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Bit Error Rate Performance Analysis of CDMA Rake Receiver

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ABSTRACT : *This paper would satisfy the upcoming generation requirement for the multiple input environments. Here a simulator have been implemented which simulates the multiple input waveform signals through wireless towards the Rake Receiver which will follow through the CDMA technique due to its performance. The simulator is a tool to evaluate these design options and trades in the different scenarios. As popularly known the CDMA has been a tremendous technique to analyze the cellular systems signals. The simulator will give an idea for the different values of the different design options. Here, the backbone of the technique is a wireless CDMA single user link in built with the Matlab. The effective method of system modeling is used to speed up the simulations. With the help of simulator the variations in the bit error rate due to its different inputs have been analyzed. The transmitted data and the received data can be analyzed in the form of signal waveforms. Here the signal analyzes the format of the input data and its performance with the help of simulator. In this simulator by changing the attenuation factor and simulating CDMA with Rake and without Rake receiver, the bit error rate will vary and the transmitted data and the received data is displayed in the form of graphical user interface, also compared the received data with and without Rake receiver for different attenuation factors.*

KEYWORDS: *AWGN- Additive White Guauisin Noise, CDMA:- Code Division Multiple Access, DS-CDMA:- Direct Sequence CDMA, MATLAB, Rake Receiver.*

I. INTRODUCTION

The growth in wireless technology has been fueled by the latest improvements in the capacity of wireless line links due to the use of multiple access techniques in association with advanced signal processing algorithms. Code Division Multiple Access (CDMA) is becoming a popular technology for cellular communications .Unlike other multiple access techniques such as Frequency Division Multiple Access (FDMA) and Time-Division Multiple Access (TDMA), which are limited in frequency band and time duration sequence, whereas the CDMA avails time-frequency space. One type of CDMA is also called as Direct Sequence CDMA (DS-CDMA) which uses a set of unique signature sequence or spreading codes to modulate the data bits of different users. This sequence also may called as chipping sequence. With the advantage of the different spreading codes, the receiver can manipulate the data according to each user by the process of Channel estimation and detection. This process also spreads the bandwidth of the underlying data signal; hence CDMA is called a direct sequence spread spectrum phenomena [2, 5].

1.1 Background:

The Code Division Multiple Access (CDMA) is a spread spectrum technique that uses neither frequency channels nor time slots. In CDMA, the narrower band message is multiplied by a larger bandwidth signal, which is called as a pseudo random noise code (PN code). All the users in a CDMA system uses the same frequency band and transmit it simultaneously. Then the transmitted signal is recovered by equating the received signal with the PN code used by the transmitter [7].

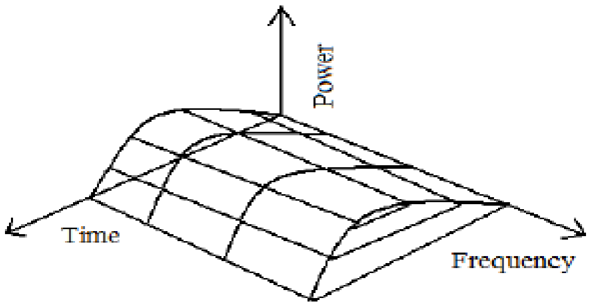


Fig. 1: Code Division Multiple Access (CDMA) [1].

Some of the useful properties of the CDMA are: Signal hiding and non-interference with existing systems, Anti-jam and interference rejection, Information security, Accurate Ranging, Multiple User Access, Multipath tolerance [9].

