VOL. 7, NO. 4, APRIL 2012 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

PERFORMANCE ANALYSIS OF SELECTIVE WEIGHTED LINEAR PARALLEL INTERFERENCE CANCELLATION SCHEME FOR MC-CDMA SYSTEM

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ABSTRACT
A novel Selective Weighted Linear Parallel Interference Cancellation (SWLPIC) technique is proposed to reduce the interference (degrading effect) on a desired user caused by other users sharing the same channel in a Multicarrier Code Division Multiple Access (MC-CDMA) system. The SWLPIC technique cancels the interference using WLPIC on selected users whose instantaneous Signal to Interference Ratio (SIR) exceed certain threshold on Rayleigh fading channels in each subcarrier. In WLPIC the multi access interference (MAI) are estimated and cancelled based on the soft outputs of individual subcarriers. The MAI estimate of individual subcarriers is scaled by a weight before cancellation. Also, the SIR for each subcarrier is determined and an expression for the optimum threshold is derived by optimizing the approximate expression for the SIR. The interference cancelled outputs of different subcarriers are then combined to form the final decision statistic. The simulation results show that the SWLPIC technique outperforms over matched filter (MF) detector and conventional Linear PIC (LPIC). Also the performance of SWLPIC approaches weighted LPIC (WLPIC).

Keywords: MC-CDMA, multi access interference, signal to interference ratio, SWLPIC, matched filter.

INTRODUCTION

Multi-carrier modulation is being proposed for fourth generation wireless communication systems for higher data rate application and to reduce the effect of Inter Symbol Interference (ISI). The same data symbol is transmitted over a large number of narrow band orthogonal carriers to eliminate ISI by the 4G systems [1]. Like CDMA systems, the MC-CDMA systems also suffer from the impairment of the MAI resulting from the symbols with the same or different transmission data rates.

Various multiuser detectors (MUD) in general [2] and interference cancellation techniques in particular are applied to multicarrier direct-sequence CDMA (MC DS-CDMA) to increase the system capacity and to reduce the MAI. As the orthogonality among users is totally distorted in the MC-CDMA uplink channel even without near/far effect, Multiuser Detection techniques are essential. The interferences are considered as an additive noise in single user detection (SUD). The interferences from other users are first estimated and then subtracted from the received signal in the case of MUD. The Non-linear MUD techniques estimate the interference caused by each user on the others, respread and cancel from the received signal. This is done through MUD techniques like Decision feedback techniques, Subtractive Interference cancellation techniques, Successive Interference cancellation (SIC), Parallel Interference cancellation (PIC) and Selective Parallel Interference cancellation (S-PIC).

A one finger selective combiner and two finger rake receiver were analyzed for DS CDMA system by [Hara *et al*.]. The performance of one finger rake was worse than the 2-finger receiver as it misses the part of the received signal energy. MAI degrades the BER gradually with the increase in number of users in two finger rake receiver. Even though the literature on Multi-Carrier based CDMA schemes are reviewed in [3], the analyses using different multipath delay profiles are missing. Fu *et al*., [4] has applied an optimum maximum-likelihood (ML) MUD technique to improve interference mitigation. However the ML has unacceptable level of high computational complexity making it not suitable for practical implementations. Theoretically, ML can be used for both uplink and downlink channels. This method appears to be practically suitable only when the spreading sequences of all users are relatively short because of the complexity of ML grows exponentially with the number of users and with the code length. Hence, to reduce the computational load, several suboptimum MUDs such as the minimum mean-squared error (MMSE) MUD, SIC, and PIC have received research attention. The performance degrades significantly as the MAI becomes more prominent in the MMSE-based MUD [4] proposed for reducing the computational load.

Also Li *et al*., [5] proposed an MMSE based hybrid serial / parallel IC method to combat the MAI, but the complexity remains very high. A combination of SIC receiver followed by maximal-ratio combining (MRC) and convolutional decoding for the MC CDMA system was proposed in [6]. The performance of SIC-MRC receiver was closer to N-tap MMSE receiver and both of them had better ability to suppress MAI than MF-MRC. Even with timing and phase tracking errors [6], SIC-MRC was able to retain its advantages over MF-MRC in MC CDMA.

A weighted LPIC (WLPIC) scheme was proposed for a MC DS-CDMA system, where the MAI estimates on individual subcarriers were scaled by weights before cancellation. [7]. Though this method can eliminate the multiuser interference by choosing the weights, the low-level sub carriers tend to be multiplied by high value of weights, and the noise components were amplified at weaker sub carriers. This noise amplification effect degrades the BER performance. A soft tentative decision output on individual sub carriers was used for estimating and canceling the MAI by the Weighted LPIC scheme [7, 8]. The Weighted LPIC scheme performs significantly better than the MF detector and close to the decorrelating and MMSE detectors. The increase in the computational complexity with the increase in number of stages was a major drawback.

