IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Optimization of Radio Resource Allocation In MIMO-OFDMA Systems Based On Different Optimal Algorithms

D.Preethi[*1] , M.Vadivel[2]

[*1] ETCE Dept, Sathyabama University, Chennai – 600119, India

[2]Assistant Professor , Sathyabama University, Chennai – 600119, India

Abstract

This paper addresses optimization of radio resource allocation for downlink MIMO-OFDMA (Multiple Input Multiple Output-Orthogonal Division Multiple Access) Systems. It has an objective of maximizing the total system capacity and proportional fairness. The proposed algorithm determines the shortest path of subcarrier to each user and then handing over subcarrier to each user. The optimization methods used for radio resource allocation are Ant Colony Optimization (ACO), Subcarrier Allocation (SA) and Genetic Algorithm (GA). Simulation results show that the proposed optimization algorithm provides better performance by increased channel capacity and better fairness among users.

Keywords: MIMO-OFDMA, SA,GA,ACO.

Introduction

In wireless communication systems the numbers of users are greater than that of the spectrum level so it is very necessary to give attention for effective way of allocating radio resources namely subcarrier and subchannels in fairly manner.

OFDMA allows multiple users to transmit simultaneously on different subcarrier per OFDMA symbol. For resource allocation, OFDMA divides the wireless radio resource spectrum into non-overlapping frequency-time chunks and offers more flexibility compared to TDMA and CDMA.In wireless technology, MIMO[1] can able to increase the system capacity of a given channel and also increases[3] spectral efficiency for a given transmit power.

For better improvement in channel capacity, the first optimization technique as Ant Colony Optimization (ACO) is used for finding shortest path for users and then other optimization methods such as Subcarrier Allocation (SA) [2] and Genetic Algorithm (GA) is applied for handing over subcarrier to each users.
Our objective is to maximize the total system capacity [4] [8] and care about fairness [10] among users.

System Model

The block diagram of MIMO-OFDMA downlink is shown Figure 1.

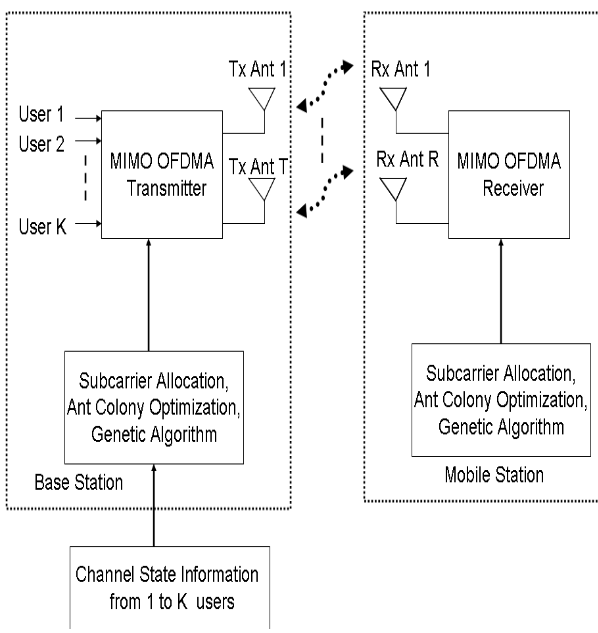

Fig1.System Model of MIMO-OFDMA downlink

It is assumed that perfect channel state information (CSI) is available at the base station transmitter and receiver. At the base station, the resource allocation [7] namely subcarrier [9] and subchannel scheme is applied to the MIMO-OFDMA transmitter.

This information is also sent via separate channel to the user. The user's data is transmitted via the MIMO channel from the base station and received by the

Mobile User. The user decodes the data with the help of subcarrier decoding out scheme received from the base station via a separate channel [5].

Here we assume that the total number of 'K' users in the system sharing 'N' subcarriers with total power P_{total}, Channel gain for user k in the subcarrier n is $h_{k,n}$ and BER constraint. Each user has 'R'receiving antennas, 'T' transmitting antennas at the base station. To meet the BER [6] constraints, the effective SNR has to be adjusted accordingly.

