Simulation of QPSK Modulation Technique in CDMA System Using Rician Channel

Ashwani Awasthi
Undergraduate Student, Department of Electronics & Communication Engineering
PSIT College of Engineering, Kanpur, Uttar Pradesh

Deepak Singh
Undergraduate Student, Department of Electronics & Communication Engineering
PSIT College of Engineering, Kanpur, Uttar Pradesh

Vikas Srivastava
Assistant professor, Department of Electronics & Communication Engineering
PSIT College of Engineering, Kanpur, Uttar Pradesh

Abstract

This paper presents a study of the QPSK (Quadrature Phase Shift Keying) modulation technique using rician channel in CDMA (Code division multiple access) systems. The selection of good modulation technique is a important factor for analyzing the performance of communication system. The simulated result of this modulation technique demonstrates the efficient BER performance result which is important for mobile communication. In this technique, modulation is achieved by varying the phase of the basis functions depending on the message symbols. We will use MATLAB 7.4 for simulation & calculation of BER and SNR for CDMA System**.**

Keywords- QPSK, Rician channel, SNR, BER, CDMA, Eye Diagram, and Scatter plot.

1. Introduction

Code Division Multiple Access (CDMA) is a new concept in wireless communication. The CDMA is a basically a spread spectrum technique. It consists of several features like multiple access capability, increase system capacity, reduces interference. The CDMA capacity can be maximize by maintaining the signal to interference ratio at the minimum acceptable. In CDMA locally generated code runs at a much higher data rate than the data to be transmitted.

In CDMA, a unique binary spreading sequence is assigned to each user, and all users share the same frequency spectrum. The signals are separated in the receivers by using a correlator which accepts only signal energy from the selected binary sequence and dispreads its spectrum. The users' signals, whose codes do not match, are not despread in bandwidth although contribute only to noise and represent a multiple access interference (MAI) generated by system.

2. System Model

2.1. *CDMA System*

Like other communication system, the CDMA System have transmitter, channel and receiver. The transmitter consists of encoder, interleaver, modulator and spreader. The receiver consists of decoder, deinterleaver demodulator, despreader and channel can be AWGN, Rician fading or Rayleigh fading.

2.2. *QPSK CDMA System*

2.2.1. *Random Integer Generator*

The Random Integer Generator generates uniformly distributed random integers in the range of [0,M-1].where M is defined as M-ary number. The M-ary number can be either scalar or vector.

2.2.2. *Integer to Bit Converter*

The integer to bit converter mapped integer value from the input to a group of bits from the output. The first bit represents the MSB (Most significant bit).The output length is M times the input length.

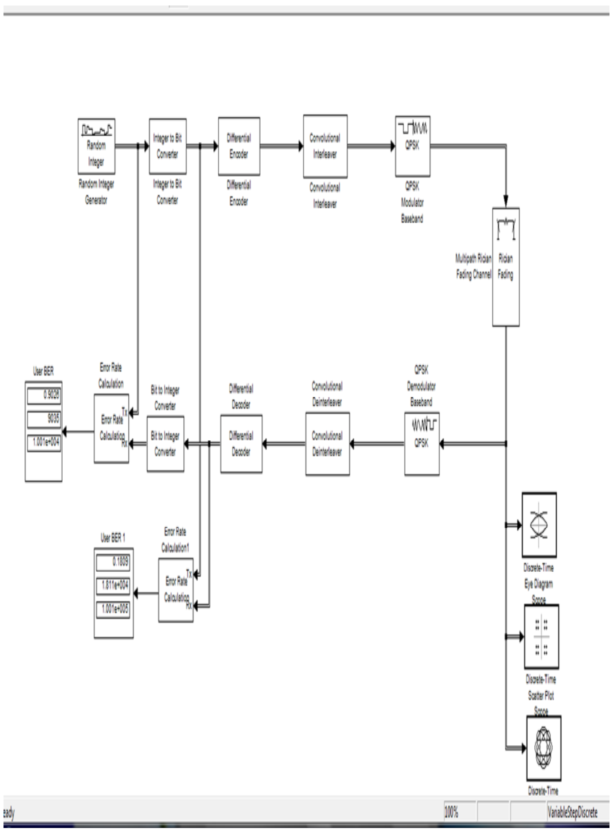

Fig. 1 Block Diagram of QPSK Modulated CDMA System using MATLAB SIMULINK

2.2.3. *Differential Encoder*

The differential Encoder block encodes the binary input signal and the output is the logical difference between the present input and the previous output. The input & output are related as

$d\ (t_0) = m(t_0)$ XOR Initial condition parameter value

$d\ (t_k) = d(t_k\text{-}1)$ XOR $m(t_k)$

Where m is the input message, d is differentially encoded output, t_k is kth time step, XOR is the logical exclusive-or operator.