M. Frikel *et al*., [9] has proposed a hybrid interference cancellation (HIC) with MMSE equalization technique to suppress MUI and to increase the system capacity. HIC proposed by L. Nithyanandan *et al*., [10] resulted in a perfect trade-off between the computation time and receiver complexity as compared to SIC and PIC receivers. Target BER was decided by the type of service offered in the HIC scheme proposed in [11] and the SIR for the target BER was decided by the modulation process used. If the SIR of the user was greater than the SIR for target BER, then PIC was performed, else, SIC was performed. However, higher degree of dependence of the SIR for target BER on noise variance making SIR unstable was a predominant trouble for IC.

A new variant of PIC is proposed in this paper for enhancing the capability of interference cancellation and suppressing the excessive noise amplification. The proposed interference cancellation scheme cancels the interference on each sub carrier from the selected users whose instantaneous SIRs exceed a certain threshold. Hence proposed SWLPIC utilizes the advantages of PIC, but it is different from the conventional LPIC [12]. Also, the SIR for each sub carrier is determined and an expression for the optimum threshold is derived by optimizing the approximate expression for the SIR. The interference cancelled outputs on different sub carriers are then combined to form the final decision statistic. The proposed SWLPIC performs significantly better than MF detector and conventional LPIC and close to the WLPIC.

This paper is organized by furnishing an introduction to MUD and IC followed by the system model in section 2. The section 3 deals with Conventional IC and the proposed SWLPIC is discussed in section 4. The simulation results are analyzed in section 5 followed by the concluding remarks in section 6.

SYSTEM MODEL

An MC-CDMA system is considered with K users and M number of sub carriers. The transmitted signal is,

$$S(t) = \sum_{k=1}^{K} \sqrt{2A_k} \left\{ \sum_{j=-\infty}^{\infty} b_k^j a_k(t - jT - \tau_k) \sum_{m=1}^{M} \cos(\omega_m t + \theta_{k,m}) \right\} \quad (1)$$

where A_k is the transmitted energy-per-chip for the k^{th} user, b_k^j is the binary transmitted symbol, the signature waveform is $a_k(t) = \sum_{n=0}^{N-1} C_k^{(n)} h(t - nT_c)$, $C_k^{(n)}$ is the spreading sequence, N is the processing gain, $h(t)$ is the impulse response of the chip wave shaping filter, $\frac{1}{T_c}$ is the chip rate, $\frac{1}{T}$ is the symbol rate, $\{\tau_k\}$ and $\{\theta_{k,m}\}$ are independent random variables uniformly distributed over $\{0, T\}$ and $\{0, 2\pi\}$ respectively, ω_m is the m^{th} sub carrier frequency, and M is the number of subcarriers.

The channel is assumed to be a Rayleigh fading channel with transfer function $\zeta_{k,m} = \alpha_{k,m} \exp(j\beta_{k,m})$, where $\{\alpha_{k,m}\}$ and $\{\beta_{k,m}\}$ are respectively i.i.d Rayleigh random variables with a unit second moment and i.i.d uniform random variables over $\{0, 2\pi\}$. The received signal is:

$$r(t) = \sum_{k=1}^{K} \sqrt{2A_k} \left\{ \sum_{j=-\infty}^{\infty} b_k^j a_k(t - jT - \tau_k) \sum_{m=1}^{M} \alpha_{k,m} \cos(\omega_m t + \theta'_{k,m}) + n_\omega(t) \right\} \quad (2)$$

where $\theta'_{k,m} = \theta_{k,m} + \beta_{k,m}$ and $n_\omega(t)$ is the Additive White Gaussian Noise.

