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DIMINISHED COMPLEXITY GENETIC ALGORITHM AIDED AND RADIAL BASIS FUNCTION ASSISTED MULTIUSER DETECTION FOR SYNCHRONOUS CDMA

Yeswanth Chowdary Malladi, Phaneendhra Madala, Ravikumar C. V. and Kalapraveen Bagadi
School of Electronics Engineering (SENSE), DET, Vellore Institute of Technology, India
E-Mail: ravikumar.cv@vit.ac.in

ABSTRACT

Radial Basis Function (RBF) Network aided Multiuser Detection (MUD) plans are fit for identifying the got signal of all clients, regardless of the possibility that the channel yield states are straightly non-distinct. In any case, their many-sided quality may end up noticeably intemperate which renders their genuine execution irrealistic, with the exception of when the quantity of clients is low. In this commitment a novel lessened multifaceted nature Radial Basis Function Network aided Multiuser Detection (RBFNMUD) is created, which conjures Genetic Algorithms [GAs] for decreasing the quantity of RBFN-MUD focuses. Our PC recreations demonstrated that GAs is able to do extensively diminishing the intricacy forced at the cost of a slight execution corruption.

Keywords: RBF, MUD, signal analysis, (RBFNMUD), genetic algorithm.

1. INTRODUCTION

The Multiuser Detector [MUD] works straightforwardly on the received signal, tested once or a few times amid each chip period. Such a beneficiary is moderately cold hearted to mistakes in the gauge of the proliferation delay and other framework parameters. Another preferred standpoint is that, it can be actualized such that lone signs that are of intrigue should be recognized. Rather than tuning the beneficiary straightforwardly from the received signal, a direct channel model of the DS CDMA framework is additionally determined.

This multivariable model has the images transmitted by all clients as information and the got chip examined motion as yield. This model is then utilized as a reason for the finder outline. Both synchronization blunders and multi-way spread is joined in this model and obscure parameters can be evaluated effortlessly. The channel model will be time invariant or gradually time shifting in a framework with short codes. At the point when long codes are utilized, the channel model will change unexpectedly from image to image, when the multipath channel is time invariant. Multiuser location manages the advancement and use of joint demodulation and obstruction cancelation strategies for enhanced identification of a coveted arrangement of computerized signs.

A differential coordinated channel which is utilized the differential data in the FIR channel coefficients mitigates the multifaceted nature. This many-sided quality diminishment is essential for the multistage identifier. The SNR is still expanded yet the finder is not Maximum Likelihood [ML] because of the nearness of Multiple Access Interference [MAI]. The viability of the traditional beneficiary is constrained in light of the fact that it ignores the structure of MAI and is defenseless to abberations in the got forces of the diverse client's signs.

MUD together identifying the flag from various clients has been under serious research as a potential strategy to enhance the framework execution of CDMA frameworks amid the most recent ten years. The DS/CDMA recipients are isolated into Single client and Multiuser finders. A solitary client beneficiary identifies the information of one client at any given moment while a multiuser recipient together distinguishes a few clients data. Single client and multiuser recipients are likewise now and again called as decentralized and brought together beneficiaries individually. In DS-CDMA frameworks all clients simultaneously have a similar data transfer capacity. The clients are recognized by allocating to every client a special code or mark arrangement, whose data transmission is considerably bigger than that of the transmitted data. This code succession is utilized to regulate the information stream.

2. ORTHOGONALITY AND ORTHONORMALITY

The continuous speech signal can be constructed as a set of orthonormal and orthogonal vector $\{h_k, 1\leq k\leq N\}$ from a given set of vectors $\{S_k, 1 \leq k\leq N\}$ such that the inner products between vectors in the set have some specified structure. Specifically, the constructed vectors are closest in a least squares sense and minimize the sum of the squared norms of the error vectors between the constructed vectors and the given vectors. The development considers both the case in which the given vectors are linearly independent and linearly dependent. The closest orthonormal vectors refer to as the Orthonormal Least Squares Vectors (OLSV). Next generalize these results to allow for unequal weighting of the squared norms of the error vectors referred to as the Weighted Orthonormal Least Squares Vectors (WOLSV). The problem of constructing orthogonal vectors that are not constrained to have equal norm and the given vectors closest in a least squares sense are referred to as the orthogonal least squares vectors.

