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SEP Performance of MPSK in Rician Fading Channel Using MRC

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Abstract - In this paper pdf of received SNR with MRC diversity under Rician fading channel is used to derive SEP (Symbol Error Probability).We assume that channel side information is known to the receiver. Error Probability for MPSK with Maximal-Ratio Combining receiver diversity is obtained by averaging the conditional SER over the Probability density function (pdf) of received SNR. Error Performance plots of MPSK modulation technique has been drawn for different value of Rician parameter K, diversity order N, modulation order M. These results provide information about error performance over fading channel.

Keywords - Maximal-Ratio-Combining (MRC), M-ary Phase Shift Keying (MPSK), Symbol Error Probability (SEP), Signal-to-Noise Ratio (SNR).

I. INTRODUCTION

The main objective of digital communication system is to transport digital data between two or more nodes. In radio communication this is usually achieved by adjusting a physical charactestics of a sinusoidal carrier, frequency, phase, amplitude or a combination thereof .This is performed in a real systems with a modulator at the transmitting end to impose the physical change to the carrier and a demodulator at the receiving end to detect the resultant modulation and reception [1]. It is important to analyses the system in term of probability of error to view the system performance. In digital wireless communication systems the modulating signal may be represented by as a time sequence of symbols where each symbol has m finite states. Each symbol can be represented as n bits of information where $n=\log_2 m$ bits/symbol. M-ary modulation schemes are one of most important digital data transmission systems as it achieves better bandwidth efficiency than other modulation techniques. Each modulation techniques have different performance while dealing with signals, which normally are effected with noise [2]. In wireless communication fading phenomenon is a boundry condition. It is a deviation of attenuation in telecommunication when signal is passing through a propagating media. The standard technique to reduce the effect of fading is diversity technique. So here we use MRC (Maximal Ratio Combining) method. M-PSK is a well known modulation technique use in wireless communication. Due to high spectral efficiency M-PSK is an attractive Modulation technique in wireless communication. For different values of Rician parameter Symbol error probability (SEP) is different. So that the performance varies with change of Rician parameter. A simple closed form expression of symbol error probability (SEP) has been presented for M-PSK, Transmitted over Rician fading channel using N- branch receiver diversity with maximal-ratio- combining (MRC). The goal of our analysis is to increase the performance of modulation technique in different working conditions.

II. FADING

The fading is deviation of the attenuation in telecommunication when signal passes through propagating media. It may vary with time, geographical position and/or radio frequency, and is often modeled as a random process. In fading the strength or power of received signal varies with respect to time. The main causes of fading are attenuation, change in transmission medium, refraction, multipath propagation, rainfall, obstacles etc. In wireless communication environment when a signal flows from transmitter to receiver, it is received by multiple paths. These multiple path arises due to scattering of signal from obstacles like tree, lamppost, and vehicles. It may be due to reflection from ground, buildings, hills etc. So the received signal at the receiver end is attenuated, delayed, phase shift version of original signal [3]. Such channels are called multipath fading channels. The modified form of signal is received at the receiver after fading process in the channel, if it is received via no line of sight then the channel is called Rayleigh fading channel and if via line of sight then the channel is called Rician fading channel.

III. DIVERSITY

Diversity is the technique used in wireless communication systems to improve the error rate performance of different modulation methods over a fading channel. A large increase in SNR relative to a non-fading environment is necessary to ensure an error rate that is acceptable for practical use [4]. To meet such a requirement, we have to increase the transmitted power, antenna size and so on, which can be costly in terms of implementation. It minimizes the effects of deep frequency-localized fades and facilitates the resolvability and subsequent coherent combining of multiple copies of the same signal. Similarly, by dividing a high-rate signal to many parallel low-rate signals, Orthogonal Frequency Division Multiplexing (OFDM) mitigates the effect of channel dispersion on high-rate signals.

