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BER Performance of M-Ary FSK on AWGN & Fading (Rayleigh & Rician) Channels

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ABSTRACT

It is our primary need today to achieve the higher data rates in limited spectrum bandwidth to improve the performance of signals. In this paper we analyze various M-ary FSK modulation schemes using simulink model of MATLAB taking BER as measure of performance when the system is subjected to AWGN and fading channel. Based on these performances a modulation scheme and channel is suggested that provides low BER at low received SNR. The simulation results for these methods show that the performance of the system is good in case of AWGN channel as compared to other fading channels. Multipath fading is the very important factors that affect the performance of a communication system. Simulations are used to compare the performance and tradeoffs of M- ary techniques, including analysis of BER in the presence of Additive White Gaussian Noise (AWGN) and multipath fading environment. The performance of different M-ary FSK methods are comparing for various types of the fading channels using the MATLAB simulation.

KEYWORDS :M-ARY Modulation, FSK, MATLAB

INTRODUCTION

I. Introduction In digital communication systems, there are several digital modulation schemes that have been proposed. These digital modulation schemes include basic schemes such as MFSK (M-ary Frequency Shift Keying), MPSK (M-ary Phase Shift Keying), MPAM (M-ary Pulse Amplitude Modulation), MQAM (M-ary Quadrature Amplitude Modulation), and GMSK (Gaussian Minimum Shift Keying). Modulation is generally used in wireless communication for data transmission. It is the process in which a property of carrier signal is varied in proportion to the message signal. In Digital Modulation digital symbols are transmitted in the form of waveforms that are compatible with the characteristics of the channel. In digital carrier systems, baseband pulses modulate a high-frequency carrier. The probability of error is depends only on the pulse energy. The digital communication system is shown in figure 1.

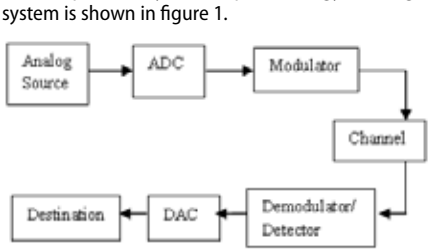

Figure1: Basic Digital Communication System

The objective of this paper is to analyze the key characteristics and performance of M-ary FSK for various channels. The performance analysis of digital communication systems over the lognormal channels remains challenging and mathematically intractable [1]. The Signal to noise ratio (SNR) knowledge at the receiver end can help in improving the performance of the receiver algorithms and it can be used for changing modulation format to achieve better performance. There are many interesting SNR estimation techniques available in the literature [2]. Several distributed probability functions are available to model the wireless propagation channel. We describe the three major frequently used distributions. Such those named Additive White Gaussian noise (AWGN), Rayleigh and Rician models. In wireless communications, fading is considered as the deflection or attenuation induced by a propagation media. Fading may vary with time, geographical position and radio frequencies. Fading may either be due to multipath propagation, referred to as multipath induced fading, or due to shadowing from obstacles affecting the wave propagation, sometimes referred to as shadow fading. Two types of fading due to multipath:

- Rayleigh Fading,

- Rician Fading.

A. Rayleigh Fading

In urban crossing buildings, vehicles and other objects, the transmitted Tx, signals arrive at the receiver Rx, on different paths. A Rayleigh channel is considered when there are different signal paths between the transmitter and receiver, none of which dominates. This means that all the paths can vary and affect the overall signal at the receiver [3].

B. Rician Fading

A fading Rician channel occurs when the received signal is a combination of a line of direct view and multipath fading between a transmitter and a receiver. The line of sight path is the strongest signal path that travels directly from the transmitter to receiver. Due to direct path, the effect of Rician fading on the transmitted signal will be less than in the case of Rayleigh fading [3] The goal for the next generation of mobile communications system is to seamlessly integrate a wide variety of communication services such as high speed data, video and multimedia traffic as well as voice signals [4]. Any data which is transmitted in a channel will incur loss. This loss of data is due to many factors comprising atmospheric, power loss and et cetera. Due to the loss in the channel the indigenous signal is not fully recovered at the receiver. The amount of signal lost is a measure of efficiency of the channel. Lower the loss better is the efficiency and vice versa. This loss in measured in terms of bits lost in the transmission [5]. Exact analysis of symbol error probability (SEP) has been presented for M-ary differentially encoded/ differentially decoded phase shift keying (MDPSK) and coherent M-ary phase shift keying (MPSK), transmitted over Rician fading channel using *N* branch receive diversity with maximal-ratio-combining (MRC) [6,7,8,9]. In an M-ary signaling scheme, we may send one of M possible signals s1(t), s2(t)…sm(t), during each signaling interval of duration Ts. For almost all applications, the number of possible signals $M=2^n$, where n is an integer. The symbol duration Ts=nTb, where Tb is the bit duration. In pass-band data transmission these signals are generated by changing the amplitude, phase, frequency of a sinusoidal carrier in M discrete steps thus we have M-ary ASK, M-ary PSK and M-ary FSK digital modulation [10]. Bit error rate (BER) of a communication system is defined as the ratio of number of error bits and total number of bits transmitted during a specific period. It is the likelihood that a single error bit will occur within received bits, independent of rate of transmission. In our simulations, we have considered the most commonly used channels: the Additive White Gaussian. Noise (AWGN) channel where the noise gets spread over the whole spectrum of frequencies [11].

