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Robust channel coding for wireless communication

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ABSTRACT - The reliability of wireless channel often makes us to use channel coding for error free transmission. The implementation of channel coding is exploited in various wireless communication standards in various dimensions. The deployment of error correction and detection coding schemes in several wireless communication standards depends on the severity of the channel and the prominence of the fidelity of the data.

In this project work a robust channel coding is proposed which can work well in any type of wireless channel. The modulation techniques signify for data rate, hence a quadrature modulation is used. As an initial step the basic wireless channel model is used to test the strength of various error control schemes in terms of probability of error. The performance of error control schemes is further tested that for two other types of wireless channel models. Channel coding can be done dynamically by including channel estimation for better robustness.

1. INTRODUCTION:

In modern communication techniques the high data rate transmission is increased significantly, but high data rate transmission requires wide range bandwidth. Bandwidth is a burning issue for communication, so it’s not wise decision to transmit data using more bandwidth. High data rate transmission in limited bandwidth leads to increased BER. The widespread use of efficient coding techniques over fading channels leads to distortion or produce the error output. This error can be corrected by using the various channel coding techniques to make the error free transmission in the wireless channel. In wireless communication system, various transmission channels are used. The small amount of fading is reduced by using the simple channel coding and for large amount of fading the complex channel coding is used to reduce the fading. This is similar to the SDR(Software Defined Radio),which changes its modulation techniques depends on the environment likewise the channel coding can be change depends on the fading which is present in the environment. The modulation techniques signify for data rate, hence a quadrature modulation is used. As an initial step the basic wireless channel model is used to test the strength of various error control schemes in terms of probability of error. The performance of error control schemes is further tested that for two other types of wireless channel models. Channel coding can be done dynamically by including channel estimation for better robustness

2. CHANNEL CODING:

Channel coding is a way of introducing controlled redundancy into a transmitted binary data stream in order to increase the reliability of transmission and lower power transmission requirements. Channel coding is carried out by introducing redundant parity bits into the transmitted information stream. The requirement of a channel coding scheme only exists because of the noise introduced in the channel. Simple channel coding schemes allow the received of the transmitted data signal to detect errors, while more advanced channel coding schemes provide the ability to recover a finite about of corrupted data. This result in more reliable communication, and in many cases, eliminates the need for retransmission. Although channel coding provides many benefits, there is an increase in the number of bits being transmitted. This is important when selecting the best channel coding scheme to achieve the required bit error rate for a system.

2.1 LINEAR BLOCK CODE:

Linear block codes are conceptually simple codes that are basically an extension of single-bit parity check codes for error detection. A single-bit parity check code is one of the most common forms of detecting transmission errors. This code uses one extra bit in a block of n data bits to indicate whether the number of 1s in a block is odd or even. Thus, if a single error occurs, either the parity bit is corrupted or the number of detected 1s in the information bit sequence will be different from the number used to compute the parity bit: in either case the parity bit will not correspond to the number of detected 1s in the information bit sequence, so the single error is detected. The encoder of the Linear Block code comprises of generation of the generator matrix with the help of message and parity matrix and then the code word matrix. The decoder of Linear Block code uses the encoded codeword to decode the original message using the hamming matrix and syndrome.

2.2 HAMMING CODE:

Hamming code is a type of Linear Block Code. Hamming code is (n,k) block code, where n= Number of data bits k= Number of encoded bits Number of check bits m=n-k. To calculate number of check bits the Equation used,

2m >= (m+k+1)

In hamming coding technique as number of data bits increases, more number of error control bits is required to generate encoded bits as per Hamming Code. One way to compute the bit error rate or symbol error rate for a communication system is to simulate the transmission of data messages and compare all messages before and after transmission.

2.3 CONVOLUTIONAL CODE:

Convolutional code is a kind of sequential code, commonly used (n, k, K) said. Where k is the number of input symbol information, n is the number of output symbols and K is the constraint length of the encoder. Its encoding efficiency is k/n x100%. The typical n and K (k<n) of the convolutional codes are small. However, in order to obtain a simple and high performance of the channel encoding and improve the reliability of data transmission, the constrained length K is preferred (K<10). In convolutional codes, N symbols of each (n, K) code word is not only related to K information element within the code word, but also it related to the information symbols that belongs to the m=K-1 code word in front. But in the (n, K) linear block codes, N symbols in the each code word is only related to its K information symbols.Therefore, in the process of encoding, the convolutional code can take full advantage of the correlation between the information code. It is a kind of memory encoding, which is superior to the block code (including cyclic code).

