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Performance Enhacement of MIMO-CDMA system using Adaptive Non-Coherent Receiver

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Abstract: ***Wireless communication systems are a key means to meet the increasing demands for greater capacity and increased quality-of-service. MIMO systems have the potential to reduce the operational power consumption and enable the use of low complexity schemes for suppressing MU interference (MUI).***
One of the cellular communication technologies is CDMA. The combine of MIMO and CDMA is most able technique beyond 4G technologies.
The DS-CDMA system is widely known for removing the effects of Multiple Access Interference (MAI) which degrades the performance of the system.
The addition of interference cancellation which is a sub-optimal procedure of multiuser detector (MUD) in a DS-CDMA-MIMO system can greatly enhance its performance relative to that of conventional CDMA receiver and this can be verified with the help of MATLAB.
Keywords: CDMA; MIMO, Multiuser Detector; Multi User Interference, Equalizer

I. INTRODUCTION

MIMO is the key technology in advanced wireless systems. It offers significant benefits over classical systems [1-2]. By using several antennas at both sides, improves the receiving of better signal that solves the major wireless communication system problem. CDMA is the most enabling technology, most suitable for cellular systems [3]. CDMA is used in 2G, 3G and in 4G, 5G along with multiple carrier technologies [4-5]. It is the technique ideally suitable for mobile communications. The CDMA technology combined with MIMO is prominent method for wireless systems.

Multiple access interference is the major challenge in multi access systems. As the users are sharing the resources that causes interference among them.

In order to solve these issues there are several design methods were introduced. They are matched filters, linear optimum filters, sub optimum filters, interference cancellation receiving systems. Among those techniques, interference suppression techniques are most popular and efficient methods. As the techniques used optimization process in order to reduce the error. In the proposed system, non coherent adaptive interference cancellation receiver developed for MIMO-CDMA system. The adaptive system is worked with MMSE scheme.

In Section II, proposed system model discussed. In section III, receiver methods are discussed. Section IV is about simulation results finally the paper is concluded in section V.

II. SYSTEM MODEL

The Figure 1, shows various operations of proposed system. The data which is to be transmitted is mapped in to parallel according to the number of antennas present in the system and then spread with signature codes, then it is modulated with Binary PSK modulation.

Then it is transmitted through MIMO antennas. In the proposed system MIMO antennas configured with spatial multiplexing method. Where the data before sending grouped first and the passed through several blocks and transmitted.

At the receiver side the data received and passed through adaptive filter to solve the wireless issue and then demodulated then despread with the spreading codes and converted back to serial data.

The CDMA system performance depends on the attributes of spreading codes. There are several robust code tracking algorithms available in literature [6]. The combination of MIMO and CDMA is the key method for advanced wireless systems, also the basis for next generation wireless systems.

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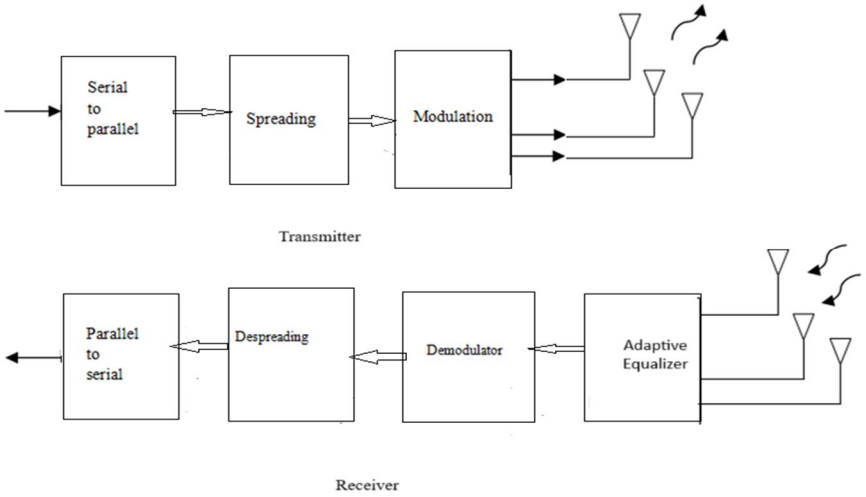

Fig.1 Block diagram of MIMO-CDMA

III. DESIGN OF ADAPTIVE NON-COHERENT RECEIVER

There are several receiving systems in use in the literature. They are coherent receivers, interference cancellation receivers [7-9]. The problem with coherent receivers is they need exact phase information for synchronization purpose. And in wireless systems obtaining exact phase information is major issue because channel characteristics. So to overcome this issue non coherent receivers introduced. The proposed system also included with adaptive techniques.