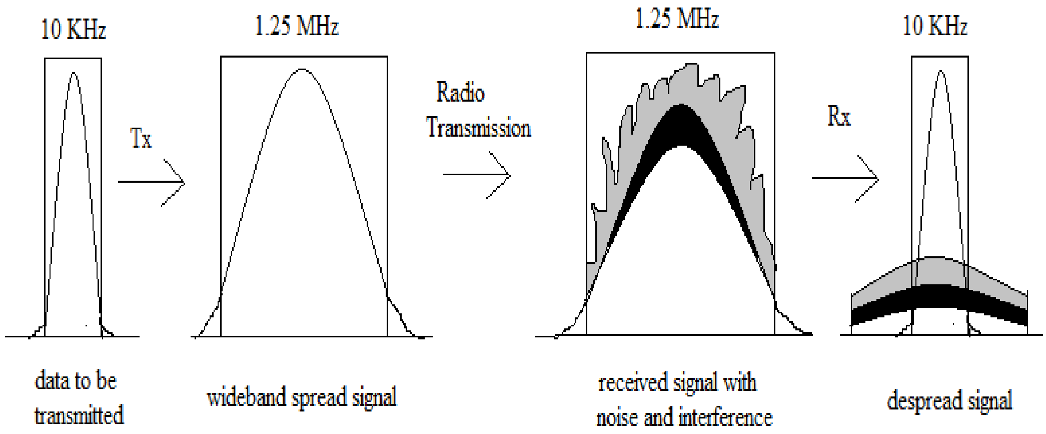


Fig. 2: Basic CDMA Generation [2].

From the above figure the data to be transmitted (a) is initially created before transmission by modulating the data using a PN code. This can convert into the wideband spread signal as shown in (b). In this example the frequency considered is 10 KHz, as the spread spectrum bandwidth is 125 times greater the data bandwidth. After the radio transmission part (c) shows the received signal. This may consist of the noisy required signal and interference from any other CDMA.The received signal is then recovered by multiplying the signal by the original spreading code or any modulating technique. This process may cause the wanted received signal to be carried out to the original transmitted data. However, all other signals, which are not correlated with the PN sequence spreading codes, become more spreader. The wanted signal in (d) is then filtered by removing the wide spread interference and noise signals which is called as despread signal.

1.2 Motivation and Objectives:

The ideal approach is to match the number of multipath signals with the number of correlators, but this would be a waste of resources and add unnecessary expense to the manufacture of the phone. This thesis aims to incorporate a new signal detection technique within the Rake receiver, where the detection technique is used to determine the number of correlators required for demodulating the 'important' multipath signals. This technique is unlike the method use in the CDMA system, which has a limited number of correlators with respect to its number of multipath signals in the present channel. The objective of this thesis is to develop a Rake receiver through MATLAB simulation that is able to increase the signal-to-noise ratio (SNR) performance with a minimum number of correlators. This paper revolves around the least mean square (LMS) algorithm, which is used to obtain a close representation of the signal or channel impulse response. A detection technique, better known as the activity detection algorithm is used to select the necessary multipath signals for demodulation. It requires an activity measure and an activity threshold to discriminate the 'important' multipath signals from the weak and negligible ones [8, 9].

II. RAKE RECEIVER

The Rake receiver consists of multiple correlators, where the received signal is then multiplied by time-shifted versions of a locally generated code sequence called as chipping sequence. The aim is to separate the signals from each fingers can sees signals coming in over a single resolvable path. The identification of the spreading code is such a way that to have a very small autocorrelation factor for any non-zero time offset. This can possibly avoids crosstalk between the all fingers. In practice, the situation is become ideal. It is not the full periodic autocorrelation factor that can determines the crosstalk between signals in different fingers of the rake receiver, is then integrated with power associated in between [4].

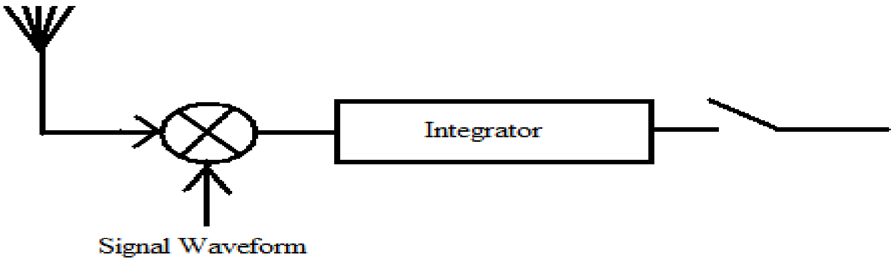


Fig. 3: Rake Receiver for AWGN Channel [2]

In the Rake receiver, the signal is correlated with the signal waveform. However, the signal is always distorted by the noisy channels; the receiver should then correlate the incoming signal either with the help of a copy of the expected received signal or other than by a copy of transmitted waveform.