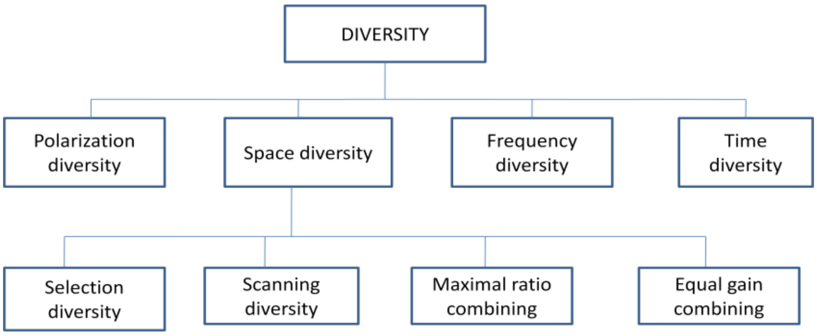

Fig.1 Diversity techniques

A. Maximal ratio Combining

In this method, all the diversity branches are weighted for maximum SNR. Co-phasing and summing is done for adding up the weighted branch signals in phase.

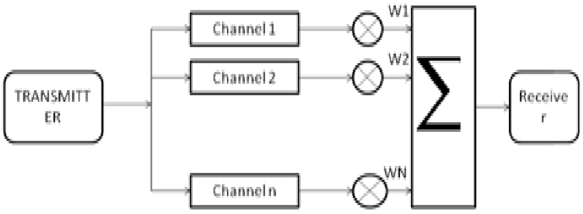

Fig.2 Maximal Ratio Combining

The combined output is given by**:-**

$$y(t) = \sum_{i=0}^{M-1} w_i\, r_i(t) \qquad (1)$$

Choose the weights to be the channel gain conjugate:-

$$y(t) = \sum_{i=0}^{M-1} A_i\, e^{-j\theta_i} r_i(t)$$

$$y(t) = \sum_{i=0}^{M-1} A_i e^{-j\theta_i}\, [A_i e^{-j\theta_i} s(t) + Z_i(t)] \qquad (2)$$

$$y(t) = (\sum_{i=0}^{M-1} A_i^2)\, S(t) + \sum_{i=0}^{M-1} A_i\, e^{-j\theta_i}\, Z_i(t) \qquad (3)$$

The SNR of the combined signal is:

$$\gamma = \frac{\sum_{i=0}^{M-1} A_i^2 E_b}{N_0} = \sum_{i=0}^{M-1} \gamma_i \qquad (4)$$

IV. SYSTEM PERFORMANCE MEASURES

A. Average Signal to noise Ratio

Probably the most common and best understood performance measure characteristic of a digital communication system is signal-to-noise ratio (SNR). Most often this is measured at the output of the receiver and thus it is related directly to the data detection process itself. It is easiest to evaluate and most often serves as an excellent indicator of the overall fidelity of the system. Although traditionally, the term noise in signal-to-noise ratio refers to the ever present thermal noise at the input to the receiver. The more appropriate performance measure is average SNR, where the word average indicates to statistical averaging over the Probability distribution of the fading. In simple mathematical terms, if γ denotes the instantaneous SNR at the receiver output which includes the effect of fading, then the average SNR [4]. Mathematically it can be expressed as-

$$\bar{\gamma} = \int_0^{\infty} \gamma\, p_\gamma(\gamma) d_\gamma \qquad (5)$$

Where $p_\gamma(\gamma)$ denotes the probability density function (PDF) of γ.

B. Symbol error probability

The second performance criterion and undoubtedly the most difficult to compute is the average symbol error probability (SEP). On the other hand, it is the one that is most revealing about the nature of the system behavior and the one most often illustrated in documents containing system Performance evaluations; thus, it is of primary requirement to have a method for its evaluation that reduces the degree of difficulty as much as possible. The primary reason for the difficulty in evaluating average SEP lies in the fact that the conditional (on the fading) SEP is, in general, a nonlinear function of the Instantaneous SNR, the nature of the nonlinearity being a function of the Modulation/detection scheme employed by the system. For example, in the multichannel Case, the average of the conditional SEP over the fading statistics is not a simple average of the per channel performance measure as was true for average SNR. The average SEP can be written as [4].

$$p_s(E) = \int_0^{\infty} P_S(E/\gamma) P_\gamma(\gamma) d\gamma \quad (6)$$

Where $p_s(E/\gamma)$ is the conditional symbol error probability.

