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Comparison of Various Techniques with PSO based Power Allocation Strategy in Cooperative Wireless Networks

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Abstract: Now a days, wireless communication using co-operative networks have attracted many attentions due to its suitability of working in different environments with acceptable performances. During the transmission, a major requirement of optimal power allocation strategy is observed and this is the major concern of many researchers. This power allocation technique requires a suitable optimization algorithm while selecting the power allocation factor for power assignment. In the paper various optimization strategies are compared with proposed particle swarm optimization technique. A cooperative communication frame work is used with amplify and forward as relaying technique. The proposed algorithm using the tech-nique is simulated and the comparison results are obtained. Simulation results when compared outperformed with other previous works.
Keywords: Cooperative networks; optimal power alloca-tion; Amplify and forward relaying; Particle Swarm Opti-mization (PSO).

I. INTRODUCTION

The proposed work in our paper [1] is considered where a cooperative communication framework has been used for transmission of signals and transmission of signals among various nodes i.e. source node, relay nodes and destination node using amplify and forward relaying technique. Thus, the signals are transmitted form source to destination via various relay nodes. The whole process of transmission can be viewed in two phases i.e. broadcast phase and relaying phase. Now, the concern is the allotment of power between these two phases by using a parameter called power alloca-tion factor under limited total power constraint. This power allocation factor 'r' has to be optimum and accordingly power going to be allotted. The r is used to obtain power to be allotted to transmitter as:

$$P_1 = P_i \;\; r \qquad (1)$$

$$P_2 = P_i \;\; P_1 \qquad (2)$$

In the above equations (1) and (2), P_1 and P_2 are the power allotted to broadcast and relaying phase respectively with P_i as total available power and r as power allocation factor. Now, if r = 1=2 the power allocation is termed as equal power allocation (EPA) and if $r = r_{optimum}$ then power allocation is termed as optimal power allocation (OPA).

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II. RELATED WORKS

The advancement in the cooperative communication and increased reliability in the wireless communication pave the way for many researches in the direction of power allocation, some of them are discussed below:

Gachhadar et al. [2] proposed a genetic algorithm (GA) scheme based power allocation method in A&F cooperative relay network. In this paper various issues related to power consumption, allocation of power and relay selection are considered in a single relay network with over Rayleigh fading channel. This paper focuses on modified GA based power allotment strategy with advantages of this search technique based on evolutionary algorithm inspired from techniques related with genetics i.e. crossover, mutation, inheritance, selection etc. This modified genetic algorithm is clustering based method which works on generation of population of the fittest chromosomes updated in every iteration. Thus, for power allocation the best results are considered as chromosomes, and it depends on the fitness function, according to which these are evaluated as good or bad chromosomes. Now on solving the fitness function the solution sets are obtained and are considered as new solution sets which are created by recombination of good chromosomes and solutions which pass the test of fitness will survive to the next generation, while bad chromosomes are not placed in the solution set. This process is continued generation by generation until an optimized solution or the termination condition is achieved.

Alexan et al. in [3] have done a comparative study on power assignment technique applied on various relaying pro-tocols which are amplify and forward (AF), adaptive decode and forward (ADF), LLR based symbol selective transmis-sion (LLRSST), SNR & LLR based hybrid forwarding. In this paper optimized power allotment is investigated under quality of service (QoS) constraints and various comparison has been performed among those relaying protocols. The performance improvement for every relaying protocols is studied and these are compared in [3]. This paper after analysis concluded that for minimizing end-to-end (e2e) BER and ultimately provide improved QoS.

Devipriya et al. in [4] proposed a Bacterial Foraging Optimization algorithm (BFOA) for optimization of power allocation which is a technique based on the behavior of Escherichia coli bacteria in human intestine whose behavior is foraging in nature. This technique used to solve an optimization problem for optimal power allocation in BER minimization has been taken as an objective function. The performance of this BFOA algorithm has been discussed in [4] and their simulation results obtained has been analyzed.

The main contribution of the paper are as follows:

1) Based on the proposed approach presented in our previous paper [1] i.e. PSO based power allocation technique in cooperative communication networks this paper compared the results with other techniques used for power allocation.
2) The numerical results of our paper [1] are compared with others' in terms of approximate values of SER obtained form the simulation results.

Rest of the paper is mentioned as follows: Section III shows a transmission model used for transmission; Section IV gives the overview of PSO algorithm; Section V analyzes the simulation results and their comparison; At last the paper concludes with future work and references in section VI and VII respectively.

