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BER Performance Analysis For Software Defined Radio Using MATLAB Simulink

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ABSTRACT

Software Defined Radio (SDR) has been one of the new techniques developed to change the way the traditional wireless communication systems work. SDRs enable us to build reconfigurable and interoperable radios that can be upgraded for future technologies. Designing a multi-user system in term of hardware will cost a lot and definitely consume power and increase the interference. This paper presents, the design and analysis of baseband processing section of Software Defined Radio using, MATLAB® SIMULINK® tool, for various channels. The performance of the modulation technique, BPSK is evaluated when the system is subjected to noise and interference in the channel.
In this paper we evaluated the performance of system over multipath fading channel and compare the BER performance of wireless communication system with multiple users for AWGN, Rayleigh fading and Rician fading channel. The results of designed SDR system are verified through simulation results.

Keywords— Software Defined Radio, Bit error Rate, Signal to Noise Ratio, Bipolar Phase Shift Keying, MATLAB/Simulink

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I. INTRODUCTION

Continuous grow of data transmission using wireless networks can be observed during the year 2012. The providers of wireless transmission of data demand more effective use of the frequency band. This demand corresponds to the appearance of new wireless technologies and standards. Therefore, new systems must be developed, which would lead to minimization of influence of disturbing phenomena in the radio transmission channel [2] of modern wireless transmission systems. This would lead to an increase of transmission speed with stress on efficiency of the frequency band use [1].

The chosen approach, software defined SDR radio [1], is very suitable for development and testing of such new systems. The key role for these transmission systems plays the software, which can be flexibly changed according to user's needs. As SDR is functioned as multiuser system, multiple access schemes are used to allow many mobile users to share simultaneously a finite amount of radio spectrum. CDMA is the best & commonly used multiple access technique. CDMA introduces various interferences like near far problem, self jamming, and multipath fading. The influence

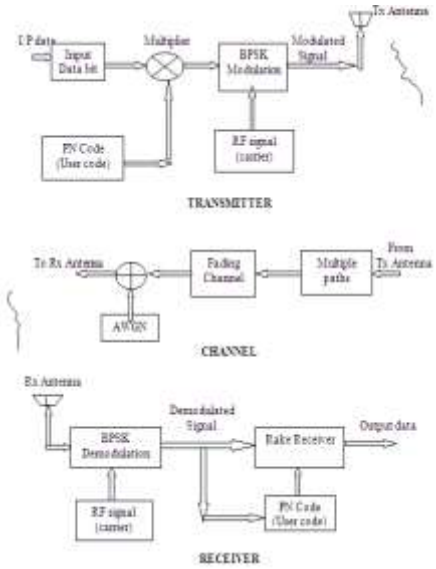

Fig.1: SDR processing

of disturbing phenomena [8], arising in transmission in the communication channel causes Frequency (or linear) distortion (e.g. various types of signal leakage, caused by multipath wave propagation or other physical phenomena, various atmospheric or industrial disturbances, etc.).

The authors deal with the implementation of equalization technique, diversity in the SDR system in order to minimize the signal-to-noise ratio SNR [2] of the transmission channel and thus reduce the transmission error rate BER [8]. With improved received signal quality and link performance at the same time.

II. INTERFERENCES AND SOLUTION

The performance of SDR can be significantly degraded due to co channel interference and near far problem. Interference is the major limiting factor in the performance of system. Equalization compensates for inter channel interference (ISI) caused by multipath in band limited time dispersive channels distorts the transmitted signal, causing bit errors at receiver. ISI has been recognized as a major obstacle to high speed data transmission over wireless channels. An equalizer within a receiver compensates for the average range of expected channel amplitude and delay characteristics. Equalizer must be adaptive since the channel is generally unknown and time varying. In wireless communication fading may be either due to multipath propagation, or due to shadowing from obstacles affecting the wave propagation. Multipath fading can result in either constructive or destructive interference, amplifying or attenuating the signal power seen at receiver. Another problem within wireless communication is errors introduced within noisy communication channels, which may destroy, duplicate or hack the original data.[2]