Thus, the receiver can estimate the delay signal of the channel, and adapt its locally generated copy with reference to this estimate.The Rake receiver is also designed to detect a DS-CDMA transmitted signal over a dispersive multipath channel.

1.3 Analysis of Rake Receiver:

As the Rake receiver detects the DS-CDMA signals with different reflected waves arrive with different delayed signal. A Rake receiver detects these different signals in the separate manner. These signals are then mixed using the diversity technique called maximum ratio combining. Considering BPSK of DS-CDMA, we denote the transmit waveform as m_0 for a digital "0" and $-m_0$ for a digital "1". The received signal is given by…

$$r_i(t) = h_k m_i(t - kT_c) + n(t)$$

Where,

- the sum is for all propagation path, i.e. k=0, 1, 2, ...,
- h_k is the complex amplitude of the k-th propagation path,
- T_c is the chip duration,
- index i represents the binary message ("0" or "1"), and
- n(t) denotes the additive white Gaussian noise.

The power for the k^{th} resolvable path is, $h_k \times h_k^*$.
The local-mean power is, $P = E \times [h_k \times h_k^*]$
Where E is the expectation amplitude operator, which can be applied to find the local-mean value and * denotes a complex conjugate.

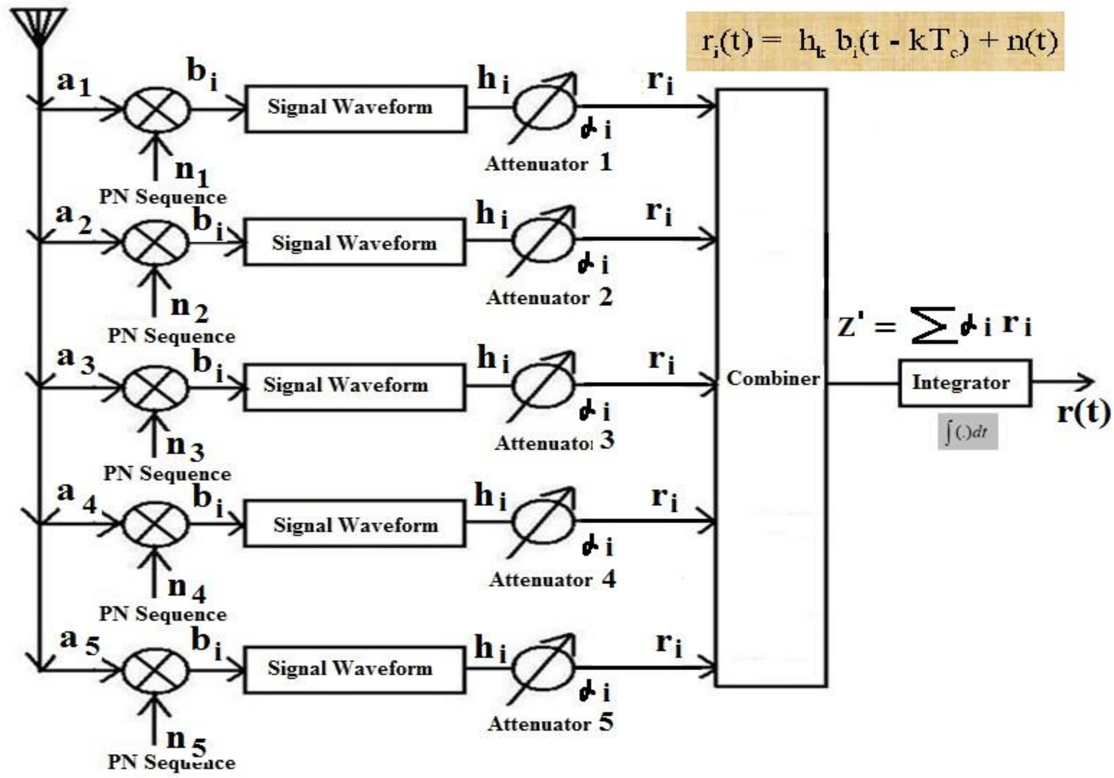


Fig. 4: Rake Receiver with 5 Fingers

In the above figure it is considered that there are 5 finger Rake receiver presented. Like a garden Rake, the Rake receiver gathers the energy received over the multiple delayed propagation paths. As per the maximum ratio combining theory, the SNR produced at the output is nothing but the sum of the SNRs in the individual branches or fingers, provided that,