Assuming that the intercarrier interference is negligible, the K-length received signal vector $y^{(m)}$ of the m^{th} sub carrier at the output of the MF stage is given by:

$$y^{(m)} = C^{(m)} H^{(m)} b + n^{(m)} \quad (3)$$

where $C^{(m)}$ is the $K \times K$ cross-correlation matrix of the m^{th} sub carrier, given by:

$$C^{(m)} = \begin{bmatrix} 1 & \rho_{12}^{(m)} & \cdots & \rho_{1K}^{(m)} \\ \rho_{21}^{(m)} & 1 & \cdots & \rho_{2K}^{(m)} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{K1}^{(m)} & \rho_{K2}^{(m)} & \cdots & 1 \end{bmatrix} \quad (4)$$

where $\rho_{ij}^{(m)}$ is the correlation coefficient between the signature waveform's of the i^{th} and the j^{th} users of the m^{th} subcarrier. $H^{(m)}$ represents the $K \times K$ channel coefficient matrix, given by, $H^{(m)} = \mathrm{diag}\ \{h_1^{(m)}, h_2^{(m)}, \ldots h_K^{(m)}\}$. The K-length data vector b is given by, $b = [A_1 b_1, A_2 b_2 \ldots A_K b_K]^T$, where A_k denotes the transmit amplitude and $b_k \in \{+1, -1\}$ denotes the data bit of the k^{th} user, and $[.]^T$ denotes the transpose operator. The K-length noise vector $n^{(m)}$ is given by, $n^{(m)} = \left[(n_1^{(m)})^*, (n_2^{(m)})^*, \ldots (n_K^{(m)})\right]^H$, where $n_k^{(m)}$ denotes the additive noise component of the k^{th} user in the m^{th} sub carrier, which is assumed to be complex Gaussian with zero mean with $E\left[n_k^{(m)} (n_j^{(m)})^*\right] = 2\sigma^2$ when $j = k$ and $E\left[n_k^{(m)} (n_j^{(m)})^*\right] = 2\sigma^2 \rho_{kj}^{(m)}$ when $j \neq k$. Here, $[.]^H$ denotes the Hermitian operator and $(.)^*$ denotes the complex conjugate.

WEIGHTED LINEAR PARALLEL INTERFERENCE CANCELLATION

In WLPIC the MAI are estimated and cancelled based on the soft outputs of individual sub carriers. The MAI estimate of individual subcarriers is scaled by a weight before cancellation and is performed next to the MF stage. The *K*-length received signal vector is denoted as, $y^{(m)} = \left(y_1^{(m)}, y_2^{(m)}, ...y_K^{(m)}\right)^T$, where T denotes the transpose operator, and $y_k^{(m)}$ is the Matched Filter (MF) output of k^{th} users in the m^{th} sub carrier and is given by:

$$y_k^{(m)} = A_k^{(m)} h_k^{(m)} b_k^{(m)} + \sum_{\substack{j=1 \\ j\neq k}}^{K} \rho_{jk}^{(m)} A_j^{(m)} h_j^{(m)} b_j^{(m)} + n_k^{(m)} \quad (5)$$

where $\rho_{jk}^{(m)}$ is the cross-correlation between the j^{th} and k^{th} users' spreading waveforms, given by $\rho_{jk}^{(m)} = \int_0^T S_j^{(m)}(t) S_k^{(m)}(t)dt$. The desired user *k* is obtained by cancelling the interference of other users on the desired user at the m^{th} sub carrier. The interference cancelled output of the desired user *k* in the m^{th} sub carrier is given by:

$$Y_k^{(m)} = y_k^{(m)} - \sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk}^{m} \rho_{jk}^{m} y_j^{(m)}$$

$$= A_k b_k h_k^{(m)} (1 - \omega_{jk}^{m} \sum_{\substack{j=1 \\ j\neq k}}^{K} (\rho_{jk}^{m})^2) + I_k + N_k \quad (6)$$

where $I_k = \sum_{\substack{j=1 \\ j\neq k}}^{K} (1-\omega_{jk}^{m}) A_j b_j h_j^{(m)} \rho_{jk}^{(m)}$

$\sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk}^{(m)} \rho_{jk}^{(m)} \sum_{\substack{\ell=1 \\ \ell\neq j,k}}^{K} \rho_{\ell j}^{(m)} A_\ell b_\ell h_\ell^{(m)}$ and $N_k = n_k^{(m)} - \sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk}^{(m)} \rho_{jk}^{(m)} n_j^{(m)}$

The first term of equation (6) represents the interference cancelled output of the desired user *k* in the m^{th} sub carrier. Also I_k and N_k are the interference and noise terms respectively introduced in the WLPIC stage because of imperfect cancellation caused due to the soft output values from the previous MF stage. As a special case, the above weighted LPIC becomes conventional LPIC for $\omega_{jk}^{(m)} = 1$ and MF detector for $\omega_{jk}^{(m)} = 0$.