This paper deals with problems associated with communication channel. The effects of interference in channel, Multipath fading problem can be resolved RAKE RECEIVER[3]. The problem of multipath fading can be resolved by using time diversity technique. The modern implementation of time diversity involves the use of Rake receiver, where multipath channel provides redundancy in transmitted message. By demodulating several replicas of transmitted signal, where each replica experience a particular multipath delay, the RAKE receiver is able to align the replica in time so that a better estimate of the original signal may be formed at the receiver [2].To explore the performance of a RAKE receiver, assume M correlotors are used in receiver to capture the M strongest

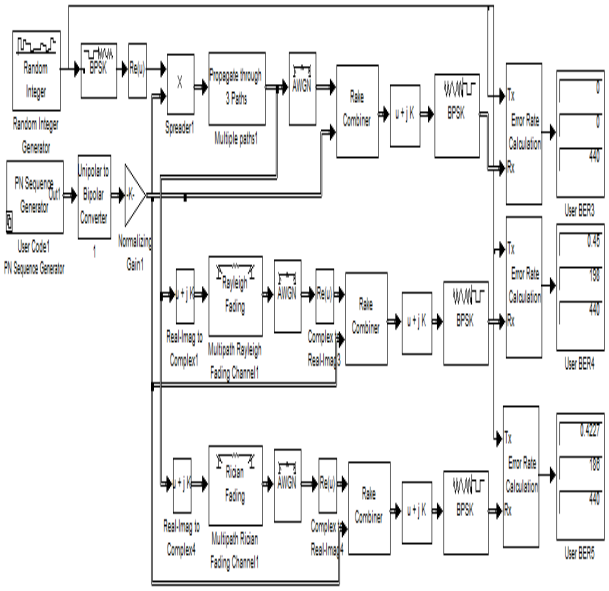

Fig. 2: Simulation model

multipath components. A weighting network is used to provide a linear combination of correlator output for bit detection. If output from one correlator is corrupted by fading the others may not be, and the corrupted signal may be discounted through the weighting process[6]. Decision based on the combination of M separate statistic offered by RAKE provide a form of Diversity which can overcome fading and thereby improve reception.

III. SYSTEM OVERVIEW

The system overview for BER improvement of SDR with Rake receiver using multipath fading channel is as shown in figure 1.At the transmitter, the information is encoded using you are using codes. The encoded information is then transformed into a data modulated symbol sequence with a baseband modulator. The modulated symbol sequence is spread in time domain by a chip sequence of PN code generator, usually Walsh code and PN sequence. The information is shaped and passed through a channel for transmission. At the receiver, the information is multiplied with the chip sequence by the correlators in the rake receiver. The information is then summed and multiplied by local generated spreading code, which is despreading. The information is demodulated and decoded and original data can be recovered. QPSK modulation scheme is used herein this paper. QPSK is much better than the other modulation schemes.

IV. SIMULINK MODEL

In this paper we have developed three models to show the performance of the baseband section of SDR with Rake receiver with AWGN, Rayleigh and Rican Fading Channel as shown in figure 6.. BER is observed for the system with BPSK modulation (baseband) and three propagation paths using the MATLAB® simulation software.

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Simulink is a software environment that runs under MATLAB. Simulink provides a graphical user interface (GUI) that is used for building system models for any specific processing operation, performing simulations, as well as analyzing results. In Simulink, models are hierarchical, and models can be discrete, continuous or hybrid [7].

At the transmitter, the input data from the Bernoulli Binary Generator is modulated using QPSK modulation technique. The QPSK modulated data is then spread by pseudo random noise (PN) sequence before transmission. The channel is modeled as an AWGN channel. At the receiver, the signal is first dispread using the same pseudo random noise (PN) sequence and then demodulated using QPSK demodulator. This is shown in figure 1. The same model can be then next implemented using another channels like Rayleigh Fading channel and Rician Fading Channel. This is shown in figure.