2.2.4. *Convolutional Interleave*

The Convolutional interleaver block permutes the symbols in the input signal. Internally It uses a set of shift registers. The delay value of the kth shift register is (k-1) times the Register length step parameter.

The input can be either a scalar or a frame-based column vector. It can be real or complex. The sample time of the input and output signals are the same.

2.2.5. *QPSK Modulator*

The QPSK Modulator Baseband block modulates using the quaternary phase shift keying method. The output is a baseband representation of the modulated signal.

If the Input type parameter is set to Integer, then valid input values are 0, 1, 2 and 3.If Constellation ordering is set to Binary, for input m the output symbol is-

$\text{Exp}\ (j\theta+j\pi m/2)$

Where θ is Phase offset parameter. In this case the input can be either a scalar or a frame based column vector.

2.2.6. *QPSK Demodulator*

The QPSK Demodulator Baseband block demodulates a signal that was modulated using the quaternary phase shift keying method.

The input must be a discrete-time complex signal. The input can be either a scalar or a frame-based column vector. The block accepts the input data types single and double.

2.2.7. *Convolutional Deinterleaver*

In this, the recovery of original signal is done. The parameters in the two blocks should have the same values. The input can be either a scalar or a frame-based column vector.

2.2.8. *Differential Decoder*

This block decodes the binary input signal. The output is the logical difference between the present input and the previous input. The block's input and output are related by

$m(t_0) = d(t_0)$ XOR Initial condition parameter value

$m(t_k) = d(t_k)$ XOR $d(t_{k\text{-}1})$

Where d is the differentially encoded input, m is the output message, t_k is the k_{th} time step.

2.2.9. *Bit to Integer Converter*

The Bit to Integer Converter block maps groups of bits in the input vector to integers in the output vector. If M is the Number of bit per integer parameter.
If the input is sample-based input, then it must be a vector whose length equals the Number of bits per integer parameter. If the input is frame-based, then it must be a column vector whose length is an integer multiple of Number of bits per integer.

3. Channel Parameters

3.1. *Bit Error Rate (BER)*
BER is a performance measurement that specifies the number of bit corrupted or destroyed as they are transmitted from its source to its destination. Several effects that affect BER are bandwidth, SNR, transmission speed, transmission medium.

3.2. *Signal to Noise Ratio (SNR)*
SNR is defined as the ratio of a signal power to noise power and it is normally expressed in decibel (dB). The mathematical expression of SNR is-
SNR =10 $\log_{10}$ (Signal Power / Noise Power) dB

4. Simulation result

4.1. *Theoretical plot of QPSK modulation*

The theoretical plot drawn between BER and E_b/N_o (dB) of QPSK modulation is shown below:

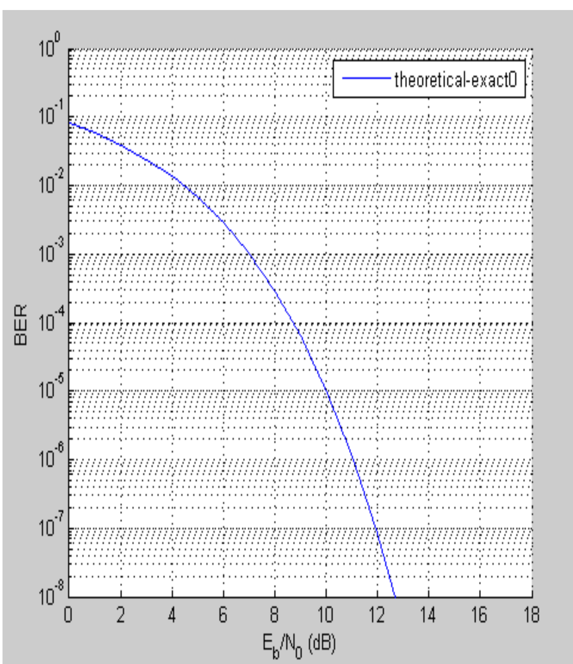

Fig. 2 Theoretical result of QPSK

4.2. *Semi analytic BER plot*

The semi analytic technique uses a combination of simulation and analysis to determine the error rate of communication system.It produces the result more quickly. The result of semi analytic is shown.