V. M-ARY MODULATIONS SCHEMES

In M-ary signaling schemes one of M signals $s_0(t), s_1(t), \ldots\ldots s_{M-1}(t)$ are transmitted during each signaling interval of duration T_S. These signals are generated by changing the amplitude, phase (or) frequency of the carrier in the M-discrete steps. In M-ary modulation, $n=\log_2 M$ data bits are represented by a symbol, where $M=2^n$.So the bandwidth efficiency is increased to n times [5] [6]. In this modulation technique the digital data is sent by varying both the envelope and phase (or frequency) of an RF carrier as the envelope and phase offer two degrees of freedom and modulation techniques map base band data into four or more possible RF carrier signals. Such modulation techniques are called M-ary modulation [7]. There are different types of digital M-ary modulation schemes such as MPSK, MFSK, MQAM, and MDPSK and so on. But here we find the Average Symbol error probability of M-QAM in Rician fading channel using MRC.

A. MPSK

An M-ary digital PSK signal is represented as:-

$$s_i(t) = A\cos(2\pi f_C t + \theta_i), \quad i = 1,2, \ldots\ldots M-1 \qquad 0 \le t \le T \quad (7)$$

Where $\theta_i = \frac{2(i-1)\pi}{M}$ (8)

There are two orthogonal basic function $\emptyset_1(t)$ & $\emptyset_2(t)$, contained in the expansion of $s_i(t)$ the above expression can be written as:

$$s_i(t) = A\cos\theta_i \cos 2\pi f_c t - A\sin\theta_i \sin 2\pi f_c$$

$$s_i(t) = s_{i1}\emptyset_1(t) + s_{i2}\emptyset_2(t) \quad (9)$$

Where $s_{i1}(t) = \int_0^T s_i(t)\emptyset_i(t)\ dt = \sqrt{E_s}\cos\theta_i$ (10)

$$s_{i2}(t) = \int_0^T s_i(t)\emptyset_2(t)\ dt = \sqrt{E_s}\sin\ \theta_i \quad (11)$$

Where $E_s = \frac{1}{2}A^2T$ is the symbol energy of the signal. The phase related to s_{i1} and s_{i2} as

$$\theta_i = tan\frac{s_{i2}}{s_{i1}} \quad (12)$$

VI. PERFORMANCE ANALYSIS

The pdf of the instantaneous SNR γ is given below [8].

$$P_\gamma(\gamma) = \left(\frac{N+K}{\bar{\gamma}}\right)\left[\frac{(N+K)\gamma}{K\bar{\gamma}}\right]^{N-1} .exp\left(\frac{(N+K)\gamma+K\bar{\gamma}}{\bar{\gamma}}\right) I_{N-1}\left(2\sqrt{\frac{K(N+K)\gamma}{\bar{\gamma}}}\right) \quad (13)$$

Where $\bar{\gamma}$ is the expected value of γ.

The conditional probability of symbol error for coherent MPSK is [9].

$$p_s\left({E}/{\gamma}\right) = \frac{1}{\pi}\int_{-\pi/2}^{\frac{\pi}{2}-\frac{\pi}{M}} exp\left[-\gamma sin^2\left({\pi}/{M}\right).sec^2\theta\right] d\theta \quad (14)$$

The probability of error is defined as:-

$$P_s(E) = \int_0^\infty p_s\left({E}/{\gamma}\right) p_\gamma(\gamma) d\gamma \quad (15)$$

By putting eq (13) and (14) into (15) we get:-

$$P_s(E) = \int_0^\infty \left(\frac{N+K}{\bar{\gamma}}\right)\left[\frac{(N+K)\gamma}{K\bar{\gamma}}\right]^{N-1} exp\left[-\frac{(N+K)\gamma+k\bar{\gamma}}{\bar{\gamma}}\right] I_{N-1}\left(2\sqrt{\frac{K(N+K)\gamma}{\bar{\gamma}}}\right) * \frac{1}{\pi}\int_{\pi/2}^{\frac{\pi}{2}-\frac{\pi}{M}} exp\left[-\gamma sin^2\left({\pi}/{M}\right).sec^2\theta\right] d\theta \quad (16)$$

