SIR-optimized Linear Parallel Interference Cancellers on Rayleigh Fading Channels

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***Abstract*— In this paper, we propose an optimum Group LPIC (linear parallel interference cancellation) scheme, where the set of interfering users to cancel in a given cancellation stage is so chosen to maximize the signal-to-interference ratio (SIR) at the interference cancelled output of that stage. We derive a closed-form expression for the SIR at the interference cancelled output on Rayleigh fading channels, which we maximize to obtain the *optimum set* of users to cancel. We also propose a simpler SIR-optimized Group LPIC scheme where the interfering users are ordered based on their SIRs and the strongest (in terms of SIR) among them are cancelled; the number of such strongest users to cancel is determined by optimizing the corresponding SIR expression. We show that the proposed SIR-optimized Group LPIC schemes perform better than the conventional LPIC scheme (where *all* the interfering users are cancelled) as well as the matched filter (MF) detector (where *none* of the interfering users are cancelled), under near-far as well as non-near-far scenarios. We also compare the performance of the proposed Group LPIC schemes with a Weighted LPIC scheme.**

Keywords – *Parallel interference cancellation (PIC), linear PIC, signal-to-interference ratio (SIR), Rayleigh fading.*

I. INTRODUCTION

Parallel interference cancellation (PIC) is a multiuser detection technique where a desired user's decision statistic is obtained by subtracting an estimate of the multiple access interference (MAI) from the received signal [1],[2]. PIC lends itself to a multistage implementation where the decision statistics of the users from the previous stage are used to estimate and cancel the MAI in the current stage, and a final decision statistic is obtained at the last stage. When an estimate of the MAI is obtained from the hard bit decisions from the previous stage, it is termed as 'hard-decision PIC' (or non-linear PIC). The multistage PIC scheme originally proposed by Varanasi and Aazhang in [3] and several other schemes considered in the literature (e.g., [4]) are of this type. On the other hand, MAI estimates can be obtained using the soft values of the decision statistics from the previous stage, in which case the PIC is termed as 'linear PIC' (LPIC) [5],[6]. LPICs have the advantages of implementation simplicity, analytical tractability, and good performance under certain conditions.

In a conventional LPIC scheme, the interference from *all* other users are estimated and cancelled. In a matched filter (MF) detector, on the other hand, *none* of the other users are cancelled. In PIC schemes, it is likely that the MAI estimates are inaccurate due to poor channel conditions (e.g., high interference, low SNRs, etc.). Under such conditions, the cancellation can become ineffective to an extent that it may be better not to do cancellation. In fact, it has been known that the conventional LPIC scheme performs worse than the MF detector (where no cancellation is done) at low SNRs [7]. This is due to the poor accuracy of the MAI estimates at low SNRs. One way to alleviate this problem is to unequally weigh the MAI estimates of the different users in different stages before cancellation. We call such a scheme as *Weighted LPIC* (WLPIC). A key question in WLPIC is how to choose the weights for different users and for different cancellation stages. An intuitive approach is to keep the weights low at the early stages and large at the later stages, as done in [7]. The reasoning is that the MAI estimates can be more reliable in the later stages since much of the interference would have been cancelled by then and better accuracy of the MAI estimate can result. We, in [8],[9], adopted a more formal approach where we obtained optimum weights that maximized the SIR at the output of the canceller. WLPIC schemes have been shown to perform better than the conventional LPIC and the MF detector [7],[8].

In this paper, we propose and analyze another technique, viz., *optimum group cancellation*, to improve the performance of LPICs. Instead of canceling *all* (as in conventional LPIC) or *none* (as in MF detector), in the proposed Group LPIC (GLPIC) scheme the other users to cancel are chosen optimally. Specifically, we propose to choose the set of users to cancel so as to maximize the signal-to-interference ratio (SIR) at the interference cancelled output. To do that, we derive a closed-form expression for the SIR at the interference cancelled output of the group canceler on Rayleigh fading channels, which we optimize to obtain the *optimum set* of users to cancel. We also propose a simpler GLPIC scheme where the interfering users are ordered based on their SIRs and the strongest (in terms of SIR) among them are cancelled; the number of such strongest users to cancel is determined by optimizing the corresponding SIR expression. We show that the proposed GLPIC schemes perform better than the conventional LPIC as well as the MF detector, under near-far as well as non-near-far scenarios. We also compare the performance of the proposed GLPIC schemes with the WLPIC scheme.