III. TRANSMISSION MODEL

The transmission model considered in this paper is based on cooperative communication protocol with single and multi-relay network is shown in Fig. 1 and Fig. 2. The transmission takes place from source node S to destination node D via N number of relay nodes R_i; 8i = 1; 2:::::; N as illustrated in Figure 2.

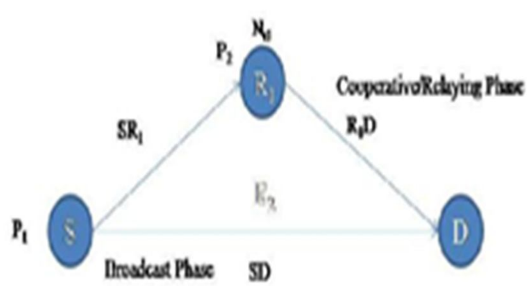

Fig. 1. The simplified wireless communication model with single relay cooperative mode.

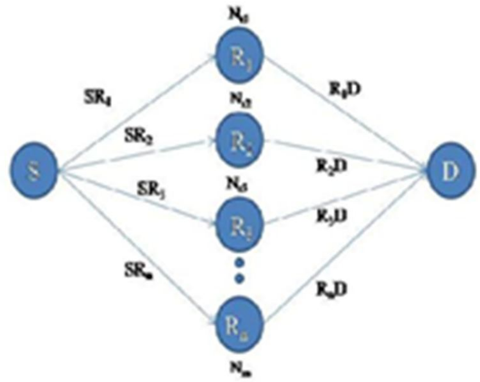

Fig. 2. The wireless communication system model with multi relay in cooperative mode.

In second phase i.e. relaying phase where AF relaying scheme is used so that relays amplify and forward the received data to the destination node using the power P_i. Optimal power allocation in cooperative system is the allo-cation of amount of power that should be given to source and relay nodes under limited available power constraint. It make the symbol error rate and outage probability to achieve optimal value.

The assumptions considered during transmission is as follows:

1) The transmission takes place in two phases i.e. broad-cast phase in which transmission from source to relays takes place and other is relaying phase in which relays forward data towards destination node.
2) BPSK modulation is used with Max-min relay selection technique. Each channel between any two nodes has independent and identically distributed (i.i.d.) channel parameters.
3) Finding the optimal source node power allocation factor 'r' by solving nonlinear multi-objective optimization problem PSO technique is used.

IV. OVERVIEW OF PSO ALGORITHM

In this section, Particle Swarm Optimization (PSO) based power allocation scheme is considered for transmit power reduction. Firstly, total power is equally divided to source and relays and thus referred as Equal power allocation (EPA) technique. Allocation of power using channel state informa-tion is denoted as optimal power allocation (OPA) technique. Optimum power allocation is required for lowering SER and improving Outage probability etc.

The algorithm considered in the paper is an optimiza-tion technique based on population search technique and is termed as PSO algorithm which has got the inspiration by the behavior of flocks of bird and fish schools. It is a computational technique used in nonlinear function for opti-mization. It provides fast convergence to optimum solution. In the work it is used as an optimization technique which solves for a number of possible solutions based on particle search and gives an optimum or best solution followed by number of iterations. At each iteration the values are updated and all the particles are moving towards optimal value. At the termination of iterations the last updated value is considered as best solution.

The Fig. 3 depicts the flowchart of PSO algorithm.

V. SIMULATION ANALYSIS AND COMPARISON

In our paper [1], the system model using BPSK modula-tion with AWGN and Rayleigh fading channel is considered and simulated in MATLAB software and the SER and outage performance using PSO power allocation is depicted by Fig. 4 and Fig. 5 respectively.

By using PSO algorithm, the SER is used as its fitness function for obtaining optimum solution. In this fitness function allocated powers are given in equation (1) and (2) where r is power allocation factor. Fig. 6 shows the convergence of PSO algorithm where its comparison has been done with equal power allocation technique (EPA) and their performances are tabulated in table I [1].

