ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology
Volume 1, Issue 3, May 2012

Performance and Analysis of DS-CDMA Rake Receiver

Y Mohan Reddy, M Nanda Kumar, K Manjunath

Abstract— **In this paper analysis the performance of a CDMA system by varying the system parameters. CDMA is a popular technology in cellular system due to its superior capacity and performance. In conventional CDMA, obtained better signal to noise ratio by using matched filter because of this rake receiver is used in CDMA to obtain desired signal to noise ratio. Rake receiver is one of the receiver technique, consists of multiple correlators, in which the receive signal is multiplied by time-shifted versions of a locally generated code sequence. To maximize the Signal to Noise Ratio and minimize the Bit Error Rate the CDMA Rake receiver is used. The aim of the paper is to compare the receiver data in CDMA based with and without Rake receiver for different attenuation factor**. **Results show that, BER performance for WITH Rake** and **WITHOUT Rake receiver by using GUI and MATLAB.**

Key Words:**-CDMA (code Division Multiplexing), DS-SS (Direct Sequence (DS) Spread Spectrum), FDMA (Frequency Division Multiplexing), PN (Pseudo Noise), SNR (signal to Noise Ratio), BER (Bit Error Rate), GUI(Graphical User Interface)**.

I. INTRODUCTION

Wireless cellular telephony has been growing at a faster rate than wired-line telephone networks. The main factor driving this tremendous growth in wireless coverage is that it does not need the setting up of expensive infrastructure like copper or fiber lines and switching equipment. This growth has also been fueled by the recent improvements in the capacity of wireless links due to the use of multiple access techniques (which allow many users to share the same channel for transmission) in association with advanced signal processing algorithms. Code Division Multiple Access (CDMA) is becoming a popular technology for cellular communications [1].

Unlike other multiple access techniques such as Frequency Division Multiple Access (FDMA) and Time-Division Multiple Access (TDMA) [7], which are limited in frequency band and time duration respectively, CDMA uses all of the available time-frequency space. One form of CDMA called Direct Sequence CDMA (DS-CDMA) uses a set of unique signature sequence or spreading codes to modulate the data bits of deferent users. With the knowledge of these spreading codes, the receiver can isolate the data corresponding to each user by the process of Channel estimation and detection. This process spreads the bandwidth of the underlying data signal; hence CDMA is called a spread spectrum technique. Standards such as IS-95 and the proposed W-CDMA are based on CDMA technology [4]**.**

II. RAKE RECEIVER

In a mobile radio channel reflected waves arrive with small relative time delays, self interference occur. Direct Sequence (DS) Spread Spectrum is often claimed to have particular properties that makes it less vulnerable to multipath reception. In particular, the rake receiver architecture allows an optimal combining of energy received over paths with different [6]. It avoids wave cancellation (fades).If delayed paths arrive with phase differences and appropriately weighs signals coming in with different signal-to-noise ratios [2].

The rake receiver [3, 6] consists of multiple correlators, in which the receive signal is multiplied by time-shifted versions of a locally generated code sequence. The intention is to separate signals such that each finger only sees signals coming in over a single (resolvable) path. The spreading code is chosen to have a very small autocorrelation value for any nonzero time offset. This avoids crosstalk between fingers. In practice, the situation is less ideal. It is not the full periodic autocorrelation that determines the crosstalk between signals in different fingers, but rather two partial correlations with contributions from two consecutive bits or symbols. It has been attempted to find sequences that have satisfactory partial correlation values, but the crosstalk due to partial (non-periodic) correlations remains substantially more difficult to reduce than the effects of periodic correlations the rake receiver is designed to optimally detect a DS-CDMA signal transmitted over a dispersive multipath channel. It is an extension of the concept of the matched filter [2, 9].

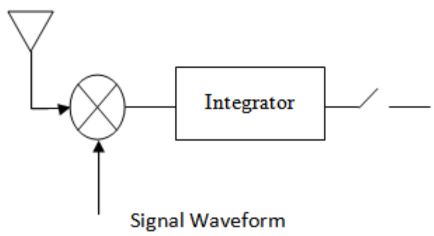

Fig 1: Matched Filter Receiver for AWGN Channel

In the matched filter receiver, the signal is correlated with a locally generated copy of the signal waveform. If, however, the signal is distorted by the channel, the receiver should correlate the incoming signal by a copy of the expected received signal, rather than by a copy of transmitted waveform. Thus the receiver should estimate the delay profile of channel, and adapt its locally generated copy according to this estimate [2, 7].