The rest of the paper is organized as follows. In Sec. II, we present the system model. Sec. III presents the proposed Group LPIC schemes and the BER analysis. Sec. IV presents the Weighted LPIC scheme. BER results and discussions are presented in Sec. V. Conclusions are given in Sec. VI.

II. SYSTEM MODEL

Consider a K-user synchronous CDMA system where the received signal is given by

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$$y(t) = \sum_{k=1}^{K} A_k h_k b_k s_k(t) + n(t), \qquad t \in [0,T], \quad (1)$$

where $b_k \in \{+1,-1\}$ is the bit transmitted by the kth user, T is one bit duration, A_k is the transmit amplitude of the kth user's signal, h_k is the complex channel fade coefficient corresponding to the kth user, $s_k(t)$ is the unit energy spreading waveform of the kth user defined in the interval $[0,T]$, i.e., $\int_0^T s_k^2(t)dt = 1$, and $n(t)$ is the white Gaussian noise with zero mean and variance σ^2. The fade coefficients h_k's are assumed to be i.i.d complex Gaussian r.v's (i.e., fade amplitudes are Rayleigh distributed) with zero mean and $E[h_I^2] = E[h_Q^2] = 1$, where h_{kI} and h_{kQ} are the real and imaginary parts of h_k. The channel fade is assumed to remain constant over one bit interval.

We consider a two-stage LPIC at the receiver. The first stage is a MF detector, which is a bank of K correlators, each matched to a different user's spreading waveform. The received vector $\mathbf{y}^{(1)}$ at the output of the MF stage (the superscript (1) in $\mathbf{y}^{(1)}$ denotes the first stage) is given by

$$\mathbf{y}^{(1)} = \left[y_1^{(1)}, y_2^{(1)}, \cdots, y_K^{(1)} \right], \quad (2)$$

where $y_k^{(1)}$ is the kth user MF output, given by

$$y_k^{(1)} = A_k h_k b_k + \sum_{j=1,\, j\neq k}^{K} \rho_{jk} A_j h_j b_j + n_k, \quad (3)$$

where ρ_{jk} is the cross-correlation between the jth and kth users' spreading waveforms, given by $\rho_{jk} = \int_0^T s_j(t) s_k(t) dt$, and n_k's are complex Gaussian with zero mean and $E[n_j n_k^*] = 2\sigma^2$ when $j = k$ and $E[n_j n_k^*] = 2\sigma^2 \rho_{jk}$ when $j \neq k$. The received vector $\mathbf{y}^{(1)}$ (without hard decision) is used for MAI estimation and cancellation in the second stage.

III. SIR-Optimized Group LPIC

In the proposed Group LPIC scheme, only some selected users are cancelled while others are not. Let kth user be the desired user. Let $S^{(k)}$ denote the set of other users who are cancelled from the desired user's 1st stage output, and let $\overline{S}^{(k)}$ denote the set of other users who are not cancelled. The MAI estimate for the desired user k in the 2nd stage is obtained by multiplying $y_j^{(1)}$ with ρ_{jk} for all $j \in S^{(k)}$, and summing them up, i.e., $\sum_{j \in S^{(k)}} \rho_{jk} y_j^{(1)}$ is the MAI estimate for the desired user k in the 2nd stage. Accordingly, the 2nd stage output of the desired user k, $y_k^{(2)}$, is given by

$$y_k^{(2)} \;=\; y_k^{(1)} - \sum_{j \in S^{(k)}} \rho_{jk}\, y_j^{(1)}. \quad (4)$$

The bit decision for the desired user k after group cancellation in the 2nd stage is then given by

$$\widehat{b}_k^{(2)} \;=\; \mathrm{sgn}\left(Re\left(h_k^* y_k^{(2)} \right) \right). \quad (5)$$

A key question in the above GLPIC scheme is how to choose the set $S^{(k)}$. We propose to choose $S^{(k)}$ optimally in the sense that the desired user's SIR at the 2nd stage output is maximized. To carry out such an optimization, an expression for the desired user's SIR at the interference cancelled output is needed. To that end, in the following, we obtain an exact expression for the desired user's SIR at the 2nd stage output.