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

2.3 Multipath and Rake Receiver*:*

One of the main advantages of CDMA systems is that the capability of using the signals which arrives in the receivers with the different time delayed signals. This phenomenon is called as multipath. FDMA and TDMA, which are narrowing band systems, which cannot be determined between the multipath arrivals, and resort to equalization to adjust the negative effect of multipath. Due to the wide bandwidth and Rake receivers, the CDMA uses all the multipath signals and combines them to create a stronger signal at the receivers. CDMA subscriber units uses Rake receivers. This is essentially a set of several multiple receivers. One of the receivers or fingers continuously finds for different multipath and feeds the information to the other three fingers. Where each finger is then demodulates the corresponding signal to a strong multipath signal. The results are then mixed together to make the stronger signal.

II. PROBLEM IDENTIFICATION

2.1 Work done so far:

By considering the earlier work we got to know that, there are certain problematic/ limited areas where we can extend the work as…

[1] Rake Receiver can receive only one signal for 4 users i.e. (1:4)
[2] From channel to receiver there was a maximum noise and maximum distortion.
[3] Deal with only one parameter i.e. attenuation factor (limited up to 1) with and without Rake.

1.2 Work to be done:

We come out with the tremendous features, where we can implement the Rake Receiver in such a way that…

[1] Rake Receiver can receive now 4 signals at a time for 16 user i.e. (4:16)
[2] From channel to receiver the noise and distortion got reduced due to CDMA techniques.

[3] Here we can deal with unlimited attenuation factors probably for 10, and also can observe the two types of signal/channel parameter i.e. AWGN channel and Relayed Fading Channel.

III. RESULT AND DISCUSSION

4.1 Simulation without Rake when Attenuation Factor is 1:

When we run the Rake1.m then this will open this GUI, This simulation will perform on GUI shows the information about the no of user, user to simulate, no. of bit error rate and attenuation factor. After the simulations we will get figure of transmit data bits and received data bits, number of bit error in received data for without Rake receiver**,** this result show the comparison between simulation with and without Rake receiver in CDMA.When we push the push button simulation without Rake Receiver button with attenuation factor 1 then the transmitting data and receiving data, no of bit error, the attenuation factor is one in this condition bit error is zero this shows that the power level of transmitting data is high then the bit error in receiving data is less.As we increase the attenuation factor the bit error rate will decreases, it shows that as we attenuate the signal frequently, we would get the efficient output at the receiver.When we push the push button simulation without Rake Receiver when attenuation factor is 1 then the multipath receiving signal will be multipath data as shown in third session.

