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MULTI USER DETECTION FOR DS-CDMA SYSTEM USING ARTIFICIAL NEURAL NETWORK (ANN) WITH MMSE

Sanjeev Chauhan, Vinay Kumar, Vivek Kanwar

***Abstract*— Multiuser detection deals with demodulation of the mutually interfering digital streams of information that occur in areas such as wireless communications, high-speed data transmission, DSL, satellite communication, digital television, and magnetic recording. The techniques used for multi user detection in MIMO systems are matched filtration, de-correlation and MMSE method. MMSE method was considered to be the best method because of its computational cost and because MMSE linear detector can perform between background noise and the interference of other users. In this paper, Artificial Neural Network (ANN) that is an intelligent system with MMSE detector is proposed for multi user detection and final result will be analyzed on the basis of BER of transmitter and receiver which is providing much better results than the traditional methods**.

***Index Terms*— BER, MMSE, ANN, AWGN, SNR, MAI.**

I. INTRODUCTION

CDMA stands for "code division multiple access". CDMA is a competing cell phone service technology to GSM which is the world's most widely used cell phone standard. CDMA provides better capacity for voice and data communications than other commercial mobile technologies [9]. CDMA has become a emerging technology for wireless industry because it provide many attractive features over the other multiple access scheme time division multiple access (TDMA) and frequency division multiple access (FDMA) to meet the high capacity and performance requirement for emerging personal communication services (PCS) [10]. CDMA has been the subject of intensive research in the field of mobile radio communication specifically the reliable transmission and detection of multiuser signal across noisy channels has received the most interest [4]. CDMA system all users share the same transmission medium in the same frequency and time. Each user transmits information over the common transmission medium by multiplying information signal and its own spreading code [12]. The spread spectrum modulation was originally developed for military applications where resistance to jamming or interference is major concern. It can be used to provide multipath rejection in a ground based mobile radio environment. There are two types of version are used in CDMA that is frequency hopping code division multiple access (FH-CDMA) and direct sequence code division multiple access (DS-CDMA) [9].DS-CDMA is a promising multiple access capability for third and next generation mobile communication system [11]. One type of wireless technology which has become popular over the last few years is direct Sequence code division multiple access (DS-CDMA) .DS-CDMA is a form of spread spectrum system, is capturing a significant interest in personal communication services[3] .DS-CDMA has emerged as the preferred technique for increasing the channel capacity through multiple access communication . This is mainly because in DS-CDMA the whole frequency band is used all the time and bandwidth can be utilized more efficiently [2]. DS-CDMA is considered as the third generation of cellular mobile, indoor wireless personal communication system. Such as frequency reuse, soft hand off, increased capacity and multipath combating [13]. CDMA systems have an interesting property that their capacity is typically limited by multi access interference (MAI). Thus MAI in CDMA puts a limit on capacity while an acceptable value of bit error rate (BER) performance of the system is considered [7].

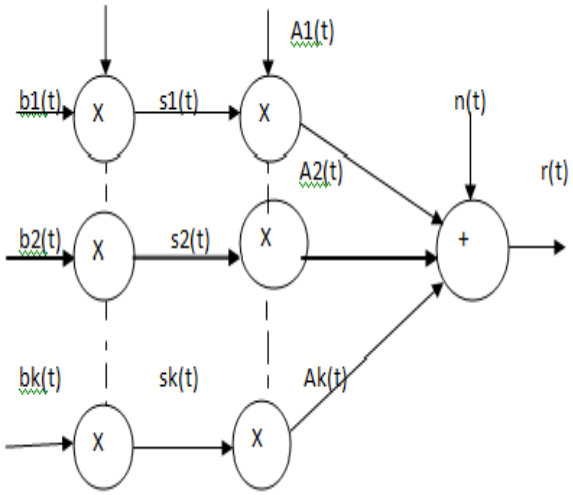

FIG (1) - System model for DS-CDMA System

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$r(t) = \sum_{k-1}^{k} A_k(t) S_k(t) b_k(t) + n(t)$ …. (1)

Where $A_k(t)$ *is channel Attenuation* , S_k (t) is chip sequence

b_k(t) is input bits and n (t) is AWGN Noise

(MUD) Multiple user detector technology exploit the character of the MAI by removal of the multiple user interference from each user received signal before making data and it offer significant gain in capacity and near far resistance [14].Multiuser detection enhance the performance of DS-CDMA system by reducing the effects of MAI [1]. MUD classified as optimal and suboptimal [13]. Verdi's seminal works published in 1986, Proposed and analyzed the

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optimum multiuser detector, or maximum like hood sequence detector. Unfortunately this is much too complex for practical DS-CDMA system. Over the last decade more of the research has focused on finding suboptimal multiuser detection solution which is more feasible to implement [15].The optimum MUD complexity, suboptimal alternatives able of resolving the detrimental effects of MAI. Suboptimal are divided into two categories that is linear and non-linear. Linear detector is Deco relating detector, Minimum mean square error (MMSE) [9]. Non-linear multi user detection, which is also called subtractive detection, the interference estimates are generated and then removed from the received signal before detection [10].