A. SIR at the 2nd Stage Output

The interference cancelled output of the 2nd stage for the desired user k can be written as

$$y_k^{(2)} \;=\; A_k h_k b_k \left(1 - \sum_{j \in S^{(k)}} \rho_{jk}^2 \right) + I_{2g} + N_{2g}, \quad (6)$$

where

$$I_{2g} = \sum_{j \in \overline{S}^{(k)}} A_j h_j b_j \rho_{jk} \; - \sum_{j \neq k} A_j h_j b_j \sum_{\substack{i \neq j \\ i \in S^{(k)}}} \rho_{ij} \rho_{ik}, \quad (7)$$

and

$$N_{2g} \;=\; n_k - \sum_{j \in S^{(k)}} \rho_{jk} n_j. \quad (8)$$

The terms I_{2g} and N_{2g} in (6) represent the interference and noise terms introduced due to imperfect cancellation in using the soft output values from the MF stage. Since h's are complex Gaussian, both I_{2g} and N_{2g} are linear combinations of Gaussian r.v's with zero mean. The variance of I_{2g}, $\sigma_{I_{2g}}^2$, can be obtained as

$$\sigma_{I_{2g}}^2 \;=\; \sum_{j \in \overline{S}^{(k)}} A_j^2 \left(\rho_{jk} - \sum_{\substack{i \neq j \\ i \in S^{(k)}}} \rho_{ij} \rho_{ik} \right)^2 + \sum_{j \in S^{(k)}} A_j^2 \left(\sum_{\substack{i \neq j \\ i \in S^{(k)}}} \rho_{ij} \rho_{ik} \right)^2, \quad (9)$$

and the variance of N_{2g}, $\sigma_{N_{2g}}^2$, can be obtained as

$$\sigma_{N_{2g}}^2 = \sigma^2 \left(1 - 2 \sum_{j \in S^{(k)}}^{K} \rho_{jk}^2 + \sum_{j \in S^{(k)}} \rho_{jk} \sum_{i \in S^{(k)}} \rho_{ik} \rho_{ij} \right). \quad (10)$$

The average SIR of the desired user k at the output of the 2nd stage, $\overline{SIR}_k^{(2)}$, is then given by

$$\overline{SIR}_k^{(2)} = \frac{A_k^2 \left(1 - \sum_{j \in S^{(k)}} \rho_{jk}^2 \right)^2}{\sigma_{I_{2g}}^2 + \sigma_{N_{2g}}^2}. \quad (11)$$

The optimum set of users to cancel $S_{opt}^{(k)}$ can be found by numerically maximizing the output SIR in (11) over all possible sets of users, where the number of possible sets is $(K-1)!$. We refer to this scheme where $S_{opt}^{(k)}$ is chosen over all possible sets of other users as GLPIC Scheme-I (GLPIC-I). It is noted that both the conventional LPIC and the MF detector become special cases of the GLPIC scheme for $S^{(k)} = \{\text{all}\, j, j \neq k\}$ and $S^{(k)} = \phi$, respectively.

The probability of bit error of the desired user k at the output of the 2nd stage can be obtained in terms of the optimized SIR as

$$P_k^{(2)} = \frac{1}{2}\left(1 - \sqrt{\frac{\overline{SIR}_{k,opt}^{(2)}}{1+\overline{SIR}_{k,opt}^{(2)}}}\right). \quad (12)$$

where $\overline{SIR}_{k,opt}^{(2)}$ is the output SIR when the optimum set of other users $S_{opt}^{(k)}$ are cancelled.

It is noted that the time complexity of the optimization in GLPIC Scheme I is high for large K. So we propose a simpler, alternate SIR-optimized GLPIC scheme which orders the other users based on their SIRs and chooses some strong users among them. We refer to this scheme as GLPIC Scheme-II (GLPIC-II) which is described in the following subsection.

B. SIR-based Ordering of Other Users

We order the other users in the decreasing order of their SIRs. Let $s_{[1]}^{(k)}, s_{[2]}^{(k)}, \cdots, s_{[K-1]}^{(k)}$ denote the ordered list of other users interfering with desired user k, where the square bracket indices in the subscript are such that [1] represents the strongest other user, [2] represents the second strongest other user, and so on. In GLPIC Scheme-II, we choose and cancel $\mathcal{N}$ top users in the above ordered list, i.e.,

$$S^{(k)} = \left\{s_{[1]}^{(k)}, s_{[2]}^{(k)}, \cdots, s_{[\mathcal{N}]}^{(k)}\right\}. \quad (13)$$