The MAI estimate of the j^{th} user causing interference on the desired user *k* in the m^{th} sub carrier is obtained by multiplying $y_j^{(m)}$ with ρ_{jk} for all $j\neq k$ and summing them up, where $y_j^{(m)}$ is the soft output of the j^{th} interfering user, and $\rho_{jk}^{(m)}$ is the correlation coefficient between the j^{th} user and k^{th} user of the m^{th} sub carrier. Also, the MAI estimate is scaled by a factor $\omega_{jk}^{(m)}$ before cancellation. Accordingly $\omega_{jk}^{(m)} \rho_{jk}^{(m)} y_j^{(m)}$ is the weighted MAI estimate of the m^{th} sub carrier for the desired user *k*. The channel coefficient 'h' and noise coefficient 'n' are assumed to be i.i.d complex Gausssian random variables with zero mean. The variances of interference and noise term can hence be obtained as follows.

$$\sigma_{N_{(m)}}^2 = E\left[N_{(m)} N_{(m)}^*\right]$$

$$= 2\sigma^2 \left(1 - 2\sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk}^{(m)} (\rho_{jk}^{(m)})^2 + \sum_{\substack{\ell=1 \\ \ell\neq k}}^{K} \omega_{\ell k}^{(m)} \rho_{\ell k}^{(m)} \sum_{\substack{j=1 \\ j\neq k,\ell}}^{K} \omega_{jk}^{(m)} \rho_{jk}^{(m)} \rho_{j\ell}^{(m)} \right) \quad (7)$$

where $N_{(m)}$ represent the noise term introduced due to imperfect cancellation in using the soft output values from the MF stage and $E\left[n_k^{(m)} (n_k^{(m)})^*\right] = 2\sigma^2 \rho_{kj}^{(m)}$ when $j\neq k$ and $2\sigma^2$ when $j=k$. To derive $\sigma_{I_{(m)}}^2$, the interference term can be rearranged in the form,

$$I_k^{(m)} = \sum_{\substack{\ell=1 \\ \ell\neq k}}^{K} A_\ell b_\ell h_\ell^{(m)} \left((1-\omega_{\ell k}^{(m)}) \rho_{\ell k}^{(m)} - \sum_{\substack{j=1 \\ j\neq k,\ell}}^{K} \omega_{jk}^{(m)} \rho_{jk}^{(m)} \rho_{j\ell}^{(m)} \right) \quad (8)$$

and hence $\sigma_{I_{(m)}}^2 = E\left[I_k^{(m)} (I_k^{(m)})^*\right]$ can be obtained as:

$$\sigma_{I_{(m)}}^2 = \sum_{\substack{\ell=1 \\ \ell\neq k}}^{K} 2A_\ell^2 \left((1-\omega_{\ell k}^{(m)}) \rho_{\ell k}^{(m)} - \sum_{\substack{j=1 \\ j\neq k,\ell}}^{K} \omega_{jk}^{(m)} \rho_{jk}^{(m)} \rho_{j\ell}^{(m)} \right)^2 \quad (9)$$

where $I_{(m)}$ represent the interference term introduced due to imperfect cancellation in using the soft output values from the MF stage. From eqn (6), (7) and (9) the average SIR of the m^{th} sub carrier can be written as:

$$SIR_k^{(m)} = \frac{\left[2A_k^2 (1 - \sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk}^{(m)} (\rho_{jk}^{(m)})^2 \right]^2}{\sigma_{I_{(m)}}^2 + \sigma_{N_{(m)}}^2} \quad (10)$$

The optimum value of $\omega_{jk}^{(m)}$ can be found by numerically maximizing the average SIR expression in Eqn.10 and equating it to zero. The interference cancellation is done on each sub carrier and the interference cancelled outputs of all the sub carriers are then combined.

$$Y_k = \sum_{m=1}^{M} y_k^{(m)} - \sum_{m=1}^{M} \sum_{\substack{j=1 \\ j\neq k}}^{K} \omega_{jk} \rho_{jk} y_j^{(m)} \quad (11)$$

SELECTIVE WEIGHTED LINEAR PARALLEL INTERFERENCE CANCELLATION

The poor reliability of the MAI estimates during the low value of SIR causes worse performance of the CLPIC than the MF detector. A novel way of applying

PIC on selective users whose instantaneous SIRs exceed a certain threshold on Rayleigh fading channels is proposed in this paper for improving the performance of CLPIC. The threshold is obtained by optimizing an approximate expression for the SIR on each sub carrier. For this, an expression for each sub carrier is derived for the average number of users, n_a, whose received SIR exceed a certain threshold, γ. The approximate SIR expression for each subcarrier is determined from the average number of users, n_a and the SIR expression is optimized to obtain the optimum threshold.