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3. LEAST SQUARE ORTHONORMALIZATION

The set of orthonormal vectors $\{h_k, 1 \leq k \leq N\}$ with set transformation H, that minimize E = ||S –H||2 F subject to $<h_m, h_K> = \delta_{mk}$, or H*H = I. Thus H is constrained to be a partial isometry.

The least squares orthonormalization problem reduces to find the partial isometry H that minimizes E = $\|S - H\|^2$ F. The optimal H denoted as H| is well known and it is partial isometry in the polar decomposition of S. Let S have a Singular Value Decomposition defined as S = UΣV*, where U is an n × N partial isometry, Σ is an N × N diagonal matrix and V is an N × N unitary matrix. Then H| = UΣV*. A partial isometry is a transformation T that satisfies T*T = I. If the vectors S_k are linearly independent, then the results obtained from H| = S(S*S)-1/2. The OLSV can also be obtained as the solution to an orthogonal problem.

Least square orthogonalization

Consider the problem of constructing an optimal orthogonal vector $\{h_k, 1\leq k\leq N\}$ from the given vectors $\{s_k, 1\leq k\leq N\}$ and the vectors are constrained to have some specified norm. Next constructing a set of orthogonal vectors $\{h_k, 1\leq k\leq N\}$ that minimize E = $\|S - H\|^2$ F. F subject to the constraint $<h_m, h_k> = c_k\ 2\ \delta_{mk}$, where the scalars $c_k \leq 0$ are specified.

The assumption without loss of generality that ck > 0 for 1 ≤ k ≤ P and the error E can be written as E = N≤ k ≤1, $< h_k - h_k, S_k - h_k >$ =N≤ k. If the vectors S_k are linearly independent and ck > 0 for all k, then the results are obtained as H| = S*C (CS*SC)-1/2.

General linear receiver

New classes of receivers consisting of a bank of correlators with correlating signals matched to a set of signals with a specified inner product structure R and are closest in an LS sense to the transmitted signals shown in Figure-3.1. These receivers depend only on the transmitted signals, so that they do not require knowledge of the noise distribution refer to as MF receivers.

In the special case in which R=I(identity), the receiver consists of a bank of correlators with orthogonal correlating signals that are closest in an LS sense to the transmitted signals referred to as the Orthogonal Matched Filter (OMF) receiver.

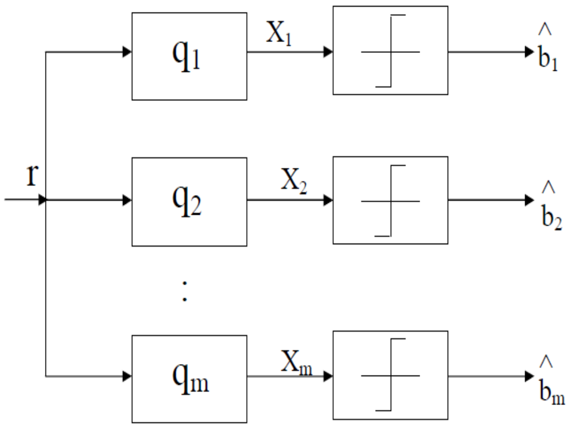

Figure-1. General linear receiver.

Multiuser receivers include the optimal multiuser receiver, the linear minimum mean squared error receiver, the decorrelator, and the Matched Filter (MF) receiver for CDMA signals. Both the optimal receiver and the linear minimum mean square error receiver require knowledge of the channel parameters, namely, the noise level and the received amplitudes of the user's signals. The MF and the decorrelator receivers are linear receivers that only require knowledge of the signature vectors. The MF optimally compensates for the white noise, but does not exploit the structure of the MAI. The decorrelator optimally rejects the MAI for linearly independent signature vectors, but does not consider the white noise.

Decorrelator receiver

The receiver shown in Figure-2 consists of a decorrelator demodulator followed by an optimal minimum mean square error whitening transformation on a space formed by the signature vectors. This whitening transformation is designed to optimally decorrelate the outputs of the decorrelator prior to detection. Specifically, it minimizes the Mean Square Error (MSE) between the vector output of the decorrelator and the output of the whitening transformation, so that distortion to the output vector is minimized under the whitening constraint.

