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Performance analysis of Matched and Blind Adaptive Multiuser Detection

HarpreetKaur
Student of Baba Banda Singh Bahadur Engineering College,Fatehgarh Sahib

Abstract—This paper deals with the development of adaptive algorithms for the multiuser detection of CDMA system. We examine the role of coding in CDMA systems that employ multiuser detection to calculate how much bit error rate (BER) has reduced during the analysis of signal by various techniques. In this paper the DS/CDMA systems with two kinds of receivers, the matched filter and the blind mud receiver are simulated using Mat lab coding. Pseudorandom noises (PN codes) are used as spreading code of user length N=31. The bit error rate plots are drawn in GUI and the BERs of multiuser receivers in AWGN channels are compared by applying various algorithms. The average of bit error rate of different users is also plotted.

Keywords—Bit error rate,Blind mud,Matched filter, Multiuser detection

I. INTRODUCTION

Spread spectrum has been widely used in military communications for decades. Recently, code division multiple-access (CDMA) based on spread spectrum techniques have been considered as having a significant role in cellular and personal communications. In particular, the DS CDMA was found to be very attractive due to its anti –multipath, anti-jamming and its potential capacity increase capabilities[1]. DSCDMA systems are very sensitive to the near/far effect. The propagation of maximum number of users through the wireless channel results in multi-access interference from non-orthogonal users. Different methods of multi user detection are proposed in the recent years to eliminate the adverse effects of multi user interference. When different CDMA user signals are simultaneously received on the same frequency, the transmitted information can be recovered by using a filter matched to each user signature sequence. The background of DS CDMA has been explained in literature[2]. Conventional detection scheme follows a single user strategy according to which each user is detected separately regardless of other users, but despite of its low complexity, two conditions must be satisfied so as to mitigate the multiple-access interference (MAI). Moreover, the conventional detector suffers from a substantial performance loss as the number of the interfering user increases or the signals are received with different power levels (near–far effect). This detector though optimal in additive white Gaussian noise (AWGN) is sub-optimal because the MAI does not necessarily resembles white Gaussian noise. The optimal multiuser detector for CDMA systems based on maximum likelihood (ML) detection technique using Viterbi's algorithm is proposed by Verdu in the mid of 1980's in [3].Alternative approach for conventional methods is suboptimal methods. Some of these methods are blind force detector, minimum mean square error detector and decorrelating detector given by [4]. For our research work we have adopted Matched filter detector and Blind Mud detector algorithmwhich have multiuser capability. The base band data is multiplied by a pseudorandom noise (PN) code, which is multiplication of each bit of base band data with the PN code, will result into a spread bandwidth but the spectral power density remains the same, because before spreading the energy was concentrated in a small bandwidth, now it spread over a large bandwidth. Now when this spread signal is transmitted it is received at the receiver, with signal from other user of the same spectrum, which became noise for this noise, plus interference from other sources. The receiver in these systems will have a correlate, which use the duplicate of the Pseudorandom code (PN) to the extracts the same information.

The organization of this paper is as follows. In Section II, the system model is described. Section III gives a brief description of the blind MUD algorithm. Section IV deals with matched filter approach. Section V shows the graphical results of matched filter and blind mud for their comparative analysis. Section VI provides the conclusion for comparison of multiuser detection techniques.

II. SYSTEM MODEL

The system consists of a synchronous CDMA channel with K users sharing the same bandwidth. The original signal is x(t) of the power P_s and the code sequence is given as g(t), the resultant modulated signal is

$$s(t)=\sqrt{2P_s}\ n(t)g(t)$$

The multiplication of the data sequence with the same spreading sequence is the first modulation. For second modulation the signal is multiplied by the carrier signal.

$$s(t)= \sqrt{2P_s}\ n(t)g(t)\sin(2\prod f_c t)$$

At the receiving end, we get

$$rcv(t)= \sqrt{2P_s}\, n(t)g(t)\sin^2(2\prod f_c t)$$

Probability of error is computed by creating the transmitting signal $s(t)$, the noise signal $g(t)$, and the matched detection process in MATLAB. To this end, the intrinsic MATLAB functions of randintis used for message signal, $s(t)$, and awgnfor noise signal, $n(t)$. For detection process, we have employed the correlation metrics.