Proposed Algorithms

An Optimization can be done by following algorithms. First one is finding shortest path using Ant Colony Optimization (ACO) then Subcarrier Allocation (SA) and Genetic Algorithm (GA).

Optimization Based on ACO

Ant Colony Optimization is **(**ACO**)** is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. This is a main idea used for finding shortest path for the users.

ACO is a good solution for Travelling salesman Problem (TSP) rather than any method, this algorithm is inspired by observation of real ants. Idea used for resource allocation as;

- Number of ants-referred as number of subcarrier.
- Food or prey–referred as Frequency.
- Colony-referred as channel.

Here an artificial ant is placed randomly in each X channel and Y channel and, during each iteration the maximum iteration consider as 600, then it chooses the next sub carrier,

1. It must visit each subcarrier exactly once.
2. A distant has less chance of being chosen
3. The more intense the pheromone trail laid out on an edge between two carriers, the greater the probability that that edge will be chosen.
4. Journey path will be very shot, if the ant may deposits more pheromones on all edges it traveled.

To find the shortest path in for a different channel conditions, we can use Ant Colony Optimization and is given by the following expression

$$C_{trans} = \sqrt{X_{ch}(a) - X_{ch}(b)} + \sqrt{Y_{ch}(a) - Y_{ch}(b)}$$

Where

a,b-vectors of a given subcarrier

Optimization Based on SA

To reduce complexity, this scheme consists of two separate stages.

1. Determine the number of subcarriers that include both used and unused to be initially assigned to each user.
2. Assign the subcarriers to each user as determined in the step1. If any unused subcarriers, then assign to the users with the aim of enhancing total systemcapacity.
3. Reorganize subcarriers among users to ensure fairness.

To evaluate the fairness of the algorithm we define a parameter called Fairness Index (FI).

The Fairness Index (FI) is defined as,

$$FI = \frac{\sum_{k=1}^{K} \alpha_k^2}{K \sum_{k=1}^{K} \alpha_k^2}$$

Where

α_k - achieved proportional rate constraint for the k^{th} user respectively.

Optimization based on GA

Genetic algorithm (GA) is routinely used to generate solutions for optimization and search techniques. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), to generate useful solutions for optimization problem.

Genetic algorithms are acknowledged as good solvers for optimization problem in wireless technology. Genetic Algorithm (GA) uses three process as

1. **Elitism**: Find the highest fitness values for Rayleigh Channel modeling is considered as Elitism.
2. **Crossover**: Randomly obtain a crossover point for the parents. Vector Pairing is done for crossover process.
3. **Mutation**: Randomly pick a chromosome from the current generation. Generate mutation children chromosomes for the next generation.

Results and Discussions

The performance of proposed algorithm can be shown in the simulation results by using MATLAB 7.9.The simulation parameters used are Total number of user K=16, Total number of subcarriers N=512, BER=1x10^{-4}, Bandwidth B= 10 MHz, Nants =30, P_{worst}=0.1565 W,T=R=10.

Simulation Results

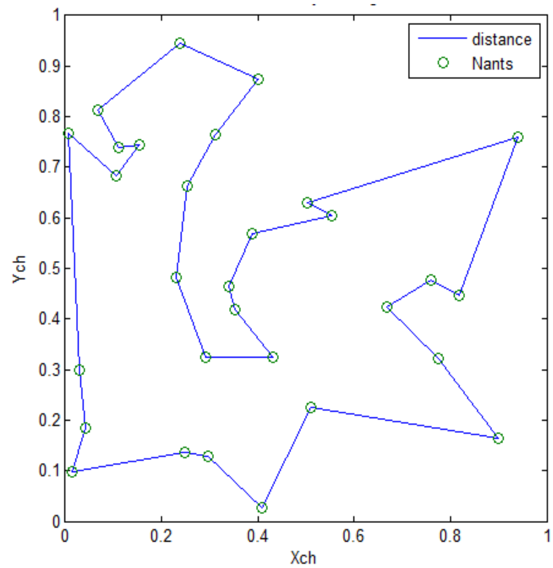

Fig. 2. Pattern formation by Ant Colony Optimization

Fig.2.Shows pattern formation by using Ant colony Optimization (ACO) method for finding shortest path of subcarrier in X -channel and Y- channel for each users.