From the convergence plot shown in Fig. 6 and table I, it has been analyzed that the optimal point is obtained by using PSO is 0.5663. Then the factor r= 0:5663 which shows the amount of power allotted amongst the two phases. The power

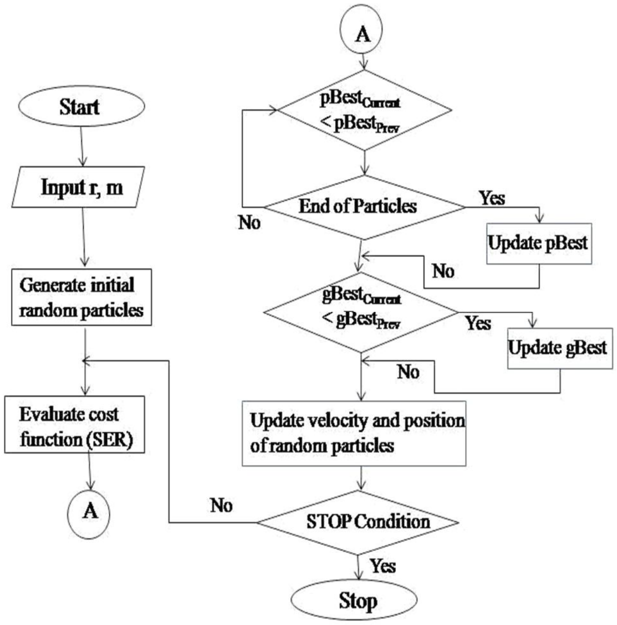

Fig. 3. Flowchart of PSO algorithm for minimizing SER.

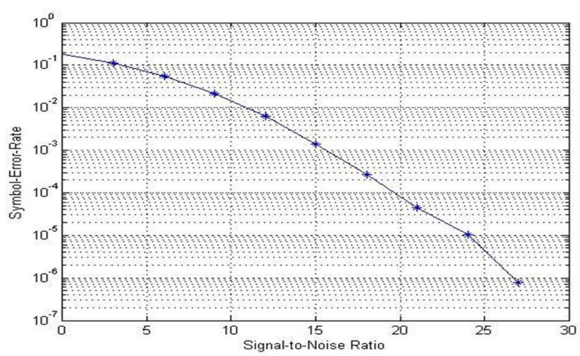

Fig. 4. Performance curves of OPA in terms of SER against SNR using PSO [1].

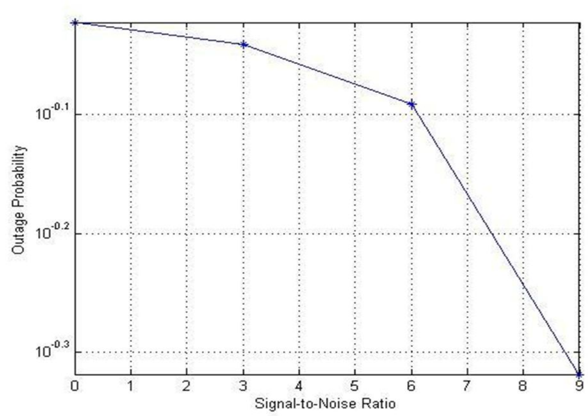

Fig. 5. Performance curves of OPA Outage Probability against SNR using PSO [1].

values is obtained as P_s = 0:5663P and P_r = 0:4337P . Now in table I and Fig 6 the system performance based on power allocation is compared between PSO based and equal power allocation and it has been observed that, the proposed PSO based allotment of power achieved better SER performance than equal power assignment at constant SNR with low complexity.

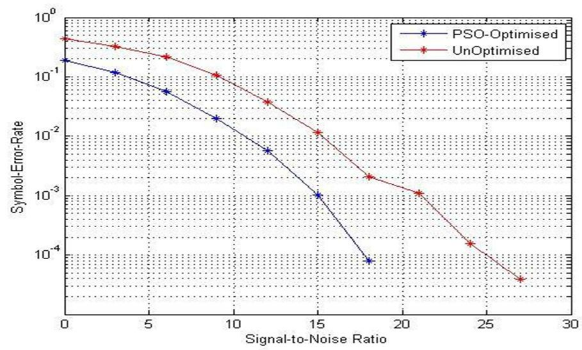

Fig. 6. Results obtained using equal and pso power allocation in AF relay models are compared

Table I
Performance Comparison Table of EPA AND OPA-PSO [1]