Manuscript received May, 2012.

Y Mohan Reddy*, student,, dept of ECE, SITAMS, Chittoor, Andhra Pradesh, India,+91-9014157437.*
M Nanda Kumar, *student, dept of ECE, SITAMS, Chittoor, Andhra Pradesh, India, +91-9652582231*
K ***Manjunath****, Assistant Professor department of ECE, SITAMS Chittoor, Andhra Pradesh, India, +91-9052232027.*

In a multipath channel, delayed reflections interfere with the direct signal. However, a DS-CDMA signal suffering from multipath dispersion can be detected by a rake receiver. This receiver optimally combines signals received over multiple Paths.

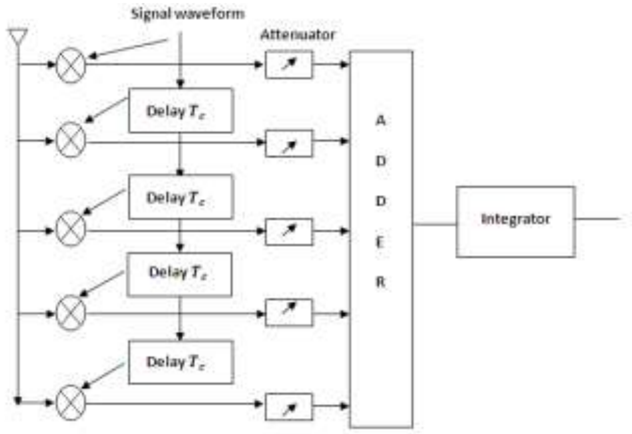

Fig 2: Rake Receiver with 5 Fingers

Like a garden rake, the rake receiver gathers the energy received over the various delayed propagation paths. According to the maximum ratio combining principle, the SNR at the output is the sum of the SNRs in the individual branches, provided that,

1. We assume that only AWGN is present (no interference).
2. Codes with a time offset are truly orthogonal.

Signals arriving with the same excess propagation delay as the time offset in the receiver are retrieved accurately, because

$$\sum_{n=1}^{N} c_1{}^2\,(nT_c + t_d) = \sum_{n=1}^{N} c_1{}^2\,(nT_c) = N \qquad (1)$$

This reception concept is repeated for every delayed path that is received with relevant power. Considering a single correlator branch, multipath self-interference from other paths is attenuated here, because one can choose codes such that [4].

$$\sum_{n=1}^{N} c_1\,(nT_c) c_1(nT_c + t_d) \cong 0 \qquad (2)$$

III. MULTIPATH AND RAKE RECEIVER

One of the main advantages of CDMA systems is the capability of using signals that arrive in the receivers with different time delays. This phenomenon is called multipath. FDMA and TDMA, which are narrow band systems, cannot discriminate between the multipath arrivals, and resort to equalization to mitigate the negative effects of multipath [5, 10]. Due to its wide bandwidth and rake receivers, CDMA uses the multipath signals and combines them to make an even stronger signal at the receivers. CDMA subscriber units use rake receivers. This is essentially a set of several receivers. One of the receivers (fingers) constantly searches for different multipath and feeds the information to the other three fingers. Each finger then demodulates the signal corresponding to a strong multipath. The results are then combined together to make the signal stronger [2].

Multipath Reception

Experiments with mobile communication were done at VHF frequencies, near 50 MHz, already in the 1920s. Results of these tests revealed a very hostile propagation environment, particularly in urban centers. The signal quality varied from "excellent" to "no signal". Moving the vehicle over a few meters resulted in dramatic changes of the received field strength [11].

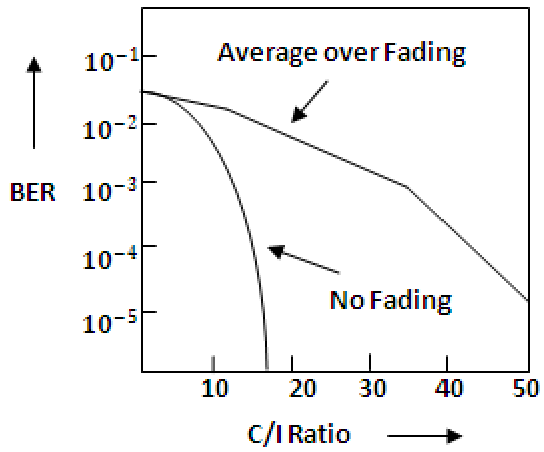

Fig 3: Bit Error in Multipath Fading

IV. ALGORITHM AND IMPLEMENTATION

In this section, discussing about GUI and MATLAB algorithm and implementation techniques

1. GUI(Graphical User Interface):

We use six section to make this project data bit generation, PN sequence generation, code generation, multipath generation and receiver section. For every section we use a different .m files.