The question here is what is the optimum value of $\mathcal{N}$. We obtain the optimum value $\mathcal{N}_{opt}$ by numerically maximizing the average SIR expression in (11) with $S^{(k)}$ in (13). For the special case of $A_i = A$, $i = 1, 2, \cdots, K$ and $\rho_{ij} = \rho$, $\forall\, i, j$, a closed-form expression for $\mathcal{N}_{opt}$ can obtained, by differentiating (11) w.r.to $\mathcal{N}$ and equating to zero, as

$$\mathcal{N}_{opt} = \frac{U_1(K,\rho,\sigma)}{U_2(K,\rho,\sigma)}, \quad (14)$$

where $U_1(K,\rho,\sigma) = A^2 - \sigma^2(1-\rho) + 2\rho A^2(K-1) - \rho^2 A^2(2K-1)$, and $U_2(K,\rho,\sigma) = \rho^4 A^2 - 2\rho^3 A^2(K-1) + \rho^2 A^2(2K-7) + 4\rho A^2 - \sigma^2(\rho^3+\rho^2-2\rho)$.

In Fig.1, we plot the average SIR in (11) as a function of $\mathcal{N}$ in GLPIC Scheme-II for $\rho = 0.02$ and 0.03, $K = 45$, and SNR = $A^2/\sigma^2 = 20$ dB. It is noted that $\mathcal{N} = 0$ and $\mathcal{N} = (K-1) = 44$ correspond to the MF detector and the conventional LPIC, respectively. It can be observed that for $\rho = 0.03$, the maximum SIR is achieved when 18 strongest other users are cancelled, i.e., $\mathcal{N}_{opt} = 18$. Likewise, $\mathcal{N}_{opt} = 24$ for $\rho = 0.02$. It can be further noted that when ρ is high ($\rho = 0.03$), the conventional LPIC ($\mathcal{N} = K-1$) performs worse than the MF detector ($\mathcal{N} = 0$), i.e., conventional LPIC achieves lesser SIR than MF detector. This is because of the inaccurate MAI estimates under poor channel conditions (e.g., high interference–large ρ, low SNR, etc.). On the other hand, when $\rho = 0.02$ (less interference), the conventional LPIC performs better than the MF detector (larger SIR for $\mathcal{N} = K-1$ than for $\mathcal{N} = 0$). As the number of other users

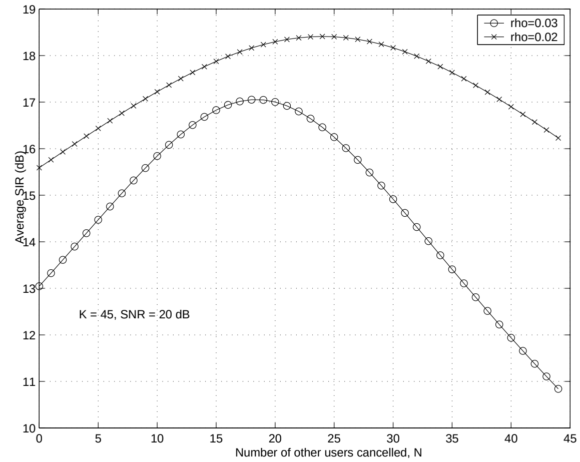

Fig. 1. Average SIR at the 2nd stage output as a function of the number of other users cancelled, $\mathcal{N}$, in GLPIC Scheme-II for $\rho = 0.02$ and 0.03. $K = 45$. SNR = 20 dB.

to cancel is chosen optimally in the proposed GLPIC scheme, it provides the best possible SIR which is significantly better than those of the conventional LPIC and the MF detector.

IV. SIR-OPTIMIZED WEIGHTED LPIC

In this section, we present a Weighted LPIC scheme the estimate of the MAI from the jth interfering user to the desired user k in stage m is weighed by a reliability factor $p_{jk}^{(m)}$ before cancellation. In other words, $\sum_{j\neq k} p_{jk}^{(m)} \rho_{jk} y_j^{(m-1)}$ is the weighted MAI estimate for the desired user k in stage m. That is, the mth stage output of the desired user k, $y_k^{(m)}$, is given by

$$y_k^{(m)} = y_k^{(1)} - \sum_{j=1,\, j\neq k}^{K} p_{jk}^{(m)} \rho_{jk} y_j^{(m-1)}. \quad (15)$$

The bit decision for the desired user k after weighted interference cancellation in stage m is then given by

$$\widehat{b}_k^{(m)} = \text{sgn}\left(Re\left(h_k^* y_k^{(m)}\right)\right). \quad (16)$$

We obtain exact expressions for the SIRs at the output of the different stages of the weighted LPIC, which are then optimized to obtain the optimum reliability factors.