The demodulator consists of a bank of correlators with correlating vectors that are projections of a set of orthogonal vectors, and are closest in a least squares sense to the decorrelator vectors and also closest in a least squares sense to the signature vectors.

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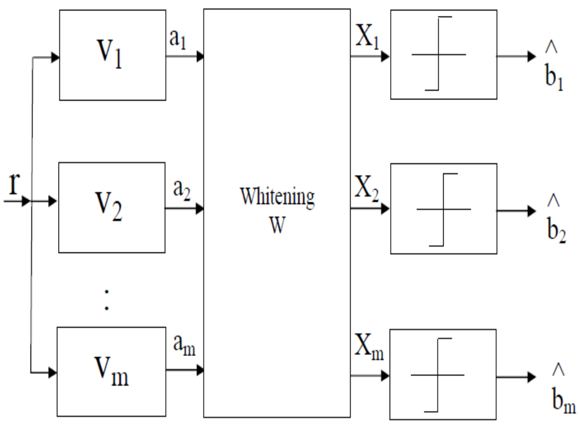

Figure-2. Block diagram.

Literature survey

In the linear multiuser detector for synchronous CDMA systems, the received signal is demodulated using an orthogonal multiuser receiver that is matched to a set of orthogonal vectors that are closest in a least squares sense to the signature vectors. This approach is equivalent to optimally whitening the noise component in the output of the decorrelator prior to detection reported by Eldar and Oppenheim (2002).

In an asynchronous CDMA environment, receiver has knowledge of the signature waveforms of all the users with white Gaussian noise. The received energies of the users are unknown to the receiver and whose BER is independent of the energy of the interfering users discussed by Lupas and Verdu (1990). A new real time, digital adaptive multiuser receiver structure over white Gaussian noise was designed. This receiver efficiently implements the decorrelating detector and adapted to incorporate decision feedback detector to further improvement in their detector performance (Dao Sheng Chen Roy 1994).

The adaptive receiver has no knowledge of the signature waveforms and timing of other users. The receiver is trained by a known training sequence prior to data transmission and continuously adjusted by an adaptive algorithm during data transmission. The linear receiver is a standard single user detector receiver consisting of a matched filter with constant coefficients discussed by Rapajic and Vucetic (1994). Several multiuser detectors such as decorrelator, the two stage detector and the decision feedback detector for the Raleigh flat fading synchronous CDMA channel was compared. In the presence of channel mismatch, the decorrelator offers better performance than more complex decision feedback and two stage detectors performed by Duel-Hallen *et al* (1995). The performance analysis of the minimum mean square error linear multiuser detector is considered in an environment of nonorthogonal signaling and additive white Gaussian noise. The probability of error of this detector is better than the decorrelating linear detector for all values of normalized cross correlations dealt by Poor and Verdu (1997). Adaptive receivers depend on number of users, their received powers, spreading codes and time delays. Two adaptive receiver architectures such as the sampled received signals are filtered and another in which the spreading codes of users is filtered considered by Teng joon lim and Sumit roy (1998).

The adaptive Multiuser Detector which converges to the minimum mean square error detector without training sequences and which requires less information discussed by Howard C. Huang and Verdu (1998). The signal detection based on additive colored non Gaussian noise, and attention is focused on one-shot structures where detection of each symbol is based only on the received process during its corresponding interval by Poor and Verdu (1998). Lupas and Verdu (1989) proposed the performance achieved by linear Multiuser Detectors whose linear memory transformation is a generalized inverse of the matrix of signature waveform cross correlations.

The multiuser receiver is quite effective in increasing capacity of users with higher data rate and lower target bit error rate for multirate CDMA system described by Guo and Aazhang (1999). The front-end Recursive Least Square-minimum mean square error filters can be implemented using systolic arrays to exploit massively parallel signal processing computation, and to achieve energy efficiency by Xiaodong Wang and Poor (1998).

Moshavi (1996) discussed with multiuser detection, where information about multiple users is used to improve detection of each individual user. The optimum receiver to detect the bits of multiple CDMA users has an exponential complexity in the number of active users using nonlinear programming relaxations define by Yener *et al* (2002).