A. Data bit generation

In this section we generate a fifteen bit user data, for this we use databit_gen.m, when we push the push button simulate with RAKE or simulate without RAKE on the GUI ,this file activate and generate random 15 bit user data.

B. PN sequence generation

In this section we generate a PN sequence data for every user, for this we use PN_gen.m, when we push the push button simulate with RAKE or simulate without RAKE on the GUI ,this file activate and generate random PN sequence data.

C. Code generation

In this section we generate code data, code is the multiplication data bit and PN sequence this code is generated with the help of code _gen.m, this code data we will send in the multipath section.

D. Multipath generator

In this section we add the AWGN noise with the code and we create multiple path with different attenuation, every multipath add random noise to code so at the end of path we will get multiple code with different noise, multipath_gen.m file is use for this purpose

.E. Receiver section

Receiver section has two part first is receiver with RAKE and second is receiver without RAKE

a) Receiver with RAKE

In this section we receive the data with the help of RAKE receiver, the working of RAKE receiver explain above here we delay the PN sequence and multiply with received data of multipath section and combine all the received data and chose the maximum output data, Race_with_rake.m file is use for this purpose.

b) Receiver without RAKE

In this section we receive the data from multipath and we delay the PN sequence and multiply with received data of multipath section

2. MATLAB

i. Generate a fifteen bit user data for each user to simulate with Rake or without Rake on MATLAB.
ii. Generate a PN sequence data for every user.
iii. Generate code data by multiplication of user data and PN sequence.
iv. Add AWGN noise with the code and we create multiple path with different attenuation, every multipath add random noise to code so at the end of path we will get multiple code with different noise.
v. Comparing performance of WITH and WITHOUT Rake receiver for different attenuation factors.

V.SIMULATION RESULTS

In this project we are showing GUI based results and MATLAB results.

1. GUI RESULTS.

In the result of this project we will show the transmit data and received data on different attenuation factor and number of bit error also show in the GUI, this project show that the number of bit error in received data with the RAKE receiver is less than the number of bit error in received data without the RAKE, and when we increase the attenuation factor the number of bit error is decrease at the attenuation factor is one the bit error is zero.

A. GUI for simulation of CDMA

When we run the rake_cdma_gui.m then this will open this gui the simulation will perform on this GUI. Figure 4, show the information about the no of bit error in simulation with and without rake, show the user data and received data, user have to put information about the no of user, user to simulate and attenuation factor and after simulation we will get figureure of transmitted data and received data, number of bit error in received data for both RAKE and without RAKE receiver, this result show the comparison between simulation with and without RAKE receiver in CDMA

B. GUI for CDMA simulation without RAKE when attenuation factor is 1

When we push the push button simulation without RAKE button with attenuation factor 1 then the transmitting data and receiving data, no of bit error, no of trial all the show on the Figure 5, the attenuation factor is one in this condition bit error is zero this show that the power level of transmitting data is high then the bit error in receiving data is less.