One of the non-linear multi user detection techniques is Neural Networks (NN) approach. The Neural Network receiver was made first by Aazhang et.al. They demonstrated that the performance of multilayer preceptron is close to that of optimum receiver, by applying a complicated training method [16]. More neural network based MUD were implements. With increasing attention focused on the application of Neural Network to the field of pattern reorganization [5], Adaptive Neuro-Fuzzy interference system [6]. Optimized chaos based system [8]. Hopfield network [17], and matched filter with neural networks. A matched filtration is obtained by correlating a known signal, or template, with an unknown signal to detect the presence of the template in the unknown signal. The second approach in MIMO for multi user detection is De-correlation and the third approach introduced was MMSE (Minimum Mean Signal Error). The advantage of this MMSE method is the low computational cost.

In this work we use MMSE detector with Neural Network. MMSE linear detector can perform between background noise and the interference of other users. Till date the MMSE was considered the best method for multi user detection because of its cost and efficiency. Since, MMSE was considered to be the best method so the technique of ANN (Artificial Neural Networks) with matched filtration was taken into consideration and it was now more effective then the MMSE method. But the problem of linear detection of background noise and the interference of other users was still faced in the matched filtration. Also the computational was high. So a technique needs to be designed to overcome all these problems.

II. MMSE DETECTOR

MMSE detector is a linear detector it applies a linear transformation to the output of matched filter and reduces the effects of MAI. MMSE minimize the mean square error between actual data and soft provides better probability of error performance then other detector [9]. The amount of modification is directly proportional to the background noise, the higher the noise level the less complex an inversion of R can be done without noise enhancement causing performance degradation. The structure of the MMSE detector is simple than the structure of other detectors an important output. MMSE detector instead tries to minimize the square of the residual noise plus interference. MMSE detector disadvantage of estimation of the received amplitude and another disadvantage is that its performance depends on the power of the interfering users. The MMSE detector implements a linear mapping L which minimize the mean square error E [| $(b_k - L_y)$|]^2.

x=sgn (Ly) …… (2)

Where y =RAb+n output of matched filter.

XMMSE=$[R + \frac{N0}{2})A^{-2}]^{-1}$ Y ……. (3)

If Xmmse < 0 then x= -1 else +1and x≠b then error = error +1[14].

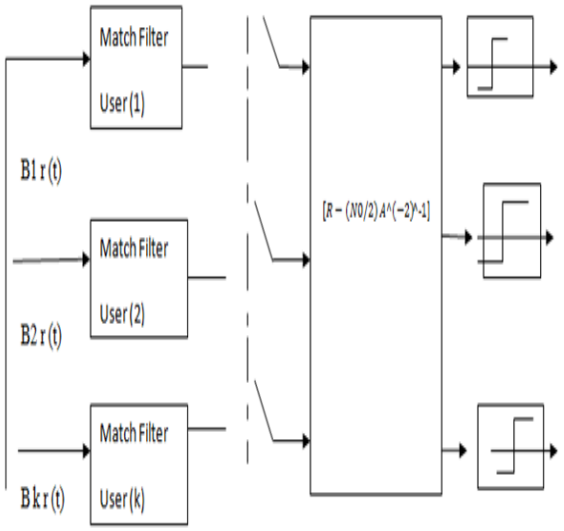

Fig (2) – MMSE Detector with Matched Filter

III. ANN (Artificial Neural Network)

Artificial Neural Network is a machine learning approach that models human brain and consists of a numbers of artificial neurons. NN imitates biological nervous system in its structure the neural network is a mathematical model inspired by biological neural network [1]. The main characteristics of NN are that they have the ability to learn complex non-linear input output relationship, use sequential training process adapt themselves to the data [5]. An Activation function is applied to these inputs which results in activation level of neuron. Three different classes of networks architecture. Single layer forward network, multi layer feed forward network and recurrent feed forward network.