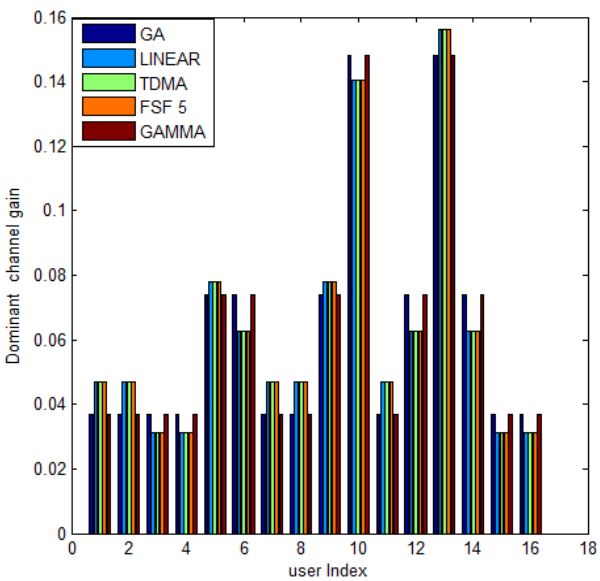

Fig. 3. User index with Sub channel gain

Fig.3. Shows sub channel gain for a Genetic Algorithm (GA) system with 16-users and 10-subchannels.This shows the result of each algorithm is varies in channel gain with respect to the user index.

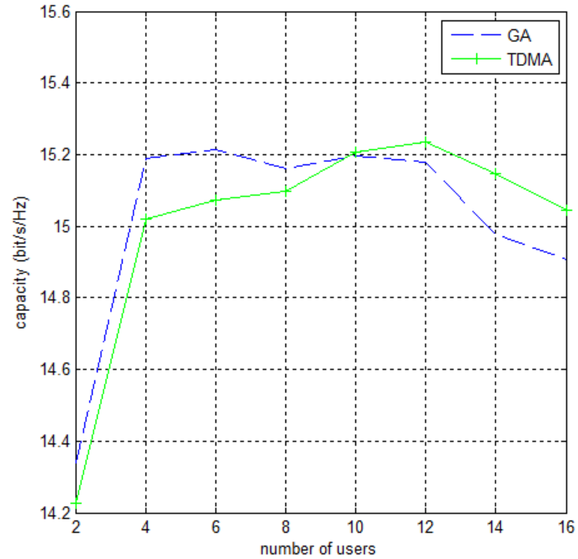

Fig. 4. Number of Users Vs Capacity

Fig.4.Shows the solution of several optimization problems related to channel capacity and number of users.

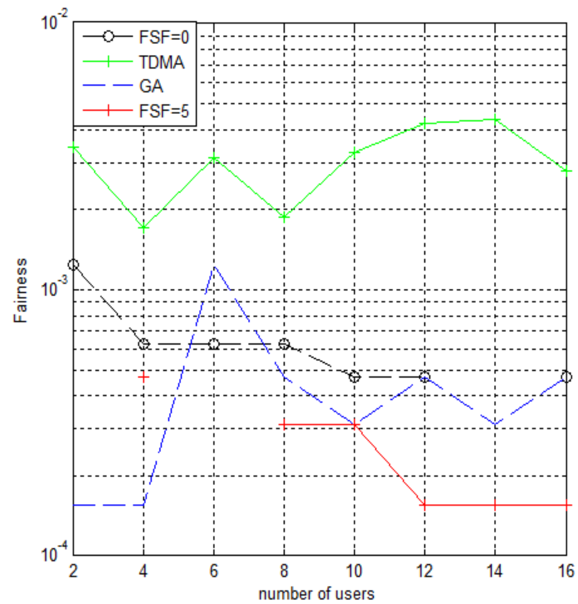

Fig.5. Number of users Vs fairness

Fig.5.Shows the number of users with comparable fairness.