OR

$$P_s(E) = \frac{1}{\pi}\left[\frac{N+K}{\bar{\gamma}}\right]^N \int_0^\infty \left(\frac{\gamma}{K}\right)^{N-1} I_{N-1}\left(2\sqrt{\frac{K(N+K)\gamma}{\bar{\gamma}}}\right) .\int_{-\pi/2}^{\frac{\pi}{2}-\frac{\pi}{M}} \exp(-k) exp\left[-\frac{(N+K)}{\bar{\gamma}} - \gamma sin^2\left({\pi}/{M}\right).sec^2\theta\right] d\theta \quad (17)$$

Compare the above eq with (17)

$$\int_0^\infty x^v e^{-\alpha x}.I_{2v}\left(2\beta\sqrt{x}\right)dx = \alpha^{-(2v+1)}\beta^{2v} exp\left(\frac{\beta^2}{\alpha}\right) \quad (18)$$

Let,

$$\alpha = \left[\frac{N+K}{\bar{\gamma}} + sin^2\left(\frac{\pi}{M}\right) sec^2\theta\right] \quad (19)$$

$$\beta = \sqrt{\frac{K(N+K)}{\bar{\gamma}}} \quad (20)$$

$2v=N-1$, $V=\frac{N-1}{2}$ (21)

$$\alpha^{-(2v+1)} = \left[\frac{N+K}{\bar{\gamma}} + sin^2\left(\frac{\pi}{M}\right) sec^2\theta\right]^{-N} \quad (22)$$

$$\beta^{2v} = \left(\frac{K(N+K)}{\bar{\gamma}}\right)^{\frac{N-1}{2}} \quad (23)$$

$$exp\left(\frac{\beta^2}{\alpha}\right) = \exp\left[-\frac{K sin^2\frac{\pi}{M} sec^2\theta}{\frac{N+K}{\bar{\gamma}} + sin^2\frac{\pi}{M} sec^2\theta}\right] \quad (24)$$

By substituting all the values we get:-

$$P_s(E) = \frac{1}{\pi}\left(\frac{N+K}{\bar{\gamma}}\right)^N \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}-\frac{\pi}{M}} \frac{\exp\left[-\frac{K sin^2\frac{\pi}{M} sec^2\theta}{\frac{N+K}{\bar{\gamma}} + sin^2\frac{\pi}{M} sec^2\theta}\right]}{\left(\frac{N+K}{\bar{\gamma}} + sin^2\left(\frac{\pi}{M} sec^2\theta\right)\right)^N} d\theta \quad (25)$$

It can be easily shown that as *K* goes to zero, that a substitution of *K*=0 in (25) yields the probability of symbol error for MPSK over a Rayleigh fading channel, i.e.

$$P_s(E) = \frac{1}{\pi} \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}-\frac{\pi}{M}} \frac{1}{\left(1+\frac{\bar{\gamma}}{N} sin^2\left(\frac{\pi}{M}\right) sec^2\theta\right)^N} d\theta \quad (26)$$

A. *Numerical Results*

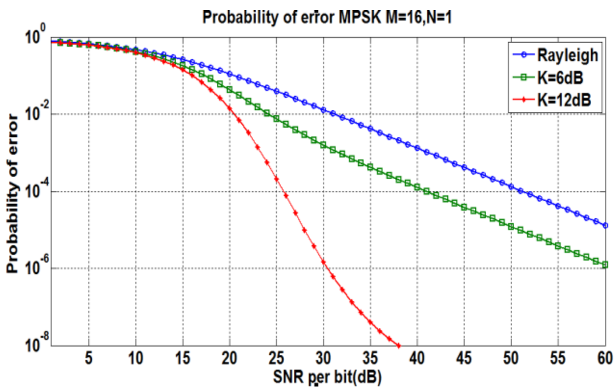

Fig. 3 SEP for MPSK over a Rician fading channel for M=16, N=1.