The weighted interference cancelled output of the second stage for the desired user k is given by

$$y_k^{(2)} = A_k h_k b_k \left(1 - \sum_{j=1,\, j\neq k}^{K} p_{jk}^{(2)} \rho_{jk}^2\right) + I_{2w} + N_{2w}, \quad (17)$$

where

$$I_{2w} = \sum_{j=1,\, j\neq k}^{K} \left(1 - p_{jk}^{(2)}\right) A_j h_j b_j \rho_{jk} - \sum_{j=1,\, j\neq k}^{K} p_{jk}^{(2)} \rho_{jk} \sum_{\substack{i=1 \\ i\neq j,k}}^{K} \rho_{ij} A_i h_i b_i, \quad (18)$$

$$N_{2w} = n_k - \sum_{j=1,\, j\neq k}^{K} p_{jk}^{(2)} \rho_{jk} n_j. \quad (19)$$

Since h's are complex Gaussian, both I_{2w} and N_{2w} are linear combinations of Gaussian r.v's with zero mean. The variance of I_{2w}, $\sigma^2_{I_{2w}}$, can be obtained as

$$\sigma^2_{I_{2w}} = \sum_{i=1,\, i\neq k}^{K} A_i^2 \left(\left(1 - p_{ik}^{(2)}\right)\rho_{ik} - \sum_{\substack{j=1\\ j\neq k,i}}^{K} p_{jk}^{(2)} \rho_{jk}\rho_{ij} \right)^2, \quad (20)$$

and the variance of N_{2w}, $\sigma^2_{N_{2w}}$, can be obtained as

$$\sigma^2_{N_{2w}} = \sigma^2 \left(1 - 2\sum_{\substack{j=1\\ j\neq k}}^{K} p_{jk}^{(2)}\rho_{jk}^2 + \sum_{\substack{i=1\\ i\neq k}}^{K} p_{ik}^{(2)}\rho_{ik} \sum_{\substack{j=1\\ j\neq k}}^{K} p_{jk}^{(2)}\rho_{jk}\rho_{ji} \right). \quad (21)$$

The average SIR of the desired user k at the output of the second stage, $\overline{SIR}_k^{(2)}$, is then given by

$$\overline{SIR}_k^{(2)} = \frac{A_k^2 \left(1 - \sum_{\substack{j=1\\ j\neq k}}^{K} p_{jk}^{(2)}\rho_{jk}^2\right)^2}{\sigma^2_{I_{2w}} + \sigma^2_{N_{2w}}}. \quad (22)$$

The optimum values of $p_{jk}^{(2)}$, $j = 1, 2, \cdots, K$, $j \neq k$ can be found by numerically maximizing the SIR expression in (22).

It is noted that the time complexity of the numerical optimization of the SIR expression in (22) to obtain the optimum weights $p_{jk,opt}^{(2)}$ is large. A less complex optimization is possible if all other users' interference is weighed equally in a given stage (yet optimally in terms of maximizing the SIR - unlike conventional LPIC which uses unit weight to all interfering users in all stages), i.e., all other users' interference in stage m, $m > 1$, is weighed by the same weight $p_k^{(m)}$. Indeed, for this scheme we can obtain the optimum weights, $p_{k,opt}^{(m)}$, in closed-form, which we present in the following.

We consider a Weighted LPIC scheme where the estimates of the interference from all other users of the desired user k in stage m, $m > 1$, are weighed by the same reliability factor $p_k^{(m)}$. Replacing $p_{jk}^{(2)}$ with $p_k^{(2)}$ in (22) gives the SIR expression to optimize in the second stage for this scheme. A closed-form expression for the optimum reliability factor $p_{k,opt}^{(2)}$ can be obtained by differentiating (22) w.r.t. $p_k^{(2)}$ and equating to zero, as

$$p_{k,opt}^{(2)} = \frac{c_1(1-a_1) + e_1}{-a_1(c_1+e_1) + c_1 + d_1 + 2e_1 - \sigma^2(a_1^2 - f_1)}, \quad (23)$$

where

$$a_1 = \sum_{\substack{j=1\\ j\neq k}}^{K} \rho_{jk}^2, \quad c_1 = \sum_{\substack{l=1\\ l\neq k}}^{K} A_l^2 \rho_{lk}^2,$$