II. Simulation Result:

In this section, study of M-ary FSK schemes i.e. 2-FSK, 4-FSK, 8-FSK is performed on AWGN, Rayleigh and Rician fading channels. The results are plotted using MATLAB in terms of bit error rate. Bit error rate analysis is done using received and transmitted data for different levels of noise added in the channel.

Figure 2 presents a comparative study of BFSK, 4FSK, and 8FSK for AWGN channel. Figure 3 presents a comparative study of BFSK, 4FSK, and 8FSK for Rayleigh channel. And Figure 4 presents a comparative study of BFSK, 4FSK, and 8FSK for Rician channel.

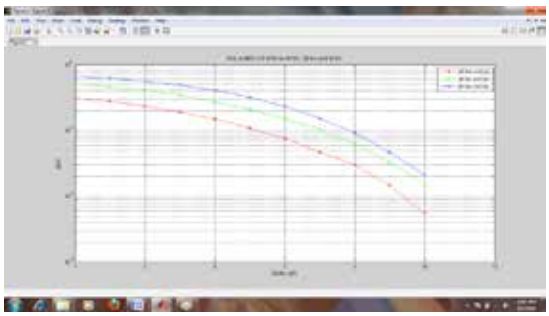

Figure2: BER performance of AWGN channel for BFSK, 4FSK, 8FSK.

Figure3: BER performance of Rayleigh fading channnel for BFSK, 4FSK, 8FSK

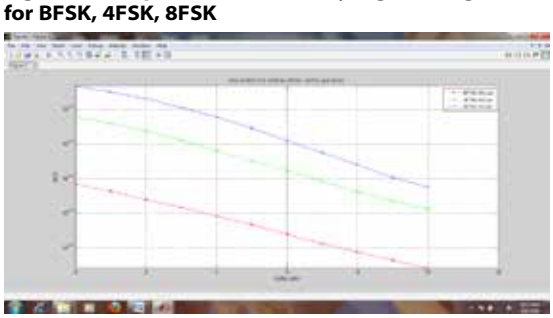

Figure4: BER performance of Rician fading channnel for BFSK, 4FSK, 8FSK

Figure 5 presents a comparative study of AWGN channel, Rayleigh and Rician fading channels for BFSK. Figure 6 presents a comparative study of AWGN channel, Rayleigh and Rician fading channels for 4FSK. And Figure 7 presents a comparative study of AWGN channel, Rayleigh and Rician fading channels for 8FSK.

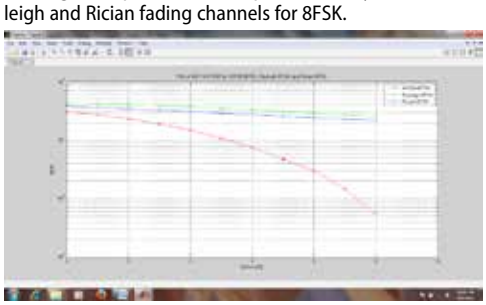

Figure5: BER performance of AWGN, Rayleigh and Rician fading channels for BFSK

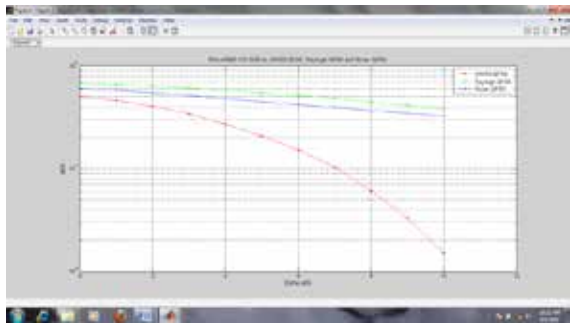

Figure6: BER performance of AWGN, Rayleigh and Rician fading channels for QFSK

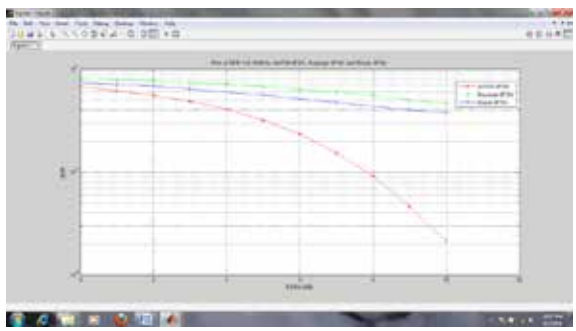

Figure7: BER performance of AWGN, Rayleigh and Rician fading channels for 8FSK

III. Conclusion

This paper is based on simulation using scientific computer simulation software, MATLAB. The simulation will be done using simulink model of MATLAB. First, the model is simulated under Additive White Gaussian Noise (AWGN). Then, the channel is simulated with Rayleigh and Rician fading channel. The performance of the M-ary FSK modulation schemes are studied. The performance analysis is based on BER and Signal-to-Noise ratio. Thus, suitable modulations techniques will be determined and concluded based on BER that will be plotted as a function of SNR. Result show that as compare to 4FSK and 8FSK, BFSK scheme work well in AWGN, Rayleigh and Rician fading channels. The Rayleigh channel has the worst performance as this channel is much affected by noise. The rician channel BER performance lies between AWGN channel and Rayleigh channel.

6. References

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