Block diagram

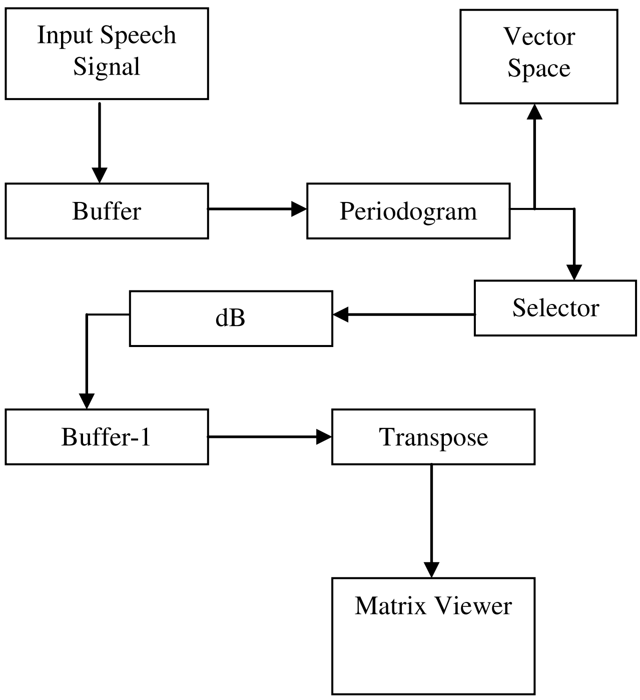

Figure-3. Block diagram.

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RESULTS AND DISCUSSIONS

The performance of OMU receiver is compared with other receivers such as decorrelating receiver, minimum mean square receiver, Kalman receiver. The speech signal is opted as an input of the all receivers. The OMU receiver has achieved low MSE than others. Most useful parameters in speech processing are found in the frequency domain. There are several ways to extract spectral information of speech. When the audio file contains two channels (stereo), the block's output is an M-by-2 matrix containing one frame (M consecutive samples) of audio data from each of the two channels.
When the audio file contains a single channel (mono), the block's output is an M-by-1 matrix containing one frame (M consecutive samples) of mono audio data. The simulink must read a continuous stream of data from the device throughout the simulation shown in Figure-3.4. Delays in reading data from the audio hardware can result in hardware errors or distortion of the signal.

At the start of the simulation, the audio device begins writing the input data to a (hardware) buffer with a capacity of Tb seconds. The Wave Device block immediately begins pulling the earliest samples off the buffer (first in, first out) and collecting them in length-M frames for output. As the audio device continues to append inputs to the bottom of the buffer, the Wave Device block continues to pull inputs off the top of the buffer at the best possible rate. Here scalar samples are converted into frame output.

Table-1. Extraction of vectors arranged in square matrix.

x= [7.1039	7.8186	8.5370	9.2648;	7.1634	7.8803	8.5986	9.3243;
7.1053	7.8222	8.5406	9.2662;	7.1655	7.8832	8.6023	9.3279;
7.1075	7.8251	8.5442	9.2698;	7.1692	7.8839	8.6030	9.3315;
7.1111	7.8259	8.5449	9.2735;	7.1728	7.8875	8.6059	9.3344;
7.1147	7.8295	8.5478	9.2764;	7.1750	7.8912	8.6095	9.3351;
7.1169	7.8331	8.5515	9.2771;	7.1764	7.8948	8.6132	9.3388;
7.1184	7.8367	8.5551	9.2807;	7.1800	7.8984	8.6146	9.3424;
7.1220	7.8404	8.5566	9.2844;	7.1837	7.9020	8.6168	9.3460;
7.1256	7.8440	8.5587	9.2880;	7.1866	7.9057	8.6204	9.3497;
7.1285	7.8476	8.5624	9.2916;	7.1873	7.9064	8.6240	9.3533;
7.1293	7.8483	8.5660	9.2952;	7.1909	7.9093	8.6262	9.3569;
7.1329	7.8512	8.5682	9.2989;	7.1946	7.9129	8.6277	9.3576;
7.1365	7.8549	8.5696	9.2996;	7.1982	7.9166	8.6313	9.3605;
7.1401	7.8585	8.5732	9.3025;	7.2018	7.9180	8.6349	9.3642;
7.1438	7.8600	8.5769	9.3061;	7.2054	7.9202	8.6378	9.3678;
7.1474	7.8621	8.5798	9.3098;	7.2091	7.9238	8.6385	9.3693;
7.1510	7.8658	8.5805	9.3112;	7.2098	7.9274	8.6422	9.3714;
7.1517	7.8694	8.5841	9.3134;	7.2127	7.9296	8.6458	9.3751;
7.1546	7.8716	8.5878	9.3170;	7.2163	7.9311	8.6494	9.3787;
7.1583	7.8730	8.5914	9.3206;	7.2200	7.9347	8.6531	9.3809;
7.1619	7.8766	8.5950	9.3228;	7.2214	7.9383	8.6567	9.3823;

