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Analysis of Rayleigh & RICIAN Channel for OFDM System

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***Abstract*— With large amount of energy consumed in wireless LAN (WLAN) system, it becomes an important and meaningful issue to reduce the energy consumption of wireless communication devices nowadays. Here we use IEEE 802.11P standard in order to reduce energy in wireless system. In this paper we draw our attention using with the concept of orthogonal frequency division multiplexing (OFDM) which is a special case of multicarrier transmission, where a single DataStream is transmitted over a number of lower rate subcarriers. The high data rate transmission capability through multipath delay spread, OFDM has been adopted in modern wireless communication systems. The main focus of our paper is analyzing the Rayleigh and Rican channel to know the performance of system. In order to analyze two channels the two parameter are used Bit Error Rate (BER) and Signal-to-Noise Ratio (SNR). Comparing both the channel with and without using Weiner filter is performed. The wireless channel is assumed to include Additive White Gaussian Noise (AWGN) and multipath fading.Simulation results show that the proposed algorithm can effectively reduce noise while using wiener filter.**

Key words: AWGN, BER, OFDM, Rayleigh fading, Rician fading, SNR.

I. INTRODUCTION

It is important to evaluate the performance of wireless devices by considering the transmission characteristics, wireless channel parameters and device structure. The performance of data transmission over wireless channels is well captured by observing their BER, which is a function of SNR [3] at the receiver. In wireless channels, several models have been proposed and investigated to calculate SNR. All the models are a function of the distance between the sender and the receiver, the path loss exponent and the channel gain. Several probability distributed functions are available to model a time-variant parameter i.e. channel gain.

Wireless communication is one of the most active areas of technology development and has become an ever-more important and prominent part of everyday life. Simulation of wireless channels accurately is very important for the design and performance evaluation of wireless communication systems and components. Fading or loss of signals is a very important phenomenon that related to the Wireless Communications Field. That leads us to the fading models which try to describe the fading patterns in different environments and conditions. Although no model can perfectly describe an environment, they strive to obtain as much precision as possible. The better a model can describe a fading environment, the better can it be compensated with other signals, so that, on the receiving end, the signal is error free or at least close to being error free. This would mean higher clarity of voice and higher accuracy of data transmitted over wireless medium. An important issue is in wireless application development is the selection of fading models.

II. PROBLEM DEFINITION AND OBJECTIVE

2.1 Problem definition

Fading and interference is the major problem in wireless or mobile communications. In order to improve the system's effectiveness and study the effect of fading, modeling and simulation of communication system, Fading channel model is of great significance in the communication system.

2.2 Objective

a) To Study the BER performance of OFDM system in AWGN channel.
b) To enhance the knowledge of Rayleigh & Rician channel.
c) To Study the performance of OFDM system over Rayleigh & Rician fading channel with

and without using weiner filter under various scenarios.

2.3 Types of small scale fading

There are many models that describe the phenomenon of small scale fading. Out of these models, Rayleigh fading, Ricean fading and Nakagami fading models are most widely used.

a). Rayleigh fading model: The Rayleigh fading is primarily caused by multipath reception [6]. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal. It is a reasonable model for troposphere and ionospheres signal propagation as well as the effect of heavily built-up urban environments on radio signals. Rayleigh fading [7] is most applicable when there is no line of sight between the transmitter and receiver.

b). Rician fading model: The Ricean fading model [6] is similar to the Rayleigh fading model, except that in Rician fading, a strong dominant component is present. This dominant component is a stationary (non-fading) signal and is commonly known as the LOS (Line of Sight Component).

c). Additive White Gaussian Noise Model: The simplest radioenvironment in which a wireless communications system or alocal positioning system or proximity detector based on Timeof-
flight will have to operate is the Additive-White GaussianNoise (AWGN) [4] environment. Additive white Gaussian noise(AWGN) is the commonly used to transmit signal while signals
travel from the channel and simulate background noise ofchannel.