IV. MULTI LAYER FEED FORWARD NEURAL NETWORK

FFNN is a more general Architecture, where there are hidden layers between input and output layers. Hidden nodes do not directly receive inputs nor send outputs to the external environments. FFNN overcome the limitation of single NN. They can handle non-linearly separable learning task. NN consist of neurons that are connected each other with weight. It can do some certain function by adjust weight factor between neurons. By adjusting weight NN processes the inputs to get desired output. Neuron in inputs layers act as buffers for distributing the signal for hidden layers. Then the various activation functions are used in neuron. Weights can be changed with various learning algorithm for getting proper outputs. In this present work we used a feed forward neural network with back propagation algorithm. The network has an input layer, Hidden layer and output layer. Tansigmoid

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Function is used for hidden layers and purelin activation function is used for output layers.

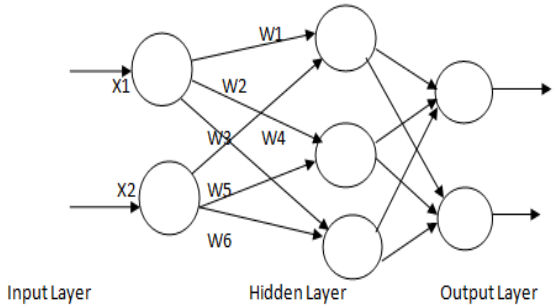

FIG (3) – Multi layer Preceptron.

V. PRESENT WORK

An ANN along with MMSE. Input signal that is given is checked through the MMSE after its implementation through multi user detection. The output signal varies from the input signal and the output signal is then taken as the input for the target. But there are variations in the input and the output signal and it generates error some time. To overcome the problem of the variation in the output signal as per the input signal an intelligent system called as ANN are added to the signal. This ANN is trained as per the input signals that means. They will produce the output signal or will manipulate the output signal as per the requirements depending on the input signal. This ANN will be give certain Specifications of the input signal as with that specification it will take its reference and then will make changes in the output signal as per the requirements. The output signal for the particular set of inputs will be given to these intelligent system and then ANN will take input signal, then it will match the input signal with the closer probability of the input signal define in it and then it will make changes or will manipulate the output signal as per the reference signal and this output signal will then be given as input to the target ,the process under goes as such the input signal is applied MUD an its output is checked, this output is then tested by ANN and the signal is manipulate according to the ANN trained and then this signal service as final output and is then given to the target as original signal.
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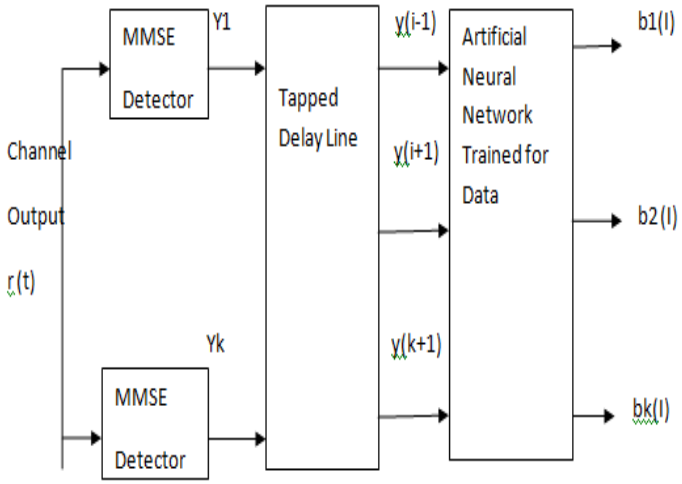


FIG (4)–MMSE Detector with Artificial Neural Network (ANN).