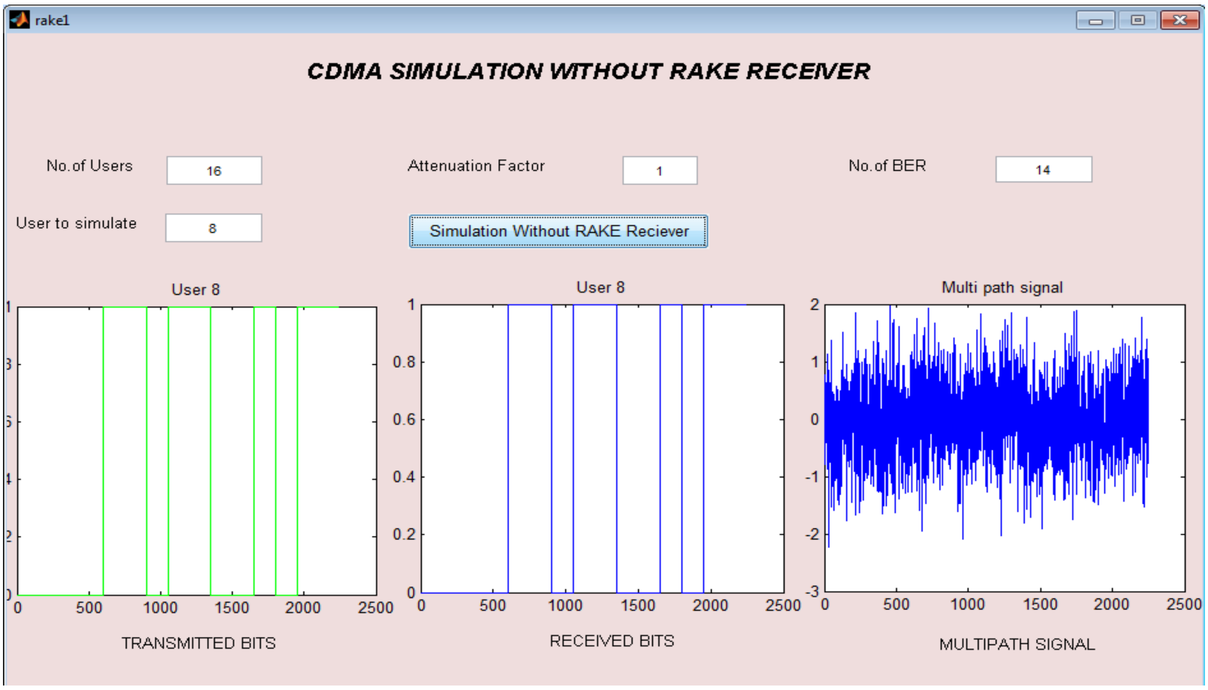


Fig. 5: Simulation without Rake when attenuation factor is 1

4.2 Simulation with Rake when Attenuation Factor is 1:

When we run the Rake2.m then this will open this GUI, This simulation will perform on GUI shows the information about the no. of user, user to simulate, no. of Rake fingers, no. of bit error rate and attenuation factor. After the simulations we will get figure of transmitted data bits and received data bits, number of bit error in received data for with Rake receiver**,** this result show the comparison between simulation with and without Rake receiver in CDMA.When we push the push button simulation with Rake Receiver button with attenuation factor 1 then the transmitting data and receiving data, no of bit error, the attenuation factor is one in this condition bit error is zero this shows that the power level of transmitting data is high then the bit error in receiving data is less.As we increase the attenuation factor the bit error rate will decreases, it shows that as we attenuate the signal frequently, we would get the efficient output at the receiver. When we push the push button simulation with Rake Receiver when attenuation factor is 1 then the multipath receiving signal will be multipath data as shown in third session.