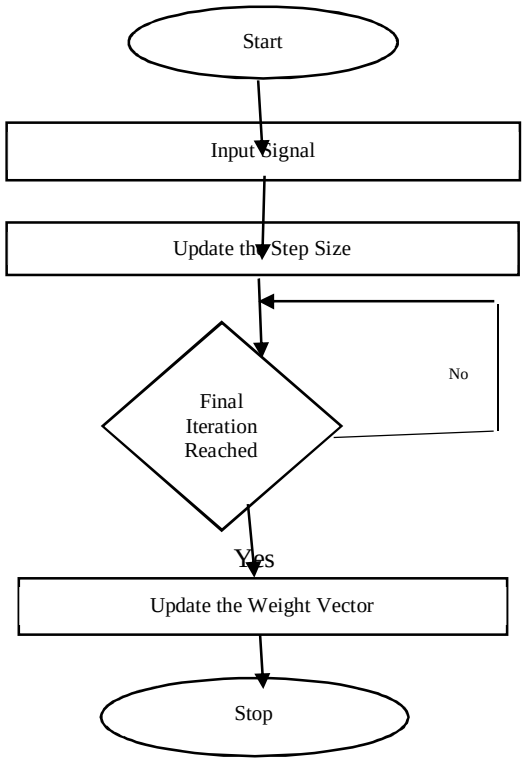

Fig. 2 Flow chart

Adaptive receivers are designed in such a way that they can able to change their characteristics according to change of channel attributes. So this is the key idea behind the adaptive receiving systems, that provides better performance than all the conventional methods. In adaptive algorithms the filter weights will be updated till the error becomes near to zero.

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The figure 2, shows the algorithms flow of adaptive technique.

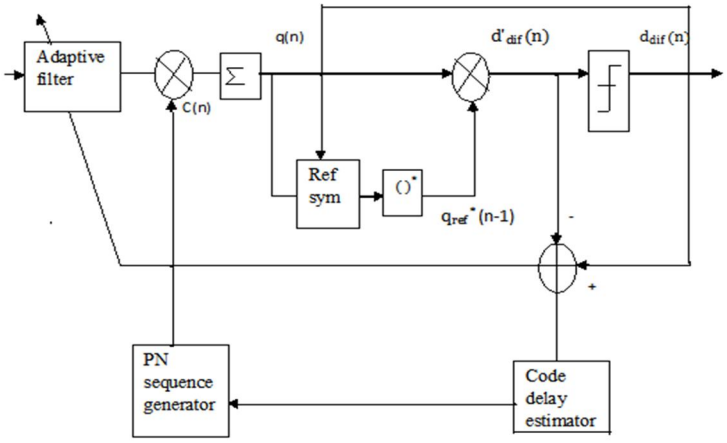

Fig. 3 Non-coherent Receiver

The figure 3, shows non coherent receiver along with adaptive technique. The proposed non-coherent receiver combines the differential detection with PN code tracking for DS-CDMA systems. The information sequence is first differentially encoded and transmitted.