In this paper, one of the important topic in wireless communications, that is the concept of fading is demonstrated by approach available in MATLAB. In this section , the results obtained from the MATLAB simulations are discussed. It is necessary to explore what happens to the signal as it travels from transmitter to the receiver. Then it is very easy to understand the concept in wireless communications. As explained earlier, one of the important aspects of the path between transmitter and receiver is occurrence of fading. MATLAB provides a simple and easy way to demonstrate fading take place in wireless systems. The different fading models and MATLAB based on simulation approach will now be described. Simulink is a graphical extension to MATLAB for modeling and simulation of systems. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagram are available as well as virtual input devices and output devices. Simulink is integrated with MATLAB and data can easily transferred between the programs. The following parameters used for BER calculations :

(i) Sample time for input data = 1/192000 samples/sec
(ii) Generator polynomial = [1 0 0 0 0 1 1]
(iii) Total bit transmitted =24000
(iv)Samples per Frame = 63
(v)Sample time for PN = 192000*63
(vi) samples/sec = 1/12096000

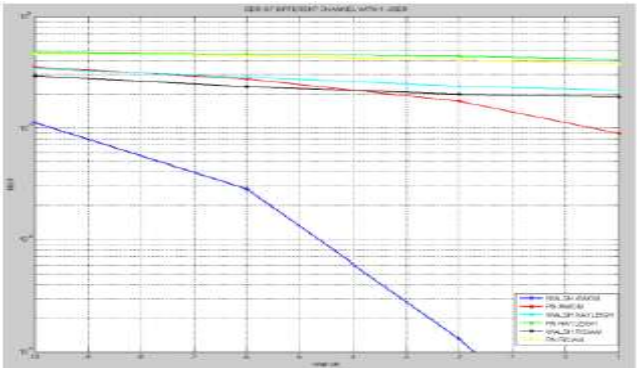
1) Matlab Simulink Model is used for Single user with BPSK modulation and Multipath with different Channels using Rake receiver.

Simulation result in bellow table shows that BER decreases with increases in SNR. The comparison of individual channel is given in table 1.

Table 1: BER in AWGN, Rayleigh and Rician fading channels over BPSK

Sr. No.	BER in AWGN (%)	BER in Rayleigh (%)	BER in Rician (%)
-8	0.3069	0.4851	0.4951
-4	0.1980	0.4752	0.4851
0	0.1181	0.4700	0.4823
4	0.02925	0.4455	0.4800
8	0.0	0.4257	0.4781

Graph 1: BER Vs SNR graph shows channel comparison for three channels



2) For comparison point of view I have taken two different codes PN Sequence and Walsh code. PN sequence generator Generate pseudo noise sequence. Walsh code generator Generate Walsh code from orthogonal set of codes. For Walsh code (orthogonal code) BER performance is better as compared to PN code

Table 2: BER for different Channel with PN and Walsh code

SNR	AWGN BER		Rayleigh BER		Rician BER	
	PN	Walsh	PN	Walsh	PN	Walsh
-10	0.35	0.11	0.47	0.340	0.46	0.291
-6	0.27	0.028	0.46	0.283	0.44	0.234
-2	0.17	0.0013	0.43	0.237	0.40	0.201
1	0.08	0.0008	0.41	0.218	0.37	0.188

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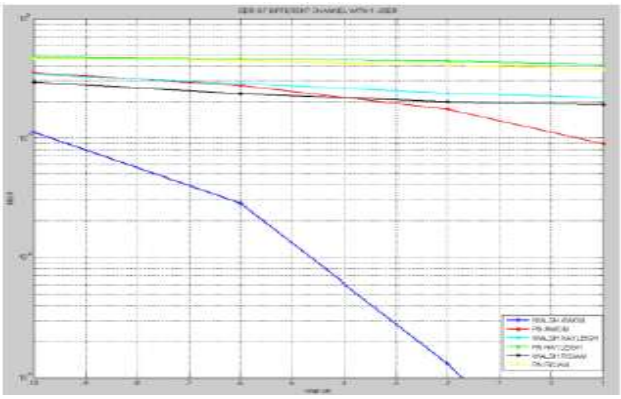
Graph 2: BER Vs SNR graph for different channels using PN code and Walsh code



3) BER performance analysis for multi-user. The increasing number of users makes BER performance degradation. For each user different PN sequences code are used for spreading. The analysis is done for all three channels using BPSK modulation scheme.