Let $\rho_{jk} = \rho, \forall j, k, j \neq k$ and the transmit amplitudes of all the users are same, i.e., $A_1 = A_2 = \ldots A_k = A$. Let the instantaneous SIR of the j^{th} user in the m^{th} sub carrier be denoted by $\beta_j^{(m)}$, given by $\beta_j^{(m)} = \frac{A^2 |h_j^{(m)}|^2}{\sigma^2}$.

The probability that the first n out of K-1 users (i.e., users other than the desired user k) of the m^{th} sub carrier's received SIRs cross the threshold γ is given by,

$$p = P\left(\beta_1 > \gamma, \ldots, \beta_n > \gamma, \beta_{n-1} < \gamma, \ldots, \beta_K < \gamma\right)$$

$$= \prod_{\substack{i=1 \\ i \neq k}}^{n} P(\beta_i > \gamma) \prod_{\substack{i=n+1 \\ i \neq k}}^{K} P(\beta_i < \gamma) \tag{12}$$

Since the random variables, $h_1^{(m)}, h_2^{(m)}, \ldots h_{k-1,}^{(m)} h_{k+1,}^{m} \ldots, h_K^{(m)}$ are independent and $|h_1|^2, \ldots, |h_{k-1}|^2, |h_{k+1}|^2, \ldots, |h_K|^2$ are i.i.d chi-square distributed, the above equation can be written as:

$$p = \left[\left(e^{-\frac{\gamma\sigma^2}{2A^2}} \right)^n \left(1 - e^{-\frac{\gamma\sigma^2}{2A^2}} \right)^{K-i-n} \right] \tag{13}$$

Let $b = e^{-\frac{\gamma\sigma^2}{2A^2}}$. Considering all possible combinations of K-1 users, the probability that the SIRs of n out of K-1 users of the m^{th} sub carrier cross the threshold γ is,

$$P(n; K\text{-}1) = \binom{K-1}{n} b^n (1-b)^{K-1-n} \tag{14}$$

The average number of users of the m^{th} sub carrier crossing the threshold is then given by:

$$n_a = \sum_{n=0}^{K-1} n p(n; K-1) = (K\text{-}1)\, b \tag{15}$$

These average numbers of users (n_a) that exceed the threshold are cancelled using the PIC. The output after interference cancellation is given by $y_k^{(m)} - \rho \sum_{\substack{j=1 \\ j \in Q}}^{K} y_j$, where Q denotes the set of the n_a users cancelled. The interference variance $\hat{\sigma}_{I_2}^2$ after IC is approximately, $\hat{\sigma}_{I_2}^2 = A^2 \rho^4 (n_a - 1)^2 n_a + A^2 (\rho - \rho^2 n_a)^2 (K - 1 - n_a)$, and the noise variance $\hat{\sigma}_{N_2}^2$ is given by $\hat{\sigma}_{N_2}^2 = \sigma^2 - \rho^2 n_a \sigma^2 + \rho^3 \sigma^2 n_a (n_a - 1)$. An approximate expression for the average SIR after interference cancellation is given by:

$$\mathrm{SIR} = \frac{A^2 (1 - n_a \rho^2)^2}{\hat{\sigma}_{I_2}^2 + \hat{\sigma}_{N_2}^2} \tag{16}$$

The optimum value of n_a, n_a^{opt}, is obtained by differentiating the above equation with respect to n_a and equating to zero, i.e.,

$$n_a^{opt} = \frac{A^2 - \sigma^2(1-\rho) + 2\rho A^2 (K-1) - \rho^2 A^2 (2K-1)}{\rho^4 A^2 - 2\rho^3 A^2 (K-1) + \rho^2 A^2 (2K-1) + 4\rho A^2 - \sigma^2(\rho^3 + \rho^2 - 2\rho)} \tag{17}$$

The optimum value of γ can be found by substituting the value of n_a^{opt} in equation (15)

$$n_a = (K\text{-}1)\, e^{-\frac{\gamma\sigma^2}{2A^2}}$$

$$\log n_a = \log (K\text{-}1) + \log e^{-\frac{\gamma\sigma^2}{2A^2}} \tag{18}$$

$$\log n_a = \log (K\text{-}1) - \frac{\gamma\sigma^2}{2A^2}$$

$$\frac{\gamma\sigma^2}{2A^2} = \log\left(\frac{A^2 - \sigma^2(1-\rho) + 2\rho A^2 (K-1) - \rho^2 A^2 (2K-1)}{\rho^4 A^2 - 2\rho^3 A^2 (K-1) + \rho^2 A^2 (2K-1) + 4\rho A^2 - \sigma^2(\rho^3 + \rho^2 - 2\rho)} \right) - \log(K\text{-}1)$$