At the receiver the sampled encoded signals are first passed through the transversal filter and then despread by the local PN sequence. The tap weight vector W(n), local PN code vector C(n), and the received sample matrix U(n) can be described as that of coherent. The normalized de-spreader output q(n) and can be represented as

$$q(n) = W^H(n)U(n)C(n)/\beta \qquad (1)$$

In the figure the decision variable $\hat{d}_{dif}(n)$ is obtained by non-coherent processing of the de-spreader output q(n),

$$\hat{d}_{dif}(n) = q(n)q^*_{ref}(n-1) \qquad (2)$$

Where the reference symbol $q_{ref}(n-1)$is generated as follows

$$q_{ref}(n-1) = \frac{1}{N-1}\sum_{l=1}^{N-1} q(n-1)\prod_{m=1}^{l-1} d_{dif}(n-m) \quad (3)$$

Where N, $N \geq 2$ is the number of de-spreader output symbols used to calculate $\hat{d}_{dif}(n)$, $d_{dif}(n)$is the hard decision result of $\hat{d}_{dif}(n)$. We can use the cost function

$$J_{dif} = E[|d_{dif}(n) - \hat{d}_{dif}(n)|^2] \qquad (4)$$

The error signal can be defined as

$$e_{dif}(n) = d_{dif}(n) - \hat{d}_{dif}(n) \qquad (5)$$

Here, $e_{dif}(n)$ at the n-th symbol time also depends on past tap weight vectors W(n-v), $v \geq 1$. For the derivation of the adaptive algorithm, these past tap weight vectors are treated as constants since $|e_{dif}(n)|^2$ is differentiated only with respect to W(n). The cost function J_{dif} minimized with required number of iterations then the filter is set with optimum valued weights.

IV. NUMERICAL RESULTS

The proposed system is simulated with MATLAB. Walsh Hadamard codes are used for spreading [10]. Rayleigh channel used for simulation. BPSK scheme used for modulating the data. Number of antennas are 2X2. The input data is 10k.

Figure 4, represents the BER vs SNR performance of both receivers. Non coherent receiver providing better performance than coherent receiver.

Similarly the figure 5, shown the throughput performance plot. In this graph also non coherent receiver providing better performance.

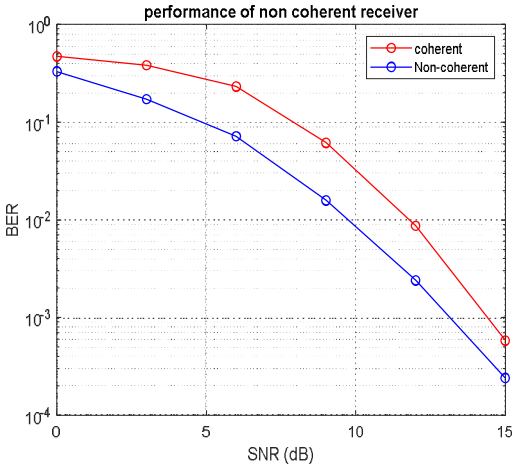

Fig. 4 BER Vs SNR for Coherent and Non-Coherent Equalizers

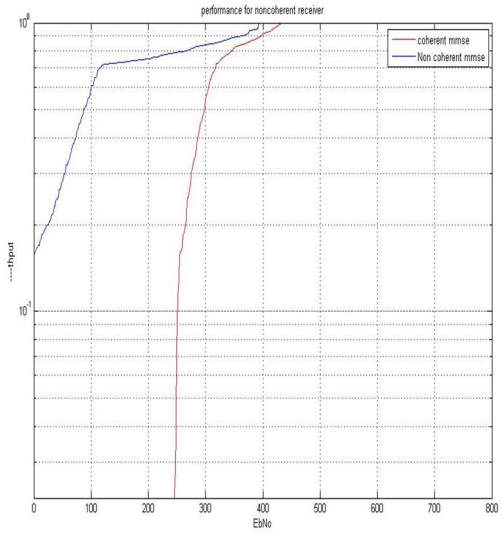

Fig. 5 Comparing Throughput Vs SNR for Non-Coherent and Coherent receivers

V. CONCLUSION

In the proposed technique the Non coherent receiver for MIMO-CDMA system is designed. And the proposed method providing better performance compared to coherent receiver. It significantly improves the bit error rate and thus capacity of the system. Since, the proposed receiver is applicable for Multimedia messages, video, high-speed Internet access, digital camera and also used in 3G, 4G, Mobile Internet, Mobile phone and next generation wireless systems. The proposed receiver design is very flexible and one can very easily make the necessary modification to investigate the Non-Coherent receivers performance under practical conditions.