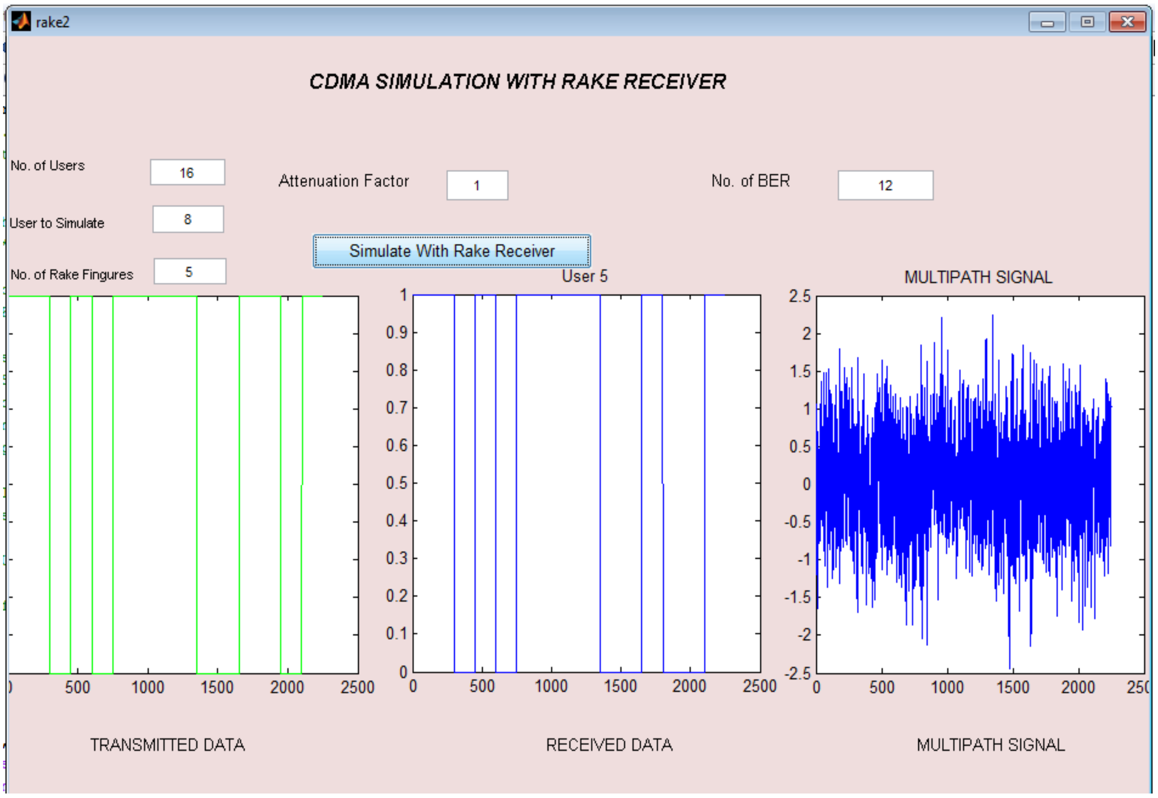
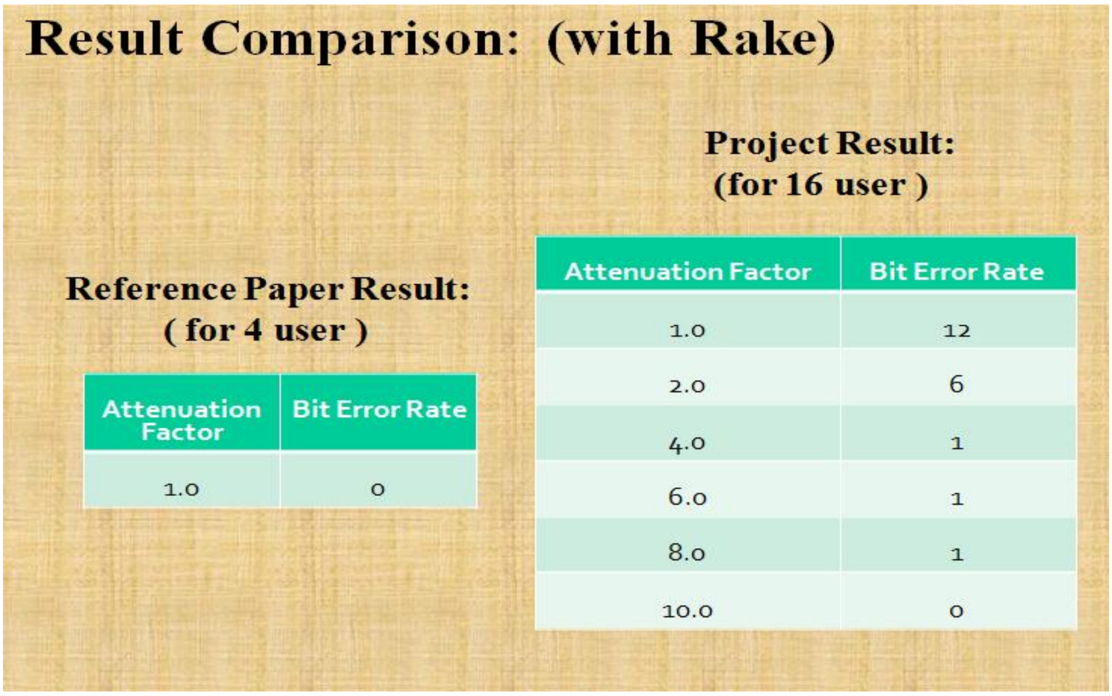


Fig. 6: Simulation with Rake when attenuation factor is 1

4.3 Result Comparison:



Result Comparison: (with Rake)

Reference Paper Result: (for 4 user)

Attenuation Factor	Bit Error Rate
1.0	0

Project Result: (for 16 user)

Attenuation Factor	Bit Error Rate
1.0	12
2.0	6
4.0	1
6.0	1
8.0	1
10.0	0

Table 1: Actual Result Comparison with Rake Receiver

Result Comparison: (without Rake)