Table 3: BER for multiuser in AWGN channel

Sr. No.	User 1 present	User 1,2 present	User 1,2,3 present
-8	0.3069	0.3093	0.3175
-4	0.1980	0.2221	0.2268
0	0.1181	0.1197	0.1219
4	0.02925	0.03558	0.03729
8	0.0	0.00267	0.00454

Graph 3: Comparison for users BER Vs SNR graph

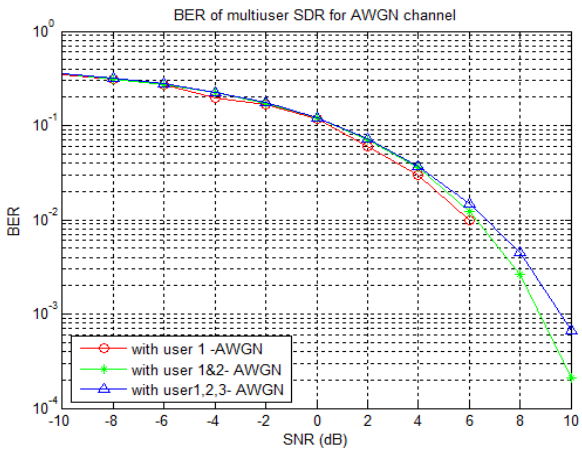


Table 4: BER for multiuser in Rayleigh channel

Sr. No.	User 1 present	User 1,2 present	User 1,2,3 present
-8	0.4697	0.4693	0.4691
-4	0.4615	0.4627	0.4515
0	0.4235	0.4255	0.4260
4	0.3845	0.3892	0.3935
8	0.3326	0.3473	0.3561

Graph 4: Comparison for users BER Vs SNR graph for Rayleigh channel

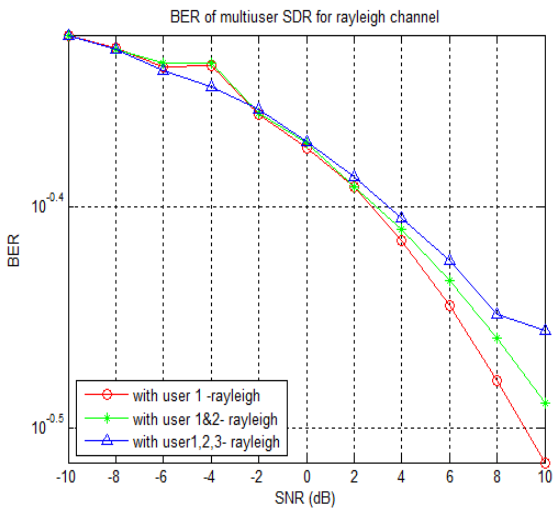
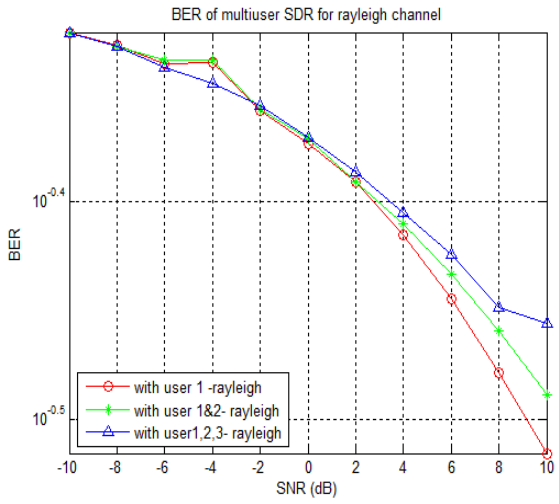


Table 5: BER for multiuser in Rician channel

Sr. No.	User 1 present	User 1,2 present	User 1,2,3 present
-8	0.4531	0.4537	0.4545
-4	0.4252	0.4267	0.4287
0	0.3857	0.3887	0.3920
4	0.3304	0.3382	0.3437
8	0.2690	0.2843	0.2981

Graph 5: Comparison for users BER Vs SNR graph for Rician channel



V. Conclusion

The developed simulation model for baseband section of SDR with Rake receiver on different channel has been analyzed and the performance of each channel has been evaluated in terms of BER. Rake receiver is used to minimize the bit error rate and obtain maximum SNR. The rake receiver is used in system to decrease BER due to multipath interference.

From the simulation results, 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 various multipath fading channels, the criterion is comparison of the variation of BER for different SNR. It is observed that the performance of AWGN channel found better as compared to Rayleigh and Rician fading channel over Binary Phase Shift Keying modulation scheme. As per fading channel performance Rician is good than Rayleigh.

If the more number of users are trying to communicate at a same time within same bandwidth, then BER increases, degrading the performance.

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