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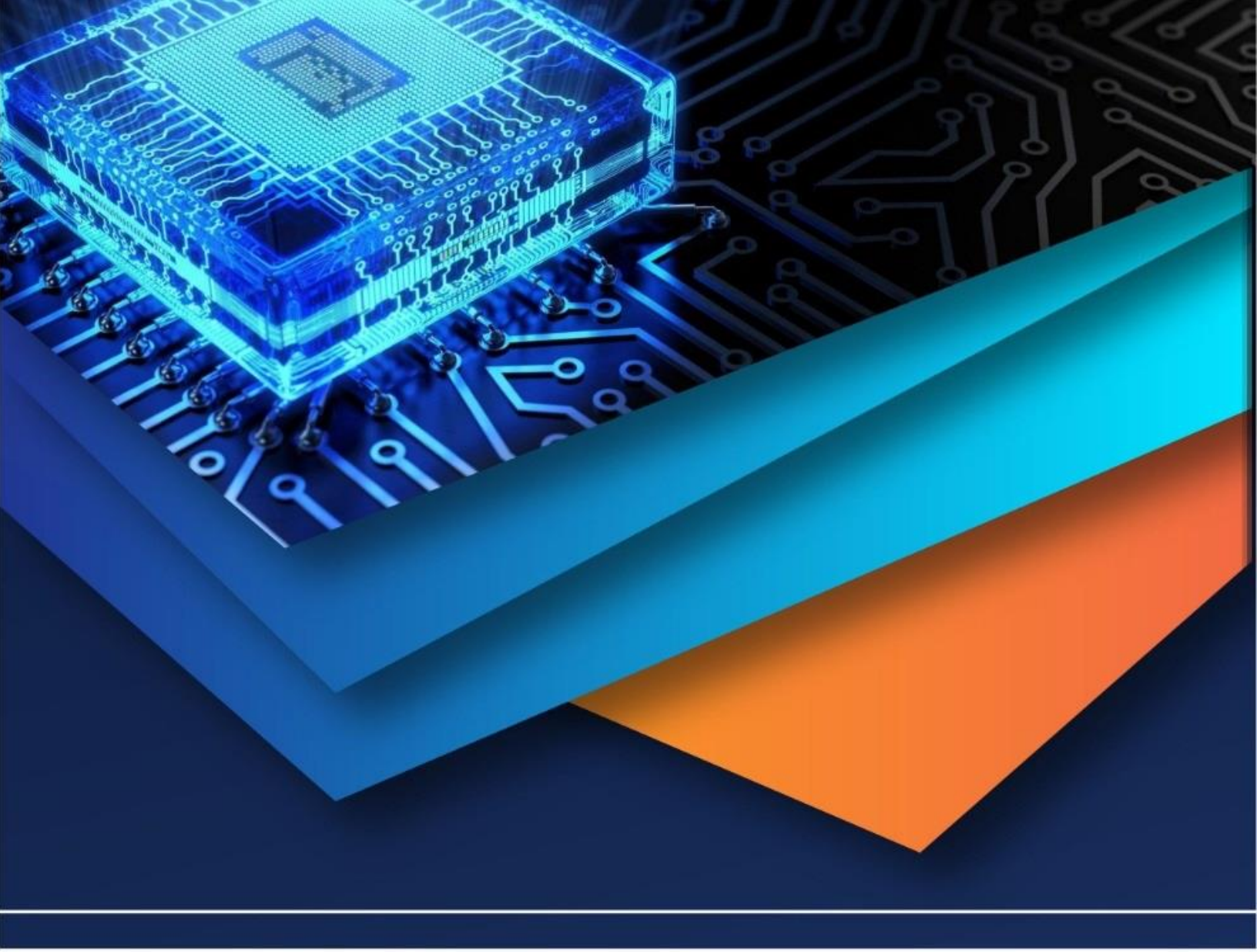

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