Using the Periodogram block a nonparametric estimate of the power spectrum of the speech signal is computed. With the use of transpose the vector input signals are treated as (Mx1) matrices shown in Table-1. For the specified inner product structure another constraint that can be applied for consistency is the least square inner product constraint. Here, the obtained optimal vectors must be orthogonal and orthonormal.

The optimal vectors are used to minimize the sum of the mean squared norms of the errors between constructed and the given vectors. For that singular value decomposition and other set transformations also satisfy the condition that the inner product of the resultant matrices will be a identity matrix, the probability value must be one for all type of vectors. The vectors are identified for linear dependent and linear independent. The exact and approximate expressions for the probability of error, as well as the asymptotic Signal to Interference and Noise Ratio (SINR) in the small system limit are derived.

The analysis suggests that over a wide range of channel parameters the OMU receiver can outperform both the decorrelator and the single user MF and perform similarly to the linear minimum mean square error receiver, despite not knowing the channel parameters. There are many ways to choose whitening transformation. Here, to choose the whitening transformation with Eigen decomposition that results in output that is as close as possible in an MSE sense to the output of the decorrelator so that minimize the distortion. This whitening transformation is designed to optimally decorrelate the outputs of the decorrelator prior to detection, and in that way compensate for the noise enhancement of the decorrelator receiver. When the signature vectors are linearly independent, it decorrelate the outputs of the decorrelator (K<M).

If the signature vectors are linearly dependent, then the noise components in the outputs are linearly dependent, i.e., they satisfy a deterministic linear relation (K=M). Thus, the vector noise output of the decorrelator lies in a subspace with probability one. The same condition can be related with coloured noise components. The kalman filter is an estimator for linear quadratic Gaussian problem estimating the instantaneous state of linear system perturbed by white noise and coloured noise.

Experimental results

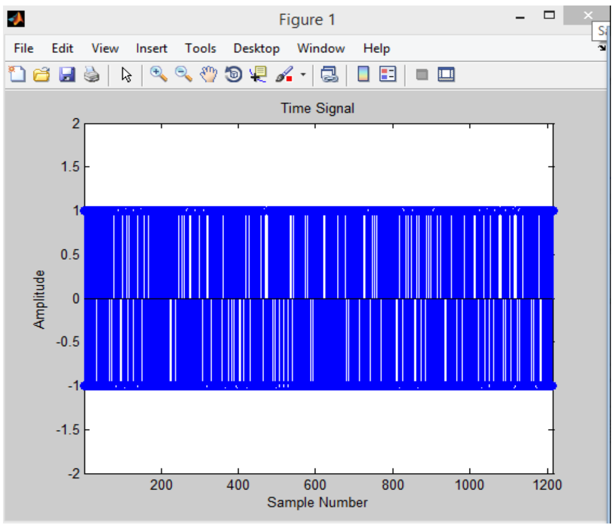

Figure-4. Time signal.

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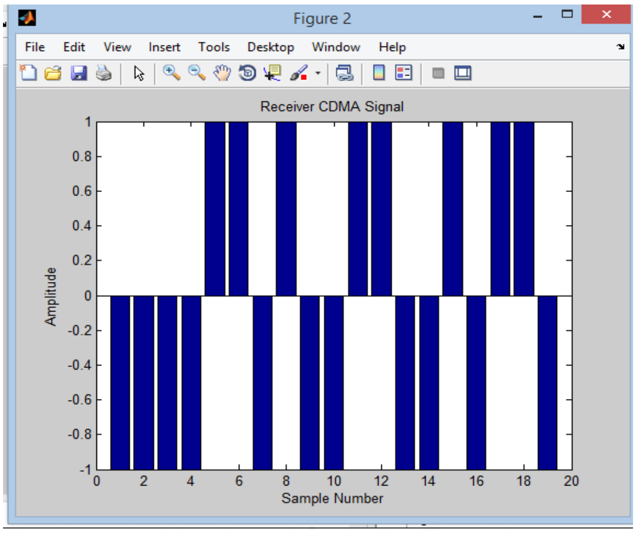

Figure-5. Receiver CDMA signal.