$$d_1 = \sum_{\substack{l=1\\ l\neq k}}^{K} A_l^2 \sum_{\substack{j=1\\ j\neq k,l}}^{K} \rho_{jk}\rho_{lj}, \quad f_1 = \sum_{\substack{j=1\\ j\neq k}}^{K} \rho_{jk} \sum_{\substack{i=1\\ i\neq k}}^{K} \rho_{ij}\rho_{ik},$$

$$e_1 = \sum_{\substack{l=1\\ l\neq k}}^{K} A_l^2 \rho_{lk} \sum_{\substack{j=1\\ j\neq k,l}}^{K} \rho_{jk}\rho_{lj}.$$

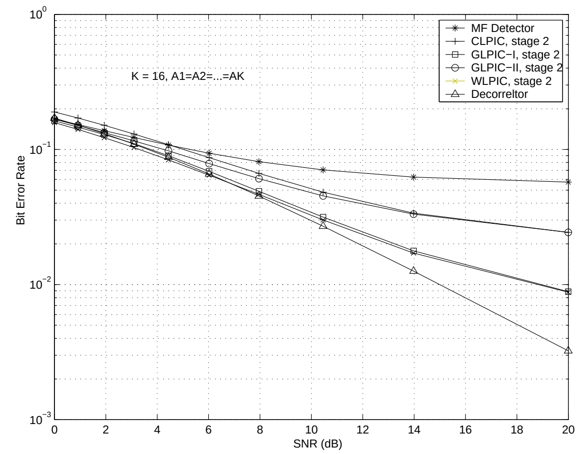

Fig. 2. BER versus SNR performance comparison of the various LPICs. $K = 16$ users. No near-far condition: $A_1 = A_2 = \cdots = A_K$.

The probability of bit error of the desired user k at the output of the 2nd stage can be obtained using (12) where $\overline{SIR}_{k,opt}^{(2)}$ is the output SIR when the optimum reliability factor $p_{k,opt}^{(2)}$ is used in (22).

Note: It can be noted that while in Weighted LPIC we cancel all other users and choose the optimum weights, in Group LPIC we fix the weights as unity and choose the optimum set of users to cancel.

V. Results and Discussion

In this section, we present the BER performance of the SIR-optimized LPIC schemes presented in the previous sections. In Fig. 2, we plot the BER as a function of SNR on Rayleigh fading channels for *a*) conventional LPIC, *b*) Group LPIC Scheme I, *c*) Group LPIC Scheme II, and *d*) Weighted LPIC, with $K = 16$ users under no near-far condition, i.e., $A_1 = A_2 = \cdots = A_K$. The performance of the MF detector and the decorrelating detector are also shown for comparison. User 1 is taken to be the desired user. The near-far ratio (NFR) A_j/A_1 is 0 dB. In all the numerical results presented in this section, we assign different random spreading sequences of processing gain 32 to different users, and the cross-correlation coefficients are computed for these random sequences. The BER plots for the LPICs are based on the analytical expression in (12) using the appropriate optimized SIR values. We have obtained the BER through simulations as well and found close match between analysis and simulation results (which is expected since the BER expression is exact and no approximation is involved).

From Fig. 2, the following observations can be made. The conventional LPIC performs better than the MF detector at high SNRs ($>$ 4.5 dB) whereas it performs worse than the MF detector at low SNRs ($<$ 4.5 dB). As pointed out earlier, this performance cross-over is due to inaccurate MAI estimates at low SNRs. The proposed Group LPIC Scheme I (where the optimum set of users to cancel is chosen over all possible sets) performs significantly better than both conventional LPIC and MF detector. Under this no near-far condition, GLPIC Scheme I performs very close to the Weighted

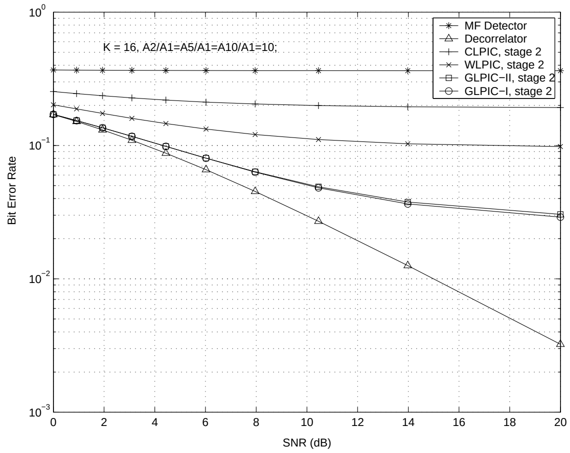

Fig. 3. BER versus SNR performance comparison of the various LPICs. $K = 16$ users. Near-far condition: $A_2/A_1 = A_5/A_1 = A_{10}/A_1 = 10$.