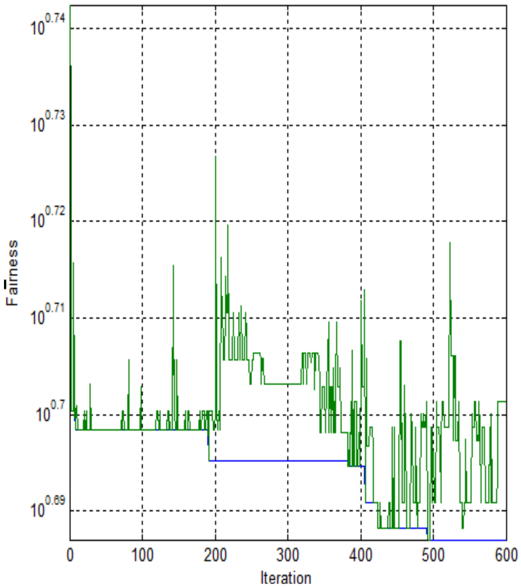

Fig.6. Iteration Vs Fairness

Fig.6. Shows the fairness over 600 Iterations.

Conclusion

This paper addresses a new method to solve the adaptive resource problem with proportional rate constraints for the MIMO-OFDMA systems. The proposed scheme based on SA with Fairness factor value achieves almost ideal fairness with a small capacity loss. Another is scheme based on ACO for finding the shortest path and it is added with GA to give achieves higher capacity. But increased capacity with the reduction in fairness among users.

Simulation results show that the proposed algorithms has better performance than the fixed subcarrier method and can reduce computational complexity by using these schemes the system capacity is distributed more fairly among users.

As future works may be extended to improve capacity and good fairness.

References

[1] Goldsmith, S. Jafar, N. Jindal, and S. Vishwanath, "Capacity limits of MIMO channels," *Selected Areas in Communications, IEEE Journal on*, vol. 21, no. 5,June 2003 pp. 684–702.

[2] J. M. Choi, J.S. Kwak, H. S. Kim, and J. H. Lee, "Adaptive Subcarrier Bit, and Power Allocation Algorithm for MIMO-OFDMA System", in Proc. VTC 2004-Spring, vol.3, pp.1801–1805.

[3] I. C. Wong, Zukang Shen, B. L. Evans, and J. G. Andrews, „A Low Complexity algorithm for Proportional Resource Allocation in OFDMA Systems", in Proc. Signal Processing Systems Conf., SIPS 2004, pp. 1-6.

[4] Z. Shen, J. G. Andrews, and B. L. Evans, "Adaptive Resource Allocation in Multiuser OFDM Systems with Proportional Rate Constraints", IEEE Trans. wireless communication, vol. 4, November 2005, pp. 2726 - 2737.

[5] G.Bauch and A. Naguib, "Map equalization of space-time coded signals over frequency selective channels", Proc. IEEE Wireless Communications. Network Conf., September, 1999, pp.261-265.

[6] P. W. C. Chan and R. S. Cheng. "Capacity maximization for Zero-Forcing MIMO-OFDMA Downlink Systems with Multiuser Diversity". IEEE Transactions on Wireless Communications, 6(5), May 2007,pp. 1880–1889.

[7] Jian Xu,Sang-Jin Lee ,woo-Seok Kang,Jong-Soo seo, " Adaptive Resource Allocation for MIMO-OFDM Based Wireless Multicast Systems", IEEE Transactions on Broadcasting, Vol. 56, No. 1, March 2010.

[8] R. S. Blum, "MIMO capacity with interference," IEEE J. Sel. Areas Communication., vol. 21, no. 5, June 2003, pp. 793-801.

[9] C. Y. Wong, R. S. Cheng, K. B. Letaief, and R. D. Murch, „Multiuser OFDM with Adaptive Subcarrier, Bit, and Power Allocation", IEEE J. Select. Areas Communication, vol. 17, October 1999, pp. 1747- 1758.

[10] J. Xu, J. Kim, W. Paik, J. S. Seo, „Adaptive Resource Allocation Algorithm with Fairness for MIMO-OFDMA System", in Proc.VTC 2006-spring, vol. 4, pp. 1585-1589