III. BLIND MUD

Blind multiuser detection for CDMA system with multipath channels has received much attention and interest recently. It shows great potential for the future wideband CDMA system because of the existence of multipath phenomenon. Blind method for multiuser detection began with the work of [6].The channel model whichisspecialized to synchronous CDMA, however blind mud does not use knowledge of any signature waveforms or data, bit error rate performance would bepoor for weak users. The environment considered here is only blind receiver in multiple user transmitters. For Multiuser detection we adopted the blind adaptive multiuser detection technique.

The linear detector in canonical form for s_1+x_1 which are orthogonal, that minimizes the output energy

$$E\,[(y,\, s_1+x_1)^2]$$

The output energy function minimum output energy lends itself to a simple stochastic gradient descent adaptation rule.

Here we find projections of the gradient of the output energy x_1 onto the orthogonal s_1

Let k output of matched filter be random variable

$$Z_{MF}[i] = <y[i],s_{1>}$$

Then proposed linear transformations be

$$Z[i]=y[i],s_1+x_1[i-1]$$

Minimum Output Energy be

$$[x]=E[(y,s_1+x_1)^2]$$

Stochastic gradient adaptation

$$X_1[i]=x_1[i-1]-\mu Z[i]\ (y[i]-Z_{MF}[i]s$$

IV. MATCHED FILTER

Matched filter was designed for orthogonal signature waveforms, which correlates the received waveform with the suitable spreading code. It does not cancel the effect of interference (MAI) from other users. The figure.1 shows the matched filter receiver. The receiver consists of a bank of filters matched to the signature waveforms assigned to the users and a multi-user detector. The output of the each matched filter can be represent as $y_1[t],y_2[t],\ldots,y_k[t]$. Here yi[t] is the output of the matched filter and so on. It is optimum receiver of known signal in additive white Gaussian noise environment. But in CDMA systems, matched filter is not the optimum receiver because the power of system's MAI signal is very high at output of matched filter. Matched filter bank is usually the first stage in the base band signal detection. The matched filter bank correlates the received signal with the signature waveform of each individual user.[5]

The output of the matched filter for a user k for synchronous CDMA can therefore be expressed as Received signal at base band is given by

$$y(t)= \sum A_k b_k s_k\,(t)+\ \sigma n(t)$$

$s_k(t)$=deterministic signature waveform assigned to the kth user, normalized so as to have unit energy

A_k=received gain of the linear time invariant channel for user k

b_k= bit transmitted by the k^{th} user values must be either 1 or -1

n(t)= white Gaussian noise with unit power spectral density

The sampled output of the matched filter for k^{th}user is

$$y_k=Y_k s_k(t)dt$$

In Matrix representation, output of the Matched filter is given by

$$y = RAb+n$$

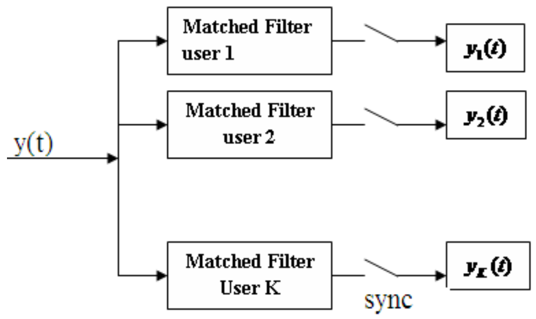


Figure:1

V. RESULTS AND DISCUSSIONS

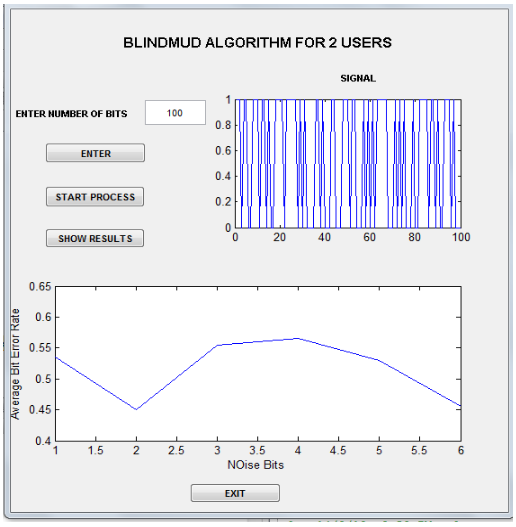
The bit error rate performance is presented in this section for CDMA system. The bit error rate is the measure of incorrectly detected bits relative to the total number of detected bits. The spreading code used for DSCDMA is m sequence code of user length N=31.The no. of user taken is 2.We have used mdl file utility of MATLAB to generate this spreading sequence. In our simulation, we run the code for K=2, number of transmitted bits are taken for n=100, n=500. For every transmitted no. of bits we apply the algorithm to receive the signal having lesser no. of bit error rate. The observations show that the Matched filter technique is far better than the Blind Mud technique.