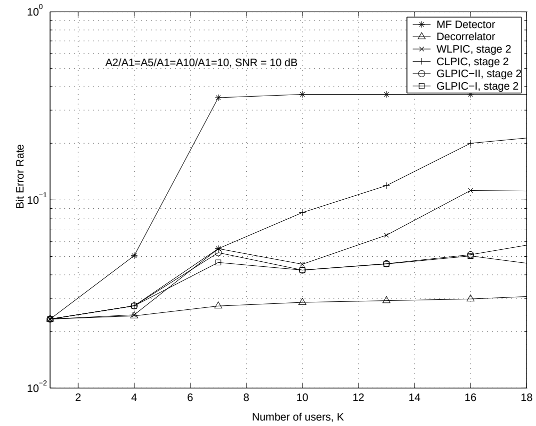

Fig. 4. BER versus number of users, K, performance of the various LPICs. Near-far condition: $A_2/A_1 = A_5/A_1 = A_{10}/A_1 = 10$. SNR = 10 dB.

LPIC scheme. The GLPIC Scheme II also performs better than the MF detector and the conventional LPIC. However, GLPIC Scheme II performs worse than the GLPIC Scheme-I under this no near-far condition. This is expected because GLPIC Scheme II chooses the set of users to cancel only from a subset of all possible sets of users, i.e., from an ordered list of users. In fact, at high SNRs, the performance of GLPIC Scheme II is the same as that of the conventional LPIC; this indicates that with equal power (NFR = 0 dB) high SNR users, the optimum thing to do in GLPIC Scheme II is to cancel all other users (i.e., $\mathcal{N}_{opt} = K - 1$). Under near-far conditions, however, GLPIC Scheme II performs significantly better than the conventional LPIC and close to GLPIC Scheme I, as will be seen next.

Fig. 3 shows the performance comparison as a function of SNR in a near-far scenario where users 2, 5 and 10 have 10 times more amplitude than the desired user 1 (i.e., $A_2/A_1 = A_5/A_1 = A_{10}/A_1 = 10$), and the remaining users have the same amplitude as the desired user 1. From Fig. 3, it can be observed that Weighted LPIC performs better than the conventional LPIC and the MF detector. Under this near-far scenario, both the proposed GLPIC Schemes I and II perform much better than the Weighted LPIC. It is interesting to note that both GLPIC Schemes I and II perform almost same; this implies that under near-far conditions, choosing the users to cancel from the SIR-ordered list (GLPIC Scheme II) is as good as choosing among all possible sets of other users (GLPIC Scheme I). Hence, GLPIC Scheme II, with its much less time complexity in the optimization compared to GLPIC Scheme I and better performance than Weighted LPIC, is advantageous under near-far conditions.

Fig. 4 shows the performance comparison as a function of the number of users K, in a near-far scenario (similar to that in Fig. 3) at an SNR of 10 dB. Here again, GLPIC Scheme II performs much better than Weighted LPIC, conventional LPIC and MF detector. In addition, it performs much close to the GLPIC Scheme I.

VI. CONCLUSION

We proposed an optimum Group LPIC scheme, where the set of interfering users to cancel in a given cancellation stage is so chosen to maximize the SIR at the interference cancelled output of that stage. We derived a closed-form expression for the SIR at the second stage output on Rayleigh fading channels, which we maximized to obtain the optimum set of users to cancel. We also proposed a simpler SIR-optimized Group LPIC scheme where the interfering users are ordered based on their SIRs and the strongest (in terms of SIR) among them are cancelled; the number of such strongest users to cancel was determined by optimizing the corresponding SIR expression. We showed that the proposed SIR-optimized Group LPIC schemes perform better than the conventional LPIC scheme as well as the MF detector under near-far as well as non-near-far scenarios. We also compared the performance of the proposed Group LPIC schemes with a Weighted LPIC scheme. The performance analysis of the proposed GLPIC schemes for the third and fourth stages of the LPIC can be carried out.

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