VI. RESULTS:-

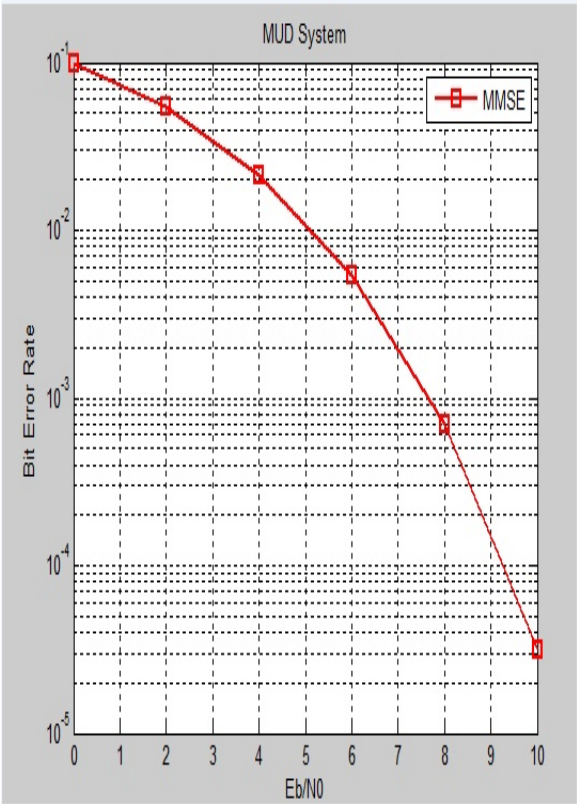
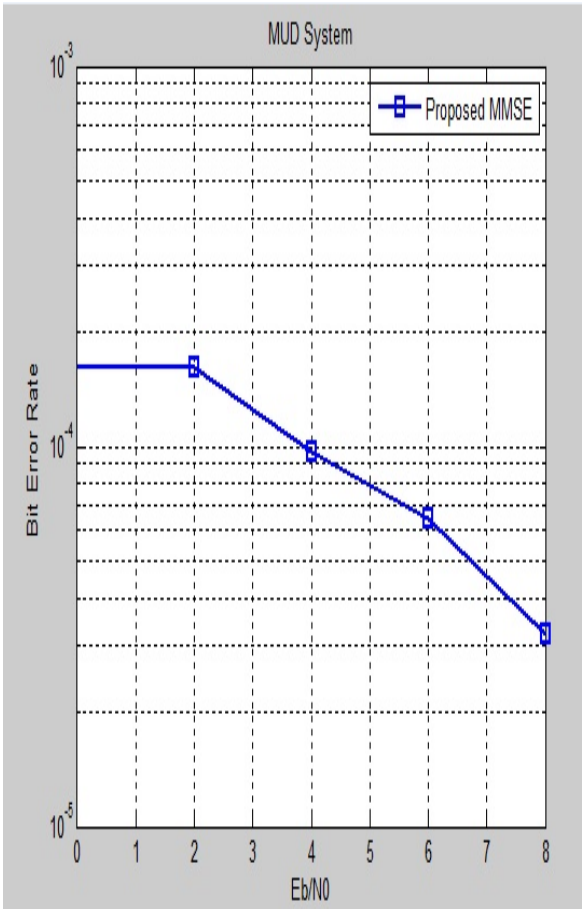
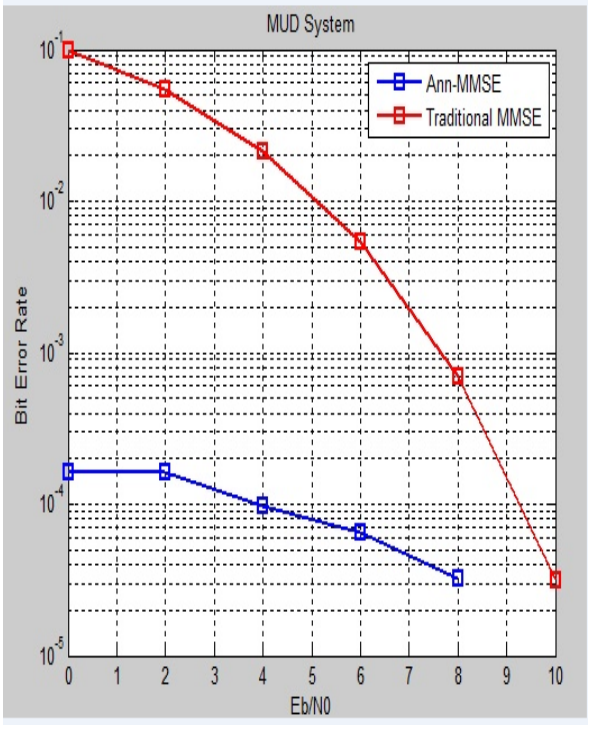


FIG (5)-BER and SNR of traditional MMSE.



FIG(6) - BER and SNR of Proposed MMSE



FIG(7)–Comparison between traditional MMSE and ANN-MMSE.

VII. CONCULSION-:

In this paper my aim is to improve the BER and SNR in as shown in fig(7) ANN-MMSE as BER approximate 10^{-4} with less than BER of traditional MMSE which is of approximate 10^{-1} its mean comparing both the MMSE. We get BER in case of AAN-MMSE is less and more SNR.

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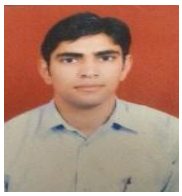

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