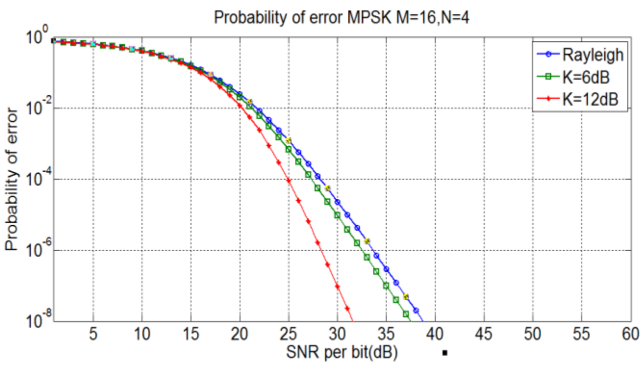

Fig. 4 SEP for MPSK over a Rician fading channel for M=16, N=4

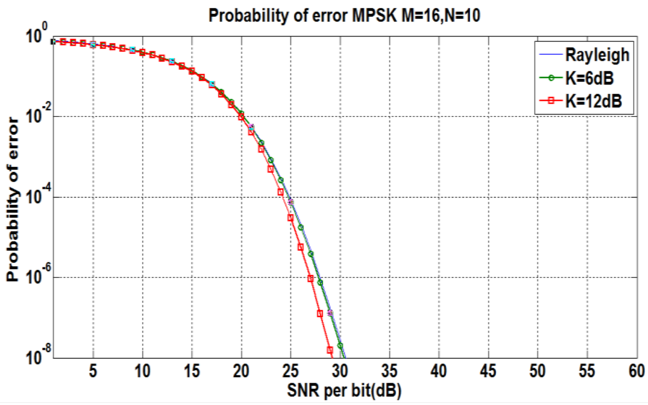

Fig. 5 SEP for MQAM over a Rician fading channel for M=16, N=10.

The effect of Rician parameter K and diversity N on the probability of symbol error for MPSK over a Rician fading channel for various values of K and N is shown in above figure. Figure 3,4,5 are the symbol error probabilities of MPSK system over a Rician fading channel versus bit SNR for various values of Rician parameter that is K=0, K=6dB, K=12dB which corresponds relative to Rayleigh fading and typical range of Rician fading .It is clear from the results that for any value of K with increase in diversity N, the error probability decreases. So the system performance will improve.

VII. CONCLUSION

Digital modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communications, and quicker system availability. Modulation technique with diversity is used to transmit message signal efficiently.In this paper the Error performance of MPSK under Rician fading channel with MRC diversity combining are analysed and SEP is calculated. On the basis of numerical calculation SEP of M-PSK is graphically plotted. From graphical representation it is analysed that the symbol error probability of M-PSK is lower than other modulation technique. M-PSK modulation technique is most suitable technique for combating fading in wireless communication for its lower SEP. SEP should keep low to transmit data perfectly from transmitter to receiver. For efficient transmission of information in wireless communication, the M-PSK modulation technique shows the better performance for its lower SEP.

REFERENCES

[1] Rapport, T.S.: Wireless Communications: Principles and Practices, Prentice- Hall, *Inc.*, New Jersey, 1996.

[2] Goldsmith and S. G. Chua, “Variable-rate variable-power M-QAM for fading Channels,” *IEEE Trans Communication*, vol. 45, pp. 1218–1230, October 1997.

[3] M. Zeng, A. Annamalai, and V. Bhargava, “Recent Advances in Cellular Wireless Communications,” *IEEE Communications Magazine*, Vol. 37, Sept. 1999, pp. 128-138.

[4] M. K. Simon and M. S. Alouini, “Digital Communications over Fading Channels”, John Wiley & Sons, *Inc.*, New York, 2000.

[5] Lijun Zhang, Zhigang Cao and Chunyan Gao, “Application of RS-coded MPSK modulation scenarios to Compressed Image Communication in Mobile Fading Channel,” *IEEE Vehi.Tech.*, 2000, pp.1198- 1203.

[6] J.G. Proakis, “Digital Communications”, 4th edition, *McGraw-Hill Publishing Company Limited*, *International Edition*, 2001.

[7] Jon Hamkins, “Modulation Classification of MPSK for Space Applications,” *Jet Propulsion Laboratory, California Institute of Technology, IEEE GLOBECOM*, 2006.

[8] Mohammad Riaz Ahmed, MD. Rumen Ahmed**, “**Performance Analysis of Different M- ary Modulation Techniques in Fading channels using different diversity,” *Journal of Theoretical and Applied Information Technology,* 2010 pp 23-28.

[9] Rashmi suthar, Sunil Joshi, Navneet Agarwal, “Performance Analysis of M-ary modulation schemes in cellular mobile communication,” *IJCA*, pp. 25-29.