Case 1: For n=100, Blind Mud algorithm is simulated using mat lab. Graph.1 shows the results of average bit error rate of two users and graph.2 represents the bit error rate of each user with the noise bits. Then considering more no. of bits, n=500, the processing is done again in mat lab. And graph.3 and graph.4 are obtained for average bit error rate of two users and for bit error rate for individual user, respectively.

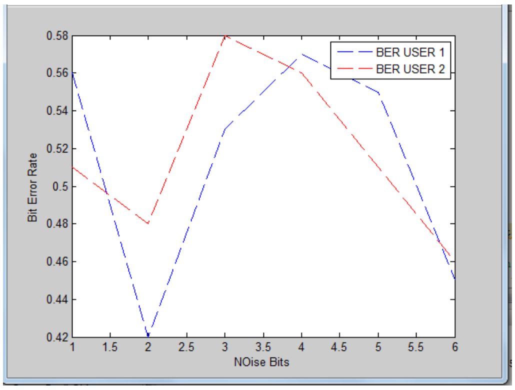
Case 2: For n=100 Matched filter multiuser detection algorithm is applied using the Mat labsimulated results of average bit error rate of two users and the BER for individual user can be observed from graph.5 and graph.6.The same experiment is done with the signal strength of n=500 and graphs 7 and graph 8 shows their results.