$$\gamma = \left[\log\left(\frac{A^2 - \sigma^2(1-\rho) + 2\rho A^2 (K-1) - \rho^2 A^2 (2K-1)}{\rho^4 A^2 - 2\rho^3 A^2 (K-1) + \rho^2 A^2 (2K-1) + 4\rho A^2 - \sigma^2(\rho^3 + \rho^2 - 2\rho)} \right) - \log (K\text{-}1) \right] \times \frac{2A^2}{\sigma^2} \tag{19}$$

The same analysis holds good for each sub carrier. The interference of the users exceeding the threshold is cancelled in each sub carrier and the resulting outputs are coherently combined. Accordingly the bit decision for the k^{th} user after interference cancellation is given by:

$$\hat{b}_k = \mathrm{sgn}\left(\mathrm{Re}\left(\sum_{m=1}^{M} (h_k^m)^* \right) y_{k_2}^m \right) \tag{20}$$

RESULTS AND DISCUSSIONS

The BER performance analysis of the proposed SWLPIC is presented in this section. Ten users (N_u = 10) with a processing gain of 63 is considered for this analysis. Orthogonal Gold Code is used as the spreading sequences on each sub carrier and the system is studied for three

VOL. 7, NO. 4, APRIL 2012 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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different sub carriers (M = 2, 4 and 8, respectively). Different number of bits processed (N_{sym}) during this study are 1000 and 3000 respectively. BPSK modulation is used for all users and the total power transmitted is assumed to be same irrespective of the number of sub carriers used. The Rayleigh fading channel with AWGN is used. The γ that maximizes the output SIR in eqn. (19) is chosen as the optimum threshold for the proposed scheme.

The BER performance of the proposed SWLPIC is compared with the MF detector, CLPIC and WLPIC. The WLPIC for N_{sym} = 1000 with 2 and 4 sub carriers are shown in Figure-1 and Figure-2, respectively. As the IC is done on each sub carrier from only those users whose instantaneous SIRs exceed certain threshold, the BER performance of the proposed SWLPIC is better than the MF detector and CLPIC. The performance of SWLPIC is closer to WLPIC at lower values of SIR and the performance deteriorates at higher values of SIR. The BER performance of WLPIC outperforms over other detectors considered for comparison for 2 and 4 sub carriers. Also as seen in Figure-1, Figure-2, and Figure-3, increasing the number of sub carriers reduces the BER performance.

The BER performance of the proposed SWLPIC with 10 users, 8 sub carriers and N_{sym} = 1000 is shown in Figure-3. As the MAI estimates become quite inaccurate for lower SIR values under poor channel conditions, the CLPIC performs worse than the MF detector. However CLPIC performs better than MF detector at higher SIR. The BER performance of the proposed SWLPIC approaches the WLPIC technique for the higher number of sub carriers (i.e., M = 8). In this case, the proposed SWLPIC has a BER of 10^{-4} at 10dB and outperforms over other techniques considered for this study. This is because, the users with possibly very inaccurate MAI estimates i.e., the users identified by their instantaneous SIR falling below the optimum threshold are not cancelled in the proposed SWLPIC. Also the MF detector and the conventional LPIC can be viewed as special cases corresponding to $\gamma = \infty$ (none of the users are cancelled) and γ = 0 (all the users are cancelled) respectively, whereas the proposed SWLPIC uses the optimum γ which maximizes the output SIR and hence performs better than both the MF and the conventional LPIC.

Figure-4 shows the BER performance comparison of the proposed SWLPIC with the MF detector, CLPIC and WLPIC for 8 sub carriers. The number of bits (N_{sym}) processed is 3000. As observed from the graph, the smoothness of the curve increases with the increase in symbol rate.