Reference Paper Result: (for 4 user)

Attenuation Factor	Bit Error Rate
1.0	0

Project Result: (for 16 user)

Attenuation Factor	Bit Error Rate
1.0	14
2.0	7
4.0	5
6.0	2
8.0	1
10.0	1

Table 2: Actual Result Comparison without Rake Receiver

IV. CONCLUSION AND FUTURE SCOPE

We have developed a simulator made in our project work, we have shown here that how Rake receiver is used for CDMA to decrease a bit error rate due to its multipath interferences.It can simulate a CDMA encoding and decoding process, the data is assumed to be traveled through different path, the effect of different path and CDMA is considered to generate the multipath effect the data is passing through the different path and assumed at receiver end just before the decoder.The developed simulator can be a very helpful tool to carry out the performance of a Rake Receiver with various attenuation factors. As for example the simulator can be used to find the antenna diversity schemes at the receiver. The simulator is very flexible and one can very easily make the necessary modification to incorporate complex statistical channel model based on measurement and investigate the Rake Receiver performance under practical mobile channel condition. We also declare that it is very simple method to employ the simulator to observe the performance of error correction coding. We have also implemented a convolutional coding scheme.

REFERENCES

[1] Vaibhav Khairnar, Jitendra Mathur and Hema Singh, "Design and Performance Analysis of DS-CDMA Rake Receiver for Wireless Communication", in International Conference on Electronics and Communication Systems, 978 IEEE Transactions, Vol.2, pp. 226-231, 13-14 February 2014.

[2] Vaibhav Khairnar, Jitendra Mathur and Hema Singh, "Design and Performance Analysis of DS-CDMA with Rake and without Rake Receiver Communication System", in International Journal of Emerging Technology and Advanced Engineering, ISSN:2250-2459, ISO 9001:2008 Certified Journal, Vol.3, Issue 12, pp. 142-149, December 2013.

[3] K. Ohno, M. Itami and T. Ikegami, "Iterative RAKE reception scheme using multi-carrier pulse for pulse based UWB system" in International Conference on Ultra Wideband-2013, ISSN: 2164-6588, pp. 249-254, IEEE Transactions, September 2013.

[4] Takahiro Kodama, Ryosuke Matsumoto, Naoya Wada, Gabriella Cincotti and Ken-ichi Kitayama, "A Novel Optical Code RAKE Receiver Using a Multiport Encoder/Decoder" in International Journal of Lightwave Technology, Vol. 31, No. 11, pp. 1675-1680, June 2013.

[5] N. Anand Ratnesh, K. Balaji, J. V. Suresh, L. Yogesh and B. Anil Babu, "Performance Analysis of DS-CDMA Rake Receiver over AWGN channel for Wireless Communications" in International Journal of Modern Engineering Research, Vol. 2, Issue 3, pp. 859-863, May-June 2012.

[6] Nikhil B. Patel and K. R. Parmar, "SNR Performance Analysis of Rake Receiver for WCDMA", in International Journal of Computational Engineering and Management, Vol. 15, Issue 2, pp. 62-66, March 2012.

[7] Mohammad Farukh Hashmi, Pradeep Dhakad and Baluram Nagaria, "Design and Analysis of DS-CDMA Rake Receiver Simulator for Wireless Communication", IEEE conferences 978, October 2011.

[8] Thierry Clessience, "A General expression of Rake Receiver performance in DS-CDMA downlink" IEEE Transactions, pp. 5807-5812, 2007.

[9] Tuncer Baykas, Mohamed Siala and Abbas Yongacoglu, "Generalized Decorrelating Discrete-Time RAKE Receiver" in IEEE Trans. On Wireless Communications, Vol. 6, No.12, pp. 4268-4274, December 2007.

[10] K. Murali Krishna, Abhijit Mitra and Cemal Ardil "A Simplified Single Correlator Rake Receiver for CDMA Communications", in International Journal of Information and Communication Engineering, Vol. 2, No. 8, 2006.

[11] John Proakis and Masoud Salehi, Digital Communications, Fifth Edition, McGraw-Hill International Edition 2008.