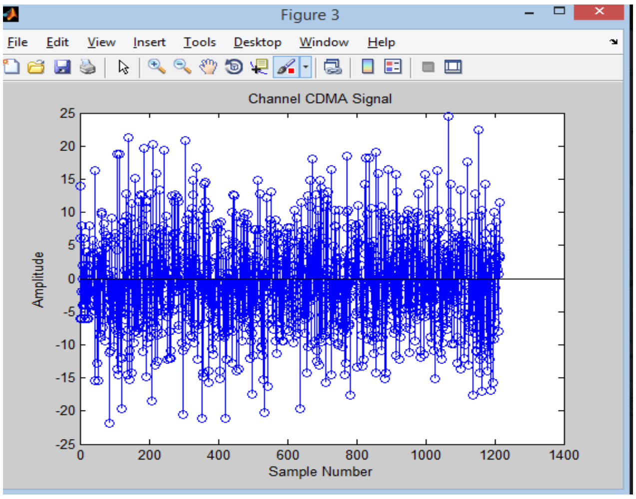

Figure-6. Channel CDMA signal.

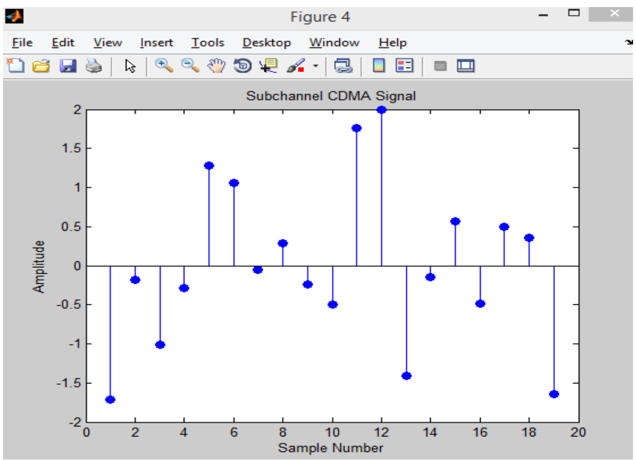

Figure-7. Subchannel CDMA signal.

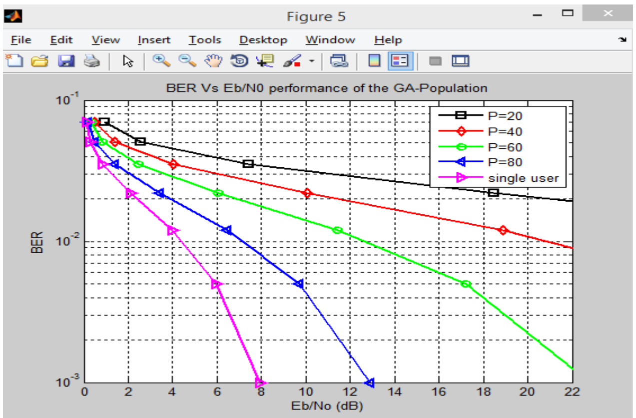

Figure-8. BER vs Eb/N0 performance of the GA population.

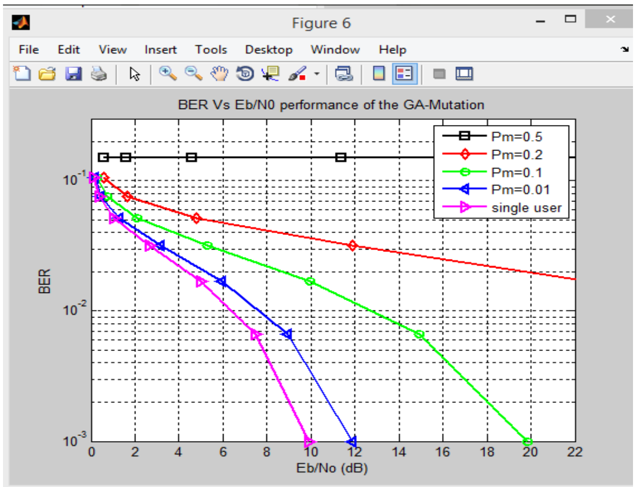

Figure-9. BER vs Eb/N0 performance of the GA mutation.

