal of Emerging Technologies and Innovative Research*, **2014**, 1(5), 312-316.
[12] Hemant Dhabhai, Ravindra Prakash Gupta and Sudha Paliwal, Study of Fading Channels and their Performance Parameters, *Technix International Journal for Engineering Research*, **2014**, 1(4), 1-6.
[13] Hemant Dhabhai and Ravindra Prakash Gupta, Performance Analysis of M-FSK over Nakagami Channel, *Proceedings of National conference on Automation and Control: Make In India*, Udaipur, India, **2015**.