III. SYSTEM MODEL

3.1Ofdm system

The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers [3]. The relative amount of dispersion in time caused by multipath delay spread is decreased because symbol duration increases for lower rate parallel subcarriers. The other problem to solve is the inter symbol interference, which is eliminated almost completely by introducing a guard time in every OFDM symbol. This means that in the guard time, the OFDM symbolism cyclically extended to avoid inter carrier interference[4]. An OFDM signal is a sum of subcarriers that are individually modulated by using Quadrature phase shift keying (QPSK) or Quadrature amplitude modulation (QAM). OFDM is a method of the digital modulation in which a signal is split into several narrowband channels at different frequencies [5].

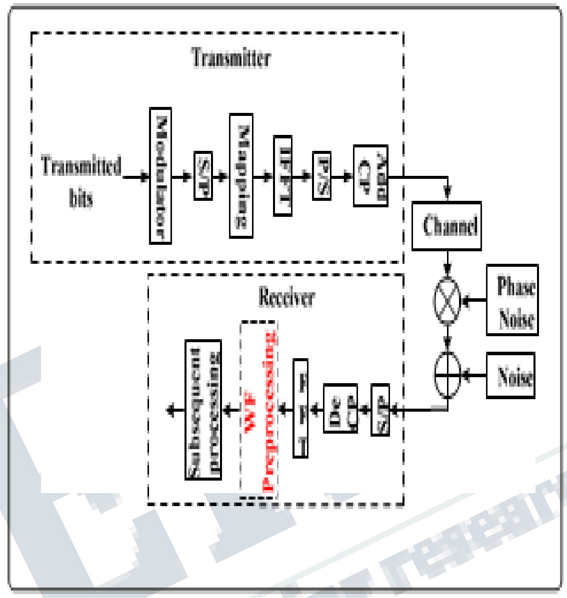

Fig 1: OFDM in presence of noise.

3.2 Weiner filter

In signal processing, the Wiener filter is a filter used to produce an estimate of a desired or target random process by linear time-invariant (LTI) filtering of an observed noisy process, assuming known stationary signal and noise spectra, and additive noise. The Wiener filter minimizes the mean square error between the estimated random process and the desired process.

The goal of the Wiener filter is to compute a statistical estimate of an unknown signal using a related signal as an input and filtering that known signal to produce the estimate as an output. For example, the known signal might consist of an unknown signal of interest that has been corrupted by additive noise. The Wiener filter can be used to filter out the noise from the corrupted signal to provide an estimate of the underlying signal of interest.Typical deterministic filters are designed for a desired frequency response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible. Wiener filters are characterized by the following:

1. Assumption: signal and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation
2. Requirement: the filter must be physically realizable/causal (this requirement can be dropped, resulting in a non-causal solution)
3. *Performance criterion: minimum mean-square error (MMSE)*

The Wiener filter problem has solutions for three possible cases: one where a noncausal filter is acceptable (requiring an infinite amount of both past and future data), the case where a causal filter is desired (using an infinite amount of past data), and the finite impulse response (FIR) case where a finite amount of past data is used.

IV. METHODOLOGY

The steps involved to design the channel model in MATLAB are as follows,

Step 1: Generating a sequence of data.

Step 2: Generating a matrix using serial to parallel conversion.

Step 3: Binary sequence is converted to the decimal because the input to the modulation system must be decimal.

Step 4: Modulating the signal to convert it into the complex numbers.

Step5: Assigning the multiple OFDM symbols to the sub-carriers.

Step 6: Converting samples from frequency domain to time domain using Inverse Fast Fourier transform (IFFT).

Step 7: Convolving each IFFT symbol with the Rayleigh& Rician fading channel.

Step 8: In Rayleigh channel& Rician channel, we used to analyze the transmitting and receiving power of the signal and Bit Error Rate (BER).

Step 9: White Gaussian noise is added between the transmitter and receiver.