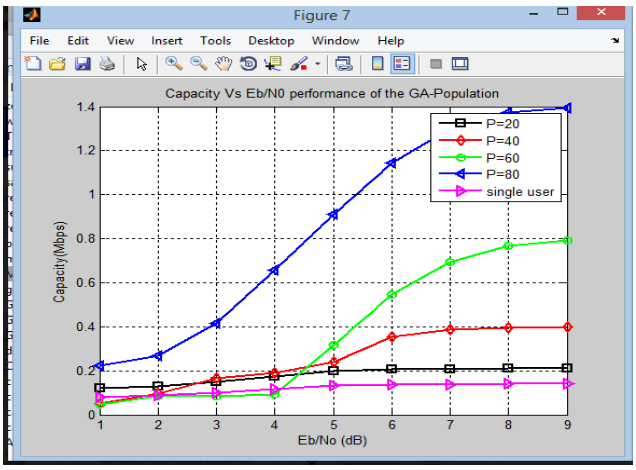

Figure-10. Capacity vs Eb/N0 performance of the GA population.

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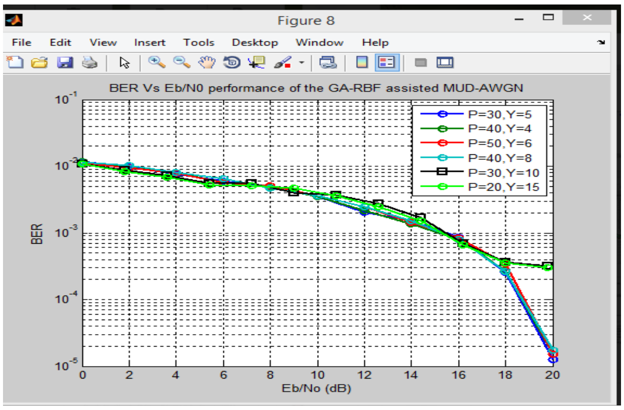

Figure-11. BER vs Eb/N0 performance of the GA-RBF assisted MUD-AWGN.

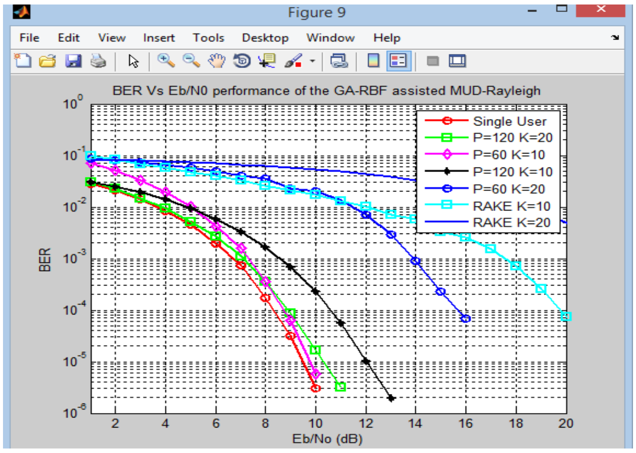

Figure-12. BER vs Eb/N0 performance of the GA-RBF assisted MUD-Rayleigh.

CONCLUSIONS

The multiuser receiver for CDMA channels, referred to as the OMU receiver has been developed which relies on knowledge of only the signature vectors to mitigate the effect of both MAI and additive noise. First, the receiver can be interpreted as a decorrelator receiver followed by a minimum mean squared error receiver that compensates for the noise enhancement without reintroducing too much MAI. Second, OMU receiver for both white Gaussian noise and coloured noise has been demonstrated and it is equivalent to an MF receiver. The corresponding curves for the decorrelator receiver, linear minimum mean squared error receiver, OMU receiver for coloured noise and also to the nonstationary filter like Kalman Filter receiver are plotted for comparisons. The OMU receiver achieved minimum probability of error at all SNR (0 dB to 10 dB) and better than the decorrelator receiver, minimum mean square error receiver and Kalman Filter receivers.

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