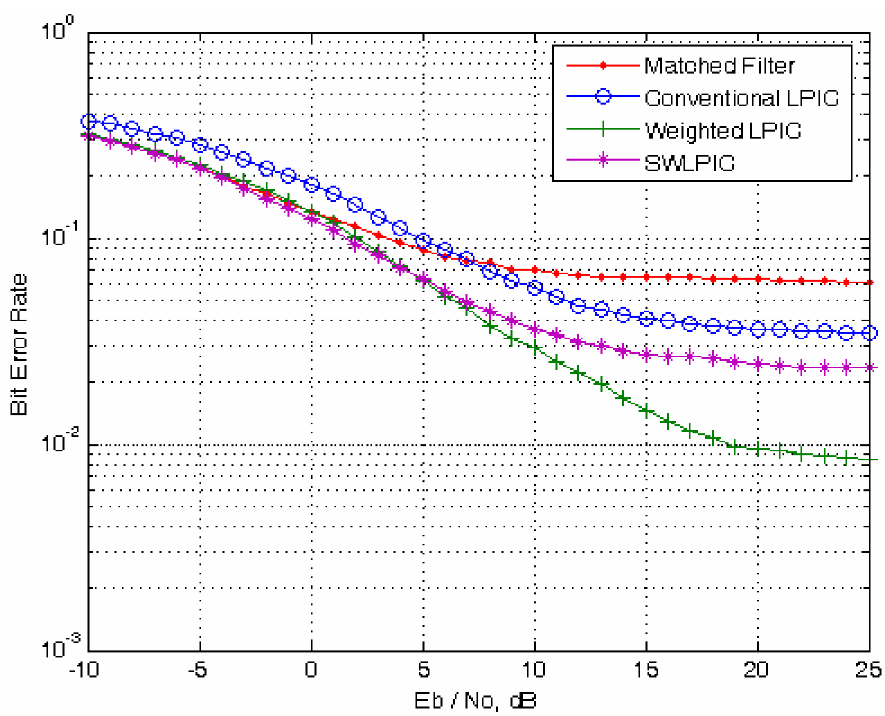

Figure-1. BER versus SNR performance of SWLPIC, conventional LPIC, weighted LPIC and MF detector for MC-CDMA system with N_{sym} = 1000, N_u =10 and M = 2.

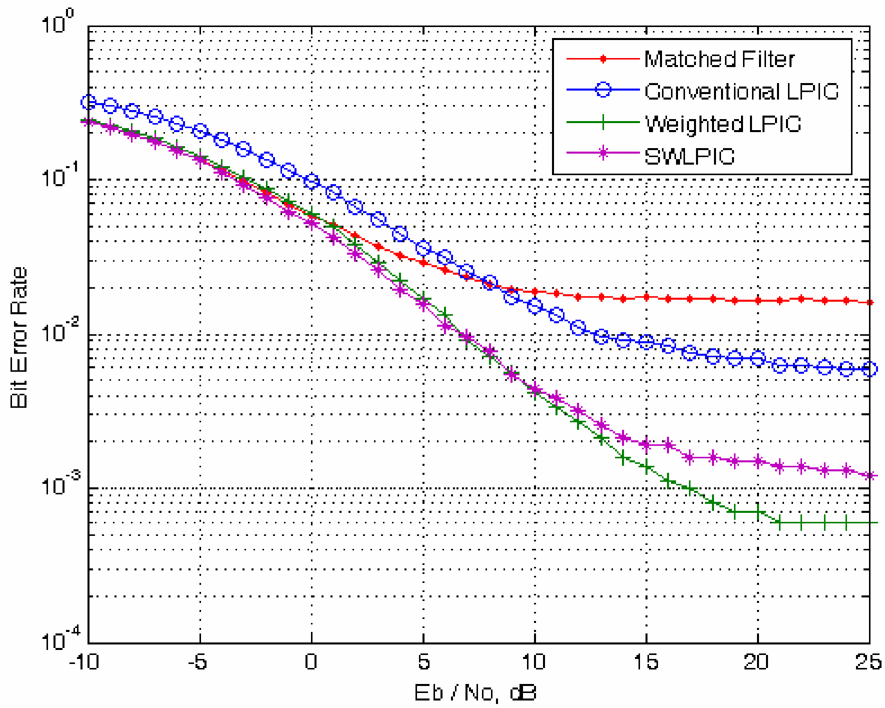

Figure-2. BER versus SNR performance of SWLPIC, conventional LPIC, weighted LPIC and MF detector for MC-CDMA system with N_{sym} = 1000, N_u =10 and M = 4.