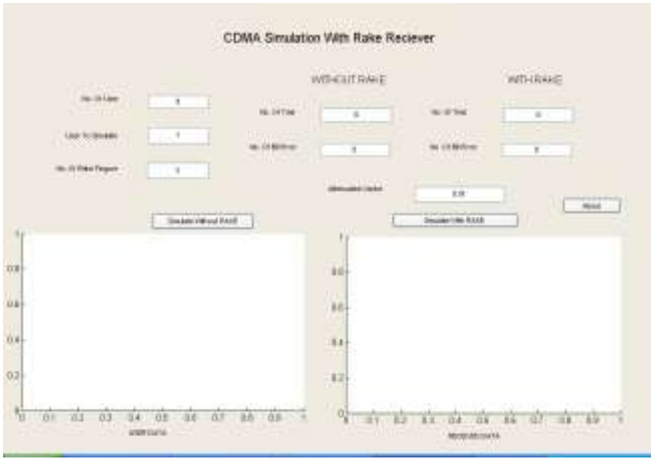

Fig 4: GUI for simulation of CDMA

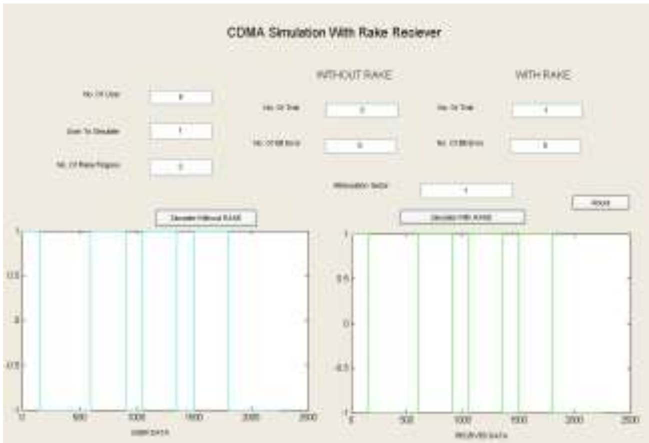

Fig 5: GUI for CDMA simulation wit out RAKE when attenuation factor is 1

C. GUI for CDMA simulation with RAKE when attenuation factor is 1

When we push the push button simulation with RAKE button with attenuation factor is 1 then the transmitting data and receiving data, no of error no of trial all the show in the Figure 6. The attenuation factor is one in this condition bit error is zero this show that the power level of transmitting data is high then the bit error in receiving data is less

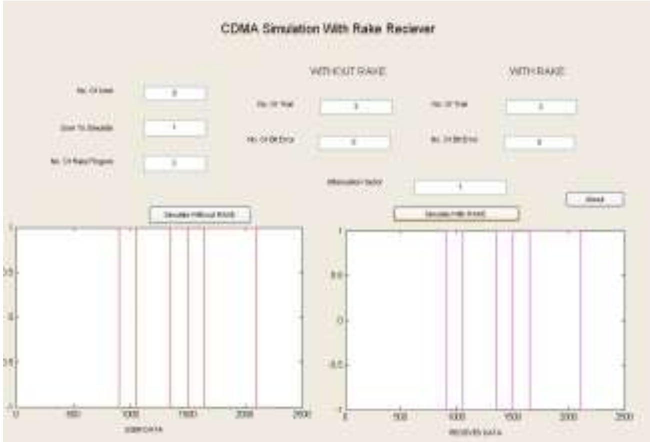

Fig6:GUI for CDMA simulation with RAKE when attenuation factor is 1

2. MATLAB RESULTS

Here we are observing the performance of CDMA system with and without rake receiver. Figure 7 shows that the performance of CDMA system with and without rake receiver for different attenuation factors to minimize the Bit Error Rate.

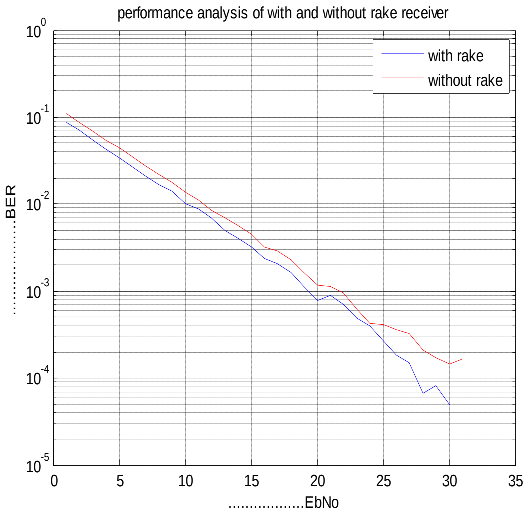

Fig 7: Performance of CDMA system with and without rake receiver.

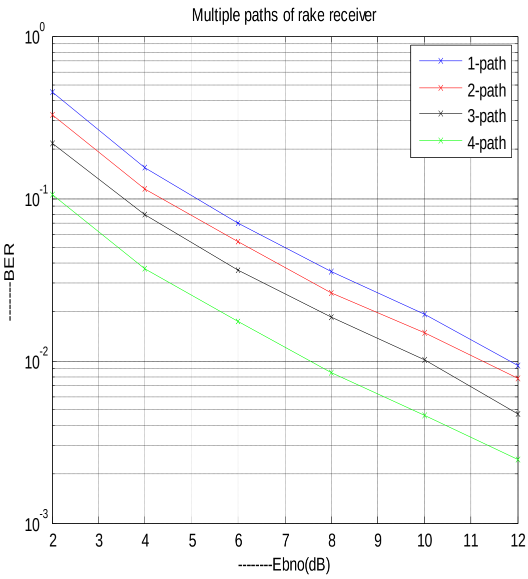

Fig 8: performance of multipath using rake receiver in CDMA system.