Power Allocation	EPA			PSO		
SNR	Outage	SER	Throughput (Bits)	Outage	SER	Throughput (Bits)
0dB	0.9600	0.2034	20393	0.9400	0.1749	21329
3dB	0.9200	0.1271	22345	0.9100	0.1085	22992
6dB	0.8300	0.0677	23868	0.8300	0.0520	24329
9dB	0.5800	0.0247	24968	0.4100	0.0198	25130
12dB	0	0.0093	25363	0	0.0059	25451
15dB	0	0.0023	25541	0	0.0010	25568
18dB	0	7:0313e 04	25582	0	3:9063e 05	25594
21dB	0	1:1719e 04	25597	0	0	25600
24dB	0	0	25600	0	0	25600
27dB	0	0	25600	0	0	25600
30dB	0	0	25600	0	0	25600

In table II a comparison has been presented among Mod-ified GA technique and ABeeC technique shown in Fig.3 of [2], where QPSK modulation has been used and its is compared with proposed PSO based PA technique in [1] with results obtained using this technique in QPSK modulation scheme shown in Fig. 7.

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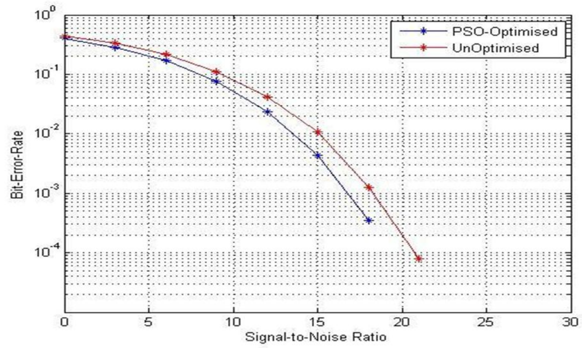

Fig. 7. Performance curves of OPA BER against SNR using PSO in QPSK modulation.

In table III the comparison of different power alloca-tion techniques are carried out and on comparing proposed PSO based power allocation technique with the technique presented in [3] i.e. hybrid LLR relaying protocol based power allocation technique for BPSK modulation, it can be

Table II
Performance Comparison Table of Various Techniques AND Proposed PSO WITH M=4

SNR	0dB	5dB	10dB	15dB	18dB	20dB
PA Type	SER	SER	SER	SER	SER	SER
Proposed PSO [1]	10 0:6	10 0:9	10 1:6	10 2:7	10 3:8	-
Modified GA [2]	10 0:5	10 0:5	10 0:9	10 2:6	10 3:8	10 4:9
ABeeC in [2]	10 0:5	10 0:5	10 0:8	10 2	10 3:7	10 4:5

observed that Fig. 6 in [3] is not yet converged at 20dB while in proposed PSO technique presented in this paper Fig. 6 the output converged at 18dB with SER around $10^{6:3}$. Also their detailed comparison is tabulated under table III.
From table III, it can be said that SER performance of proposed method gives comparable results with LLR relaying protocol based PA method in [3].

VI. CONCLUSION

In this paper, the wireless communication system using cooperative protocol for transmission is considered under amplify-and-forward protocol on Rayleigh fading channel. The results of our previous work [1] are taken in which technique for optimal power allotment based on PSO algo-rithm is considered for cooperation in a cooperative Wireless networks and compared with other recent techniques used for this. The simulation results of these are compared their analysis has been discussed. From the analysis of simulation results, it has been observed that the overall system perfor-mance improves and comparable in terms of lowered SER (symbol error rate) when PSO based power allocation is used.

VII. FUTURE WORK

The scope of future work is better analysis and comparison is present in this paper can be used for further related works.

Table III
SER Versus SNR Comparison for PSO and Hybrid LLR Based PA [3] WITH M=2

Power Allocation (PA)	5dB (SNR)	10dB (SNR)	15dB (SNR)	20dB (SNR)	25dB (SNR)	27dB (SNR)	30dB (SNR)
PSO PA (SER)	$10^{1:4}$	10^{2}	10^{3}	$10^{4:3}$	$10^{5:8}$	$10^{6:3}$	-
Hybrid-LLR [3] (SER)	2:04156 10^{3}	2:04156 10^{3}	1:97093 10^{4}	1:85586 10^{5}	1:75549 10^{6}	-	-
BFOA [4] (SER)	$10^{1:}$	$10^{1:7}$	$10^{2:2}$	10^{3}	$10^{3:9}$	$10^{4:6}$	10^{5}

This paper helps in selection of optimization algorithm for efficiency enhancement using a multi objective algorithm. Discussion present in this paper can be used for improvising the system performance and future innovations.

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