Blind Mud Results

For n=100

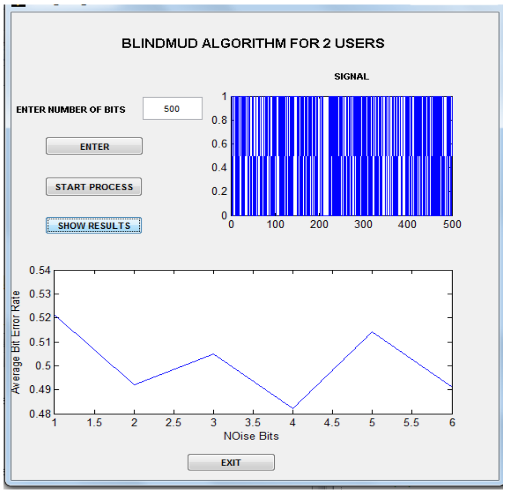


Graph.1

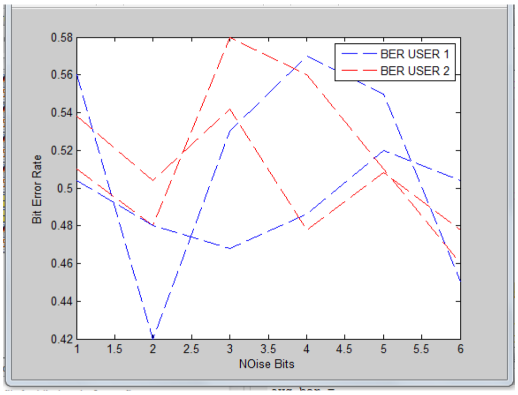


Graph.2

Bit Error rate oor n=500



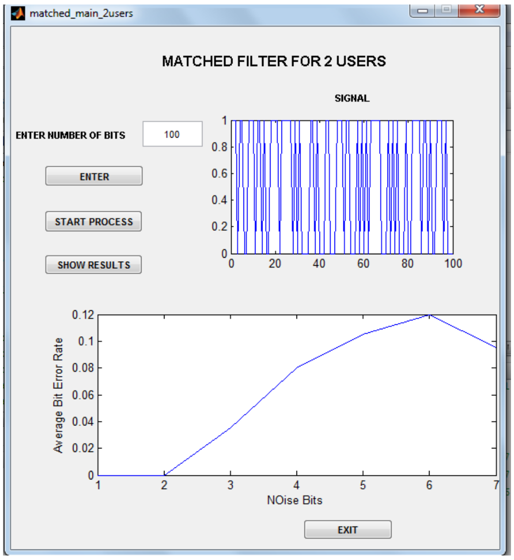
Graph.3



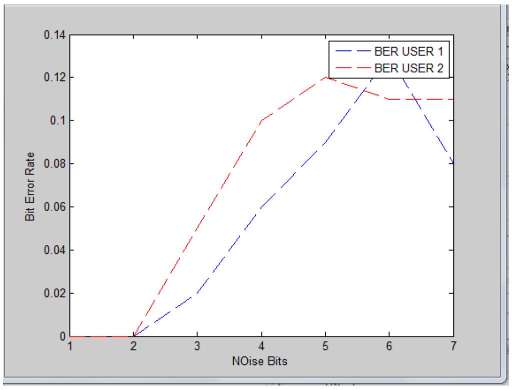
Graph.4

Matched Filter Results

For n=100

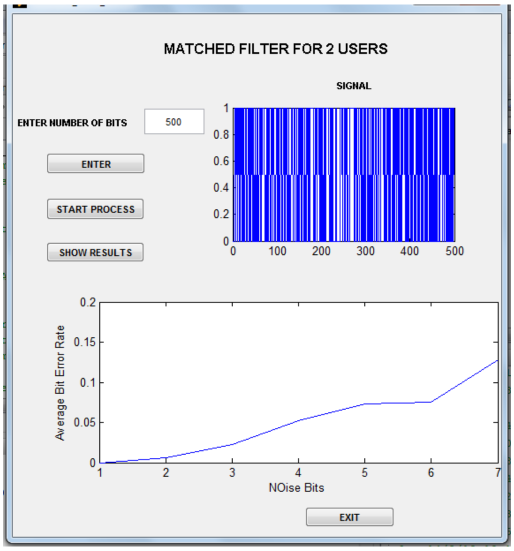


Graph.5

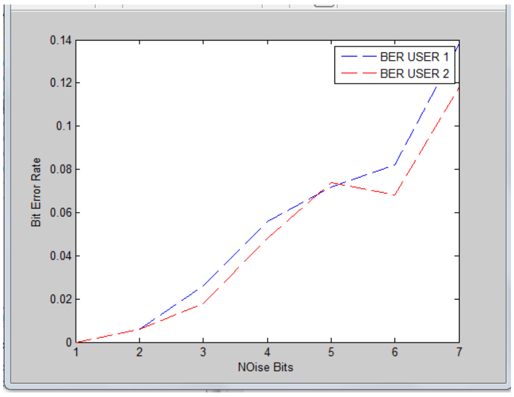


Graph.6

For n=500



Graph.7



Graph.8

VI. CONCLUSION

In this paper we proposed a novel signal processing algorithm, which shows betterresults as compare to blind MUD techniques. Multistage detector based on these search algorithms is simulatedwith different signal strengths and no. of users. These results exhibit superior performance of matched algorithm over blind MUD techniques.In blind mud there is a problem of mismatch of the transmitted signal with the spreading code for signal of greater strength. For further studies the adaptive minimum mean square error algorithm (MMSE) can also be applied to compare the results of former two multiuser algorithms.

REFERENCES

[1]. *IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS*, VOL. 3, NO. 1, JANUARY 2004 235

[2]. A.J.Viterbi, "The Orthogonal-Random wave form Dichotomy for digital Mobile Personal Communications." IEEE Personal commun.,First quarter1994,pp.18-24.

[3]. Verdu. S, "*Minimum probability of error for asynchronous Gaussian multiple-access channels"*. IEEE Transactions on Information Theory, vol.32, (Jan. 1986) pp. 85-96.

[4]. Turin. G.L., *Introduction to Spread-spectrum Antimultipath Techniques and their Applications to Urban Digital Radio.* IEEE Proceedings, vol.68 (March 1980) no.3, pp.328-353,.

[5]. M.Angeline "*Multiuser Detection For MIMO CDMA systems*" International Journal of computer Applications (0975-8887) volume 4-no.6, July 2010

[6]. M. Honig, U. Madhow, and S. Verdú, "*Blind multiuser detection*," *IEEE Trans. Inform. Theory*, vol. 41, pp. 944–960, July 1995.

[7]. J. G. Proakis and M. Salehi, "*Communication Systems Engineering"*, 2nd ed., Prentice Hall, 2002, ch. 7.