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BER Performance analysis for different multilevel modulating technique under Rayleigh fading channel

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Abstract- In this thesis work, BER performance for different modulating technique under Rayleigh fading has been analysed. Fading can produce significant random variation of signal power in the scale dBs, can be extremely destructive to the signal. Frequency flat, fast Rayleigh fading may be considered the most critical disturbance in a wireless communication system. In this work we observe the BER performance after passing the channel. The synthetically generated analog signal is first converted to digital signal using PCM and MQAM. Modulation technique is used for signal mapping. Different case studies have also been investigated to evaluate the BER performance. Here we have to choose different bit QAM. Several simulation software such as PSpice, Microsoft Visio, Paint and MATLAB/SIMULINK have been used for this purpose.

Keywords- BER performance, QAM modulation, Rayleigh fading channel

I. INTRODUCTION

When the mechanisms that cause fading in communication channels were first modeled in the 1950s and 1960s, the principles developed were primarily applied to over-the-horizon communications covering a wide range of frequency bands. The 3-30 MHz high-frequency (HF) band used for ionosphere propagation, as well as the 300 MHz-3 GHz ultra-high-frequency (UHF) and the3-30GHz super high frequency (SHF) bands used for tropospheric scatter, are examples of channels that are affected by fading phenomena. Although the fading effects in mobile radio channels are somewhat different from those encountered in ionosphere and tropospheric channels, the early models are still quite useful in helping to characterize the fading effects in mobile digital communication systems. This article emphasizes so-called *Rayleigh* fading, primarily in the UHF band, which affects mobile systems such as cellular and personal communication systems (PCS). The primary goal is to characterize the fading channel and in so doing to describe the fundamental fading manifestations and types of degradation. Then 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 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. We describe the three important and frequently used distributions. Those are AWGN, Rayleigh and Rician models. The signal is detected and decoded by employing several replicas of the received signal. So, we consider multilink receiver structure. In our evaluation, we consider OFDM and DSSS. For binary convolution coding, the receiver uses a Viterbi decoding, which is recommended by the IEEE standard.

II. Fading

2.1 Fading and Multipath

Fading refers to the distortion that a carrier-modulated telecommunication signal experiences over certain propagation media. In wireless systems, fading is due to multipath propagation and is sometimes referred to as multipath induced fading. To understand fading, it is essential to understand multipath. In wireless telecommunications, multipath is the propagation phenomenon that results in radio signals' reaching the receiving antenna by two or more paths. Causes of multipath include atmospheric ducting, ionospheric reflection and refraction, and reflection from terrestrial objects, such as mountains and buildings. The effects of multipath include constructive and destructive interference, and phase shifting of the signal. This distortion of signals caused by multipath is known as fading. In other words it can be said that in the real world, multipath occurs when there is more than one path available for radio signal propagation. The phenomenon of reflection, diffraction and scattering all give rise to additional radio propagation paths beyond the direct optical LOS[2] (Line of Sight) path between the radio transmitter and receiver.

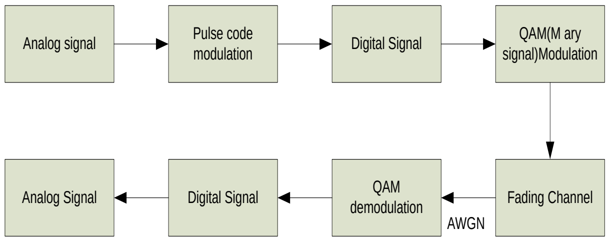
2.2 Rayleigh fading

Rayleigh fading is the name given to the form of fading that is often experienced in an environment where there is a large number of reflections present. The Rayleigh fading model uses a statistical approach to analyse the propagation, and can be used in a number of environments.

The Rayleigh fading model is normally viewed as a suitable approach to take when analysing and prediction radio wave propagation performance for areas such as cellular communications in a well built up urban environment where there are many reflections from buildings, etc.. HF ionospheric radio wave propagation where reflections (or more exactly refractions) occur at many points within the ionosphere is also another area where Rayleigh fading model applies well. It is also appropriate to use the Rayleigh fading model for tropospheric radio propagation because, again there are many reflection points and the signal may follow a variety of different paths. The Rayleigh propagation model is most applicable to instances where there are many different signal paths, none of which is dominant. In this way all the signal paths will vary and can have an impact on the overall signal at the receiver.

III. Performance

3.1 Communication Model



3.2 QAM Modulation

QAM is the encoding of the information into a carrier wave by variation of the amplitude of both the carrier wave and a „quadrature" carrier that is 900 out of phase with the main carrier in accordance with two input signals. That is, the amplitude and
the phase of the carrier wave are simultaneously changed according to the information you want to transmit. Suppose in 16-in 16-state Quadrature Amplitude Modulation (16-QAM), there are four I values and four Q values. This results in a total of 16 possible states for the signal. It can transition from any state to any other state at every symbol time. Since 16 = 24, four bits per symbol can be sent. This consists of two bits for I and two bits for Q. The symbol rate is one fourth of the bit rate. So this modulation format produces a more spectrally efficient transmission.