3.QPSK MODULATION:

In this modulation technique, four symbol transmitted over four different phases 0,π/2,π,3π/2 respectively. Each symbol consists of two bits binary data shown by basic QPSK signal equation.

$$\boldsymbol{QPSK}((\boldsymbol{t}) = \{\sqrt{\boldsymbol{ES}}\,\boldsymbol{cos}\left[\frac{(\boldsymbol{i}-\mathbf{1})\boldsymbol{\pi}}{\mathbf{2}}\right]\emptyset\mathbf{1}(\boldsymbol{t}) - \sqrt{\boldsymbol{ES}}\,\boldsymbol{sin}\left[\frac{(\boldsymbol{i}-\mathbf{1})\boldsymbol{\pi}}{\mathbf{2}}\right]\emptyset\mathbf{2}(\boldsymbol{t})\}$$

Where i=1,2,3,4

Grouping of bits per symbol reduces the bit rate. Hence requirement of channel bandwidth is less.

4.PERFORMANCE PARAMETERS:

Following parameters are used to analyze the system performance.

4.2.1 BIT ERROR RATE (BER)

The error generated in received data represent by probability of error using following formula

Bit Error Rate (Pb) = Number of bit in error /Total number of transferred bits

This parameter affected by signal to noise ratio, transmission speed, bandwidth and channel properties.

4.2.2 SIGNALS TO NOISE RATIO

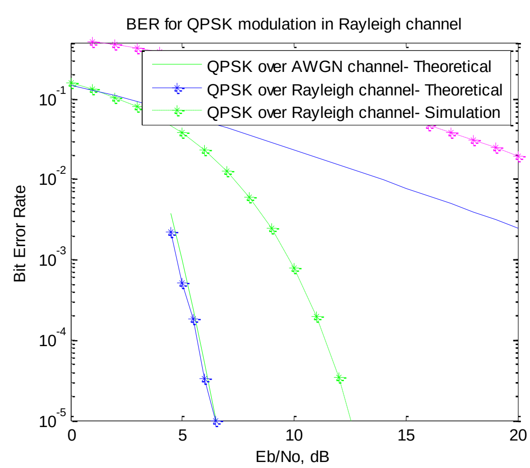
This parameter related to transmit signal power and received signal power which is decreases up to certain amount due to noise [6]. SNR in dB shown by following formula,

SNR =10log$_{10}$(Signal Power)/(Noise power) dB

5.BER PERFORMANCE OF RAYLEIGH CHANNEL WITH ERROR CONTROL CODING :

In this channel received data affected by the Doppler shift and multipath fading effect. This effect creates error while receiving data and BER performance will be reduce at receiver.

From simulation we found that BER is low in AWGN as compare to Rayleigh for higher values of SNR. Hence minimum errors occur in received data for AWGN channel compare to Rayleigh. Keeping SNR with high valuerequires high power amplifiers which increases non linearity. To improve SNR one way is design match filter, but using match filter we can improve the SNR up to certain values only. Hence it is necessary to find such method which gives lower BER in Lower SNR values. For lower SNR a value, where maximum noise is present gives the maximum error in received data. To avoid maximum error and to get actual transmitted data at receiver in noisy condition, efficient method is “Error Correcting Codes” used in receiver side. The error correcting codes used in digital communication are Linear Block Codes, Hamming codes, Reed-Solemn codes, Convolution code, and Turbo code. Out of these codes convolution codes is better for high SNR.As the SNR values goes increasing, the BER values goes decreasing for AWGN channel. This means maximum error gets corrected at receiver using convolution code.



6.CONCLUSION:

Using QPSK modulation techniques, BER performance is better in AWGN as compared to Rayleigh channel over noisy environment. Convolutional code gives better error correction for received data bits, if more noise present at receiver. Due to various channel codings the error can be controlled in the wireless channels.

7.FUTURE WORK:

We can analyze performance of BER, SNR & Improvement in spectral efficiency using different modulation technique like OQPSK, Pi/4 QPSK, GMSK, MPSK& DQPSK with AWGN channel and Rayleigh fading channel by generating binary data source for various data rates, images and other information signals. Also we can implement error correction scheme such as convolution coding and turbo coding particularly with higher modulation technique.

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