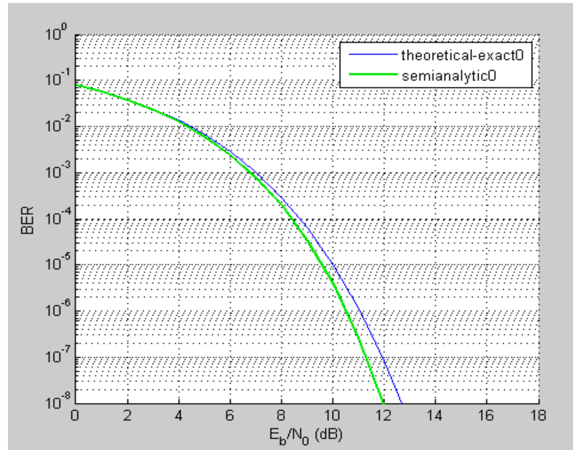

Fig. 3 Semi analytic BER result

4.3. *Monte Carlo BER plot*
The Monte Carlo plot in MATLAB comes under the bertool which is used to find out the BER vs E_b/N_o (dB) characteristics. Here the simulated BER performance of QPSK using rician channel in CDMA System are shown.

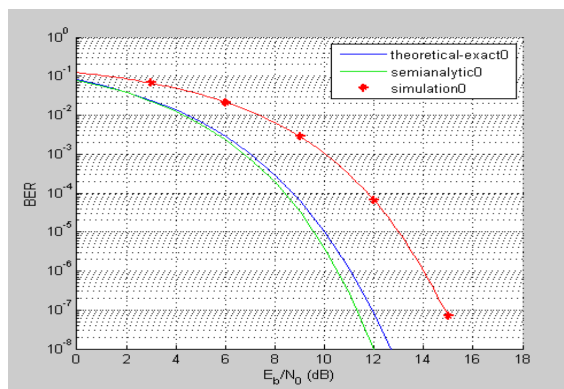

Fig. 4 Monte Carlo Plot

5. Conclusion

In mobile communication, it is important that the information conveys in limited bandwidth from transmitter to receiver as efficiently as possible. In QPSK technique, the RF bandwidth required is half that required by BPSK, by given the same data rate. Hence twice as much data transmitted in QPSK as compared to BPSK. The capability of quadriphase signals to pass through limiting with minimal processing loss has great deal of importance.

The performance of CDMA system in rician channel shows that QPSK modulation technique has a better performance than other techniques like BPSK, FSK etc. The simulated result shows the expected BER performance and all other plots are also good.

6. Reference

[1] R.C.Dixon,Spread Spectrum Systems with commercial applications,3rd addition,john wiley & sons,New York,1984.

[2] Communication System,Symon Haykin,John wiley & sons.

[3] Wireless communicatons,Rappaport,Theodore,PHI publication,2002.

.

[4] CDMA -overview, from internet at: http://en.wikipedia.org/wiki/Code_division_multiple_access

[5] "Comarision of modulation and detection techniques for CDMA cellular system"by Michael Xiaolong Li, B.E. Tsinghua University, 1990, Beijing, China.

[6] De Fina, S.;Lombardo,P.; "Error probability analysis for CDMA systems with closed loop power control" IEEE transactions on Communications,7 august 2002.

[7] Kim, S.R.; Hun Lee; Kang, B.S.; Jeong,J.W., "A coherent dual channel QPSK modulation for" IEEE transactions on Vehicular technology, May 1996.

[8] Digital Modulation technique from internet at: http://www.digitalmodulation.net

[9] Digital Modulation Techniques by Fuqin Xiong.

[10] Rician channel at: http://wireless.per.nl/reference/chaptr03/ricepdf/rice.htm

[11] Communication block set with MATLAB 7.4

[12] "Information, Transmission, Modulation & Noise", Schwartz, McGraw Hill publication