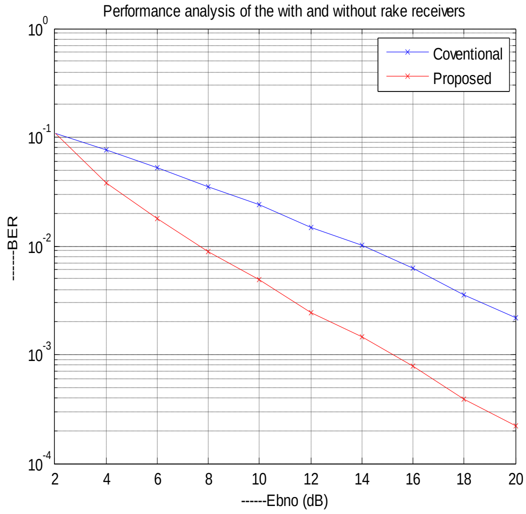

Fig 9: BER graph for conventional and proposed systems

Figure 8 shows that performance of multipath using rake receiver in CDMA system and figure 9 shows that BER performance for conventional CDMA and proposed RAKE Receiver.

CONCLUSION

In this paper, Rake receiver is used for CDMA technique rather than using conventional CDMA with matched filter. Rake receiver is used to minimize the bit error rate and obtain desire signal to noise ratio. Further work, Analyzing BER performance in presence of nonlinear distortion in DS-CDMA system.

REFERENCES

[1] Peter Flanagan, "Personal Communications Services: The Long Road Ahead," Telecommunications, February 1996.

[2].http://wireless.per.nl/reference/chaptr05/cdma/rake.htm.

[3] W. C. Y. Lee, "Overview of Cellular CDMA,"IEEE Trans. On Vehicular Technology, Vol. 40, no. 2, pp. 291-302, May 1991.

[4] R. A. Cameron and B. D. Woerner, "An Analysis of CDMA with Imperfect Power Control," Proceedings of 42nd IEEE Vehicular Technology Conference, Denver, CO, pp. 977-980, 1992.

[5] R. Lupas and S. Verdu, "Linear Multiuser Detectors for Synchronous Code Division-Multiple-Access Channels," IEEE Trans. Info. Theory, vol. 35, no.1, pp. 123-136, Jan. 1989.

[6]. K.Murali.Krishna, Abhijit Mitra and Cemal Ardil" A Simplified Single Correlator Rake, Receiver for DMA Communications" International Journal of Information Technology Volume 2 Number 4 2005.

[7] P. Jung, P. W. Baier, and A. Steil, "Advantages of CDMA and Spread Spectrum Over FDMA and TDMA in Cellular Mobile Radio Applications," IEEE Transactions Vehicular Technology, Vol. 42, no. 3, pp. 357- 364, August 1993

[8] Electronic Industries Association, "Cellular System Dual-Mode Mobile Station Base Station Compatibility Standard," IS-54, May 1990.

[9] K. S. Gilhousen, "On the Capacity of a Cellular CDMA System,"IEEE Transactions on Vehicular Technology, Vol. 40, no. 2, pp. 303-311,May 1991.

[10] Electronic Industries Association, "Widband Spread Spectrum Digital Cellular System Dual Mode Mobile Station - Base Station Compatibility Standard," IS-95, April, 1992.

[11] J. C. Liberti and T. S. Rappaport, "Analytical Results for Capacity Improvements in CDMA," IEEE Transactions on Vehicular Technology, Vol.43, No. 3, pp. 680-690, August 1994.

ABOUT THE AUTHORS

Mr. Y MOHAN REDDY *received B.Tech degree from JNT University, Anantapur and is pursuing his M.Tech degree from JNT University, Anantapur. He presented 2 technical papers in various national level conferences. His areas of interest is wireless communication.*

Mr. M NANDA KUMAR *received B.Tech degree from JNT University, Anantapur and is pursuing his M.Tech degree from JNT University, Anantapur. He presented 3 technical papers in various national level conferences . His areas of interest is digital signal processing and wireless communication networks.*

Mr.K.MANJUNATH *working as Assistant Professor in the department of ECE in SITAMS, chittoor. He received B.Tech degree from Anna University, Chennai and M.Tech degree from VIT University, Vellore. He presented 2 technical papers in various national level conferences. His areas of interest is digital image processing and wireless networks.*