Step 10: Converting a received signal from the time domain to the frequency domain using Fast Fourier Transform (FFT). Later wiener algorithm is used in order to filter out the noise.

Step v11: Received signal is divided using the subcarriers.

Step 12: Demodulation of the signal is done to recover the original signal.

Step 13: Decoding has to be made to translation of receiving messages into coded words of a given code.

4.1 Simulation Result

Here we will construct stochastic models of the channel, assuming that various channel behaviors appear with different probabilities, and change over time (with specific stochastic properties). In fig 2,fig 3,fig 4 we can estimate signal of where in BER obtained at different SNR . With the presence of weiner filter the Rayleigh fading channel exibits the maximum BER OF 0.001($10^{-3.1}$ to $10^{-4)}$ where as Rician fading channel exhibits the less BER of 0.0019(10^{-2} to $10^{-3)}$ and in without using any filter the user specific curve fit is obtained.

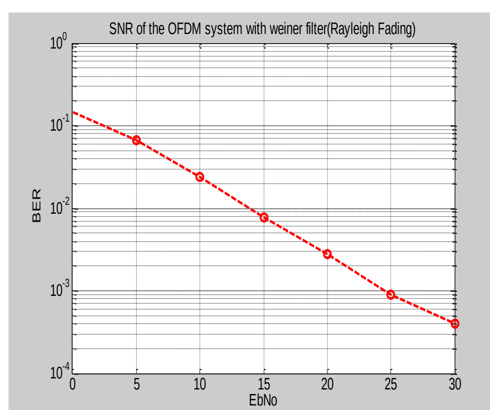

Fig 2:SNR of Rayleigh channel using OFDM with presence of wiener filter

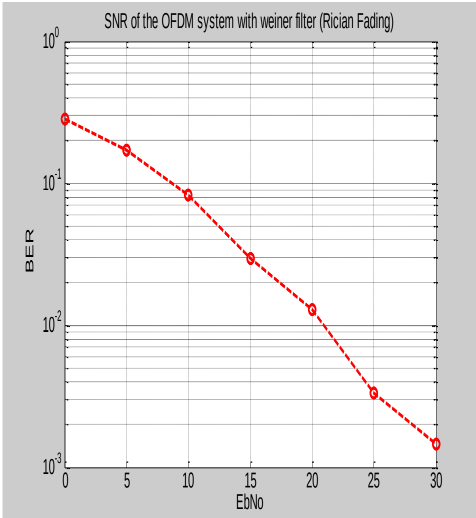

Fig 3: SNR of Rician channel using OFDM with presence of wiener filter

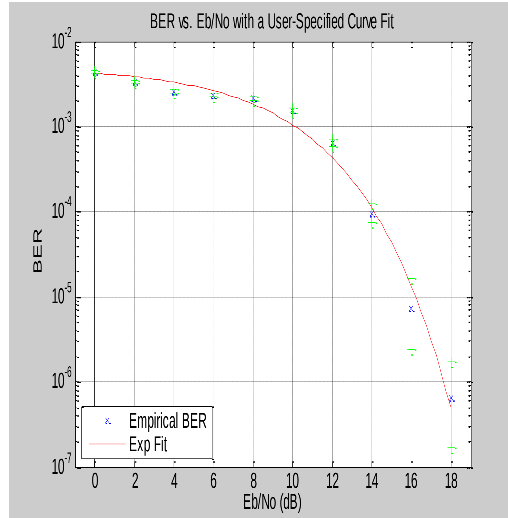

Fig 4: SNR of OFDM without the presence of wiener filter

V. CONCLUSION

From the simulation results, The Bit Error Ratio of a digital communication system is an important figure of merit used to quantify the integrity of data transmitted through the system. By implementing the different modulation techniques, the criterion is comparison of the variation of BER for different SNR. It is observed that the BER is minimum for AWGN and maximum for RAYLEIGH and RICIAN. For RICIAN it is found that the BER is less than AWGN and RAYLEIGH.

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