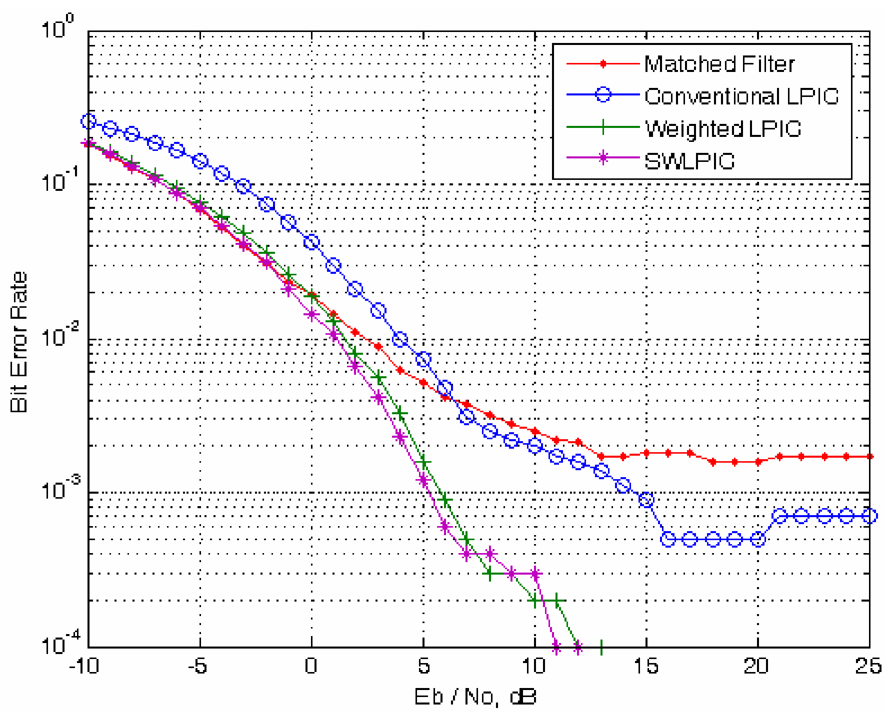

Figure-3. BER versus SNR performance of SWLPIC, conventional LPIC, Weighted LPIC and MF detector for MC-CDMA system with N_{sym} = 1000, N_u =10 and M = 8.

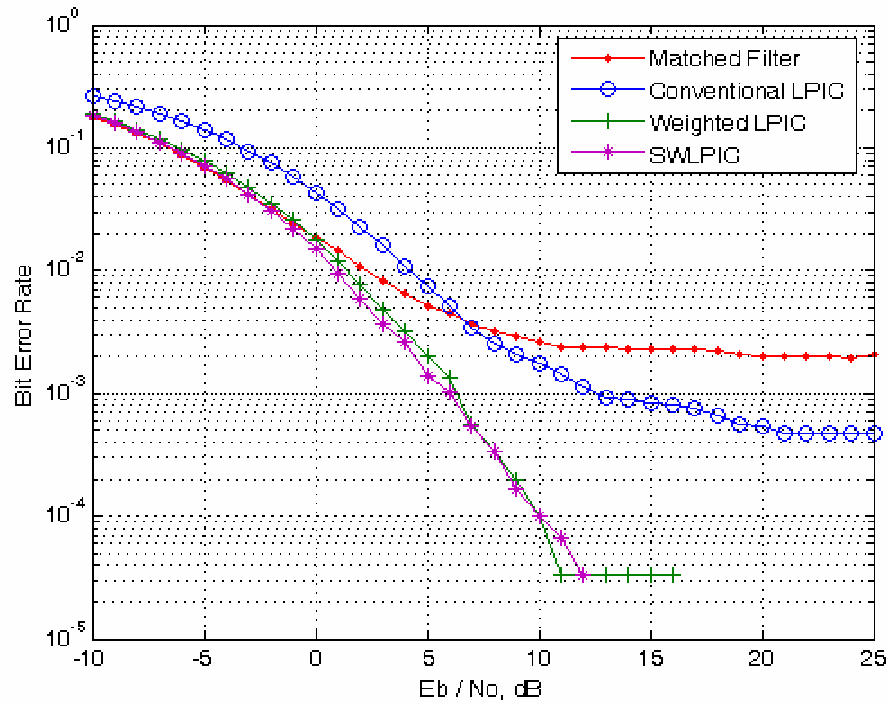

Figure-4. BER versus SNR performance of SWLPIC, conventional LPIC, weighted LPIC and MF detector for MC-CDMA system with N_{sym} = 3000, N_u =10 and M = 8.

CONCLUSIONS

The proposed SWLPIC scheme is proved to perform better than the matched filter (MF) detector, CLPIC scheme and WLPIC scheme by performing IC selectively on each subcarrier from only those users whose instantaneous SIRs exceed certain threshold on Rayleigh fading channels. The Signal to Interference ratio for each subcarrier was determined and the expression for optimum threshold was derived by optimizing an approximate expression for the SIR. The interference cancelled outputs on different subcarriers were then combined to form the final decision statistic.

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