3.3 Fading Channel

Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, such as that used by wireless devices.

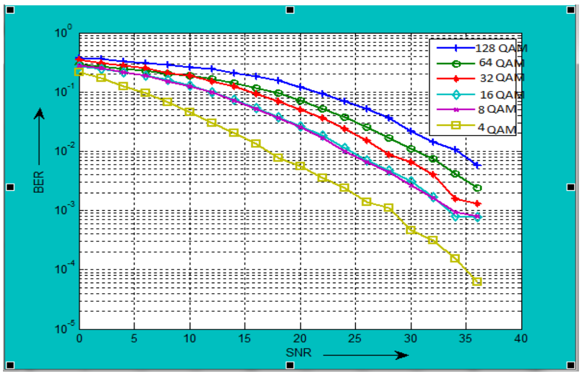
Rayleigh fading models assume that the magnitude of a signal that has passed through such a transmission medium (also called a communications channel) will vary randomly, or fade, according to a Rayleigh distribution the radial component of the sum of two uncorrelated Gaussian random variables.

Rayleigh fading is viewed as a reasonable model for tropospheric and ionospheric signal propagation as well as the effect of heavily built-up urban environments on radio signals. Rayleigh fading is most applicable when there is no dominant propagation along a line of sight between the transmitter and receiver. If there is a dominant line of sight, Rician fading may be more applicable.After QAM modulation the m aray data is passed through a channel.Here we consider only Rayleigh fading channel. A digital data is received from the channel which is converted into analog form. Then for different value of SNR we observe the BER different bit value QAM.

3.4 BER Table for different QAM

128-QAM		64-QAM		32-QAM		16-QAM		8-QAM		4-QAM	
SNR	BER	SNR	BER	SNR	BER	SNR	BER	SNR	BER	SNR	BER
0	0.371875	0	0.290344	0	0.344188	0	0.273063	0	0.278313	0	0.2129375
2	0.355656	2	0.271313	2	0.307625	2	0.2445	2	0.249063	2	0.1709688
4	0.327156	4	0.247188	4	0.282313	4	0.216313	4	0.218625	4	0.1250625
6	0.308594	6	0.229656	6	0.249656	6	0.188469	6	0.186219	6	0.096
8	0.289344	8	0.201688	8	0.211688	8	0.158594	8	0.152969	8	0.0664063
10	0.265125	10	0.188313	10	0.186625	10	0.13	10	0.126094	10	0.046
12	0.243719	12	0.166813	12	0.151781	12	0.100313	12	0.097688	12	0.0299063
14	0.209938	14	0.1425	14	0.123438	14	0.074656	14	0.070594	14	0.0201875
16	0.184313	16	0.117125	16	0.092813	16	0.053969	16	0.051063	16	0.0135
18	0.153375	18	0.094875	18	0.070344	18	0.038	18	0.036125	18	0.0077813
20	0.121313	20	0.072469	20	0.050594	20	0.026438	20	0.025125	20	0.0055625
22	0.093438	22	0.05225	22	0.035938	22	0.01825	22	0.0165	22	0.0035625
24	0.06875	24	0.037375	24	0.023656	24	0.011188	24	0.009938	24	0.0024375
26	0.051844	26	0.025813	26	0.015125	26	0.006906	26	0.006469	26	[illegible]
28	0.036594	28	0.016813	28	0.008875	28	0.004688	28	0.004438	28	0.0010938
30	0.021625	30	0.011094	30	0.0065	30	0.003063	30	0.002656	30	0.0004688
32	0.014219	32	0.007563	32	0.004063	32	0.001688	32	0.001625	32	0.0003125
34	0.010625	34	0.004219	34	0.001563	34	0.000813	34	0.000938	34	0.0001563
36	0.005844	36	0.002438	36	0.001281	36	0.000781	36	0.000813	36	0.0000625

3.5 BER Performance Analysis curve



Here we see that for same SNR, BER value of 128 QAM is greater than others and this value is decreasing consequently. because for any symbol error in 128 QAM all 128 bit is loosed but for 4 bit symbol only 4 bit is loosed consequently BER is less for 4 QAM than 128 QAM.

IV. 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 it is observed that higher order QAM is much better than lower order QAM. Here 32 QAM is performing better than 64 QAM and 8-QAM is performing better than 16-QAM. For higher values of Eb N0, the BER is decreasing in all the fading channels for different modulation schemes.

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