Spectrum Allocation of Secondary Users Using Optimization Problem of Linear Cooperative Spectrum Sensing Techniques

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Abstract— Resource allocation is used for complete utilization of frequency spectrum in cognitive radio networks. To maximize capacity is current research problem because of the many practical limitations such as transmission power, interference threshold of primary users and traffic demands of secondary users. In this paper consider spectrum access scenario which consists of two groups of users, namely Primary Users (PUs) and Secondary Users (SUs) in Cognitive Radio Networks (CRNs). Genetic algorithm (GA) is an efficient technique used for achieving power allocation in proposed systems. Cognitive radio has attracted a lot of attention recently due to its superior spectral efficiency and could play a vital role in improving the capacity of future networks. This paper presents resource allocation in terms of number of user, power. Simulation is done in MATLAB software and results shows that resource allocation gives complete utilization of spectrum bandwidth with minimum power along with maximum data rate.

Keywords-Cognitive Radio, OFDM, MATLAB, Power.

I. INTRODUCTION: Cognitive radio (CR) is known to be a promising technology to improve spectral efficiency of a communication system by sharing the licensed spectrum of Primary User (PU) to the unlicensed Secondary User (SU) [1]. Conventionally, it does so by listening to the received signals and identifying the spectrum holes. These spectrum holes can then be used by the SUs for their transmission provided that they do not interfere or cause minimal interference to the PU. Two major challenges of Cognitive Radio Networks (CRNs) are the PU detection and the transmission opportunity exploration. CRs may operate in three different modes i.e., overlay, interweave and underlay modes [2]. In the interweave mode, the SU searches for spectrum holes and then obtain access to these spectrum holes opportunistically [3]. By contrast, simultaneous PU and SU transmissions are legitimized in underlay mode if the interference caused by the SU transmission does not worsen the performance of the PU. The overlay mode relates to a class of more sophisticated scenario, where the CR nodes are equipped with advanced signal processing capabilities are capable of decoding the PU messages. In addition, they are capable of maintaining or even improving the quality of PU transmission, while simultaneously obtaining spectrum opportunities to transmit their own SU messages [2].

Cognitive nodes can interact with their surrounding nodes and make decisions to improve their communications. These smart nodes will be employing their neighboring nodes to assist in their communications and in return will pay them back either in the form of monetary benefits or might trade with them their bandwidth, power or any other resource that their neighbors might need. These complex interactions provide new areas and challenges for the researchers to explore. One of the best tools for defining and modeling interactions between different participants or entities is game theory. Game theory found its roots in economics and now it is being widely used in different fields of social, behavioral and natural sciences [4].

Cooperative communications constitute a powerful technique that combats channel fading due to multipath propagation in a wireless environment. Cooperative communications technique was first conceived by Van der Meulen back in 1970s [8], where he constructed a three-terminal relay channel and derived both upper and lower bounds on its capacity. It gained ample interest 30 years later and has been seen as an essential technique for its significant capacity and multiplexing gain improvements. Many relaying protocols have been developed, including Amplify and Forward (AF), Decode and Forward (DF), Compress and Forward (CF), Selection and Dynamic Relaying (SDR) and Incremental Relaying (IR) [9].

Allocation in cognitive radio is the concept of distribution of resources such as power, channel availability, frequency and so on. Spectrum resource allocation for cognitive radio networks (CRNs) presents many unique challenges in which the mutual interference between Primary Users (PUs) and Cognitive Radio (CR) users. Resource allocation must maximize the efficiency of the spectral resources utilization and minimize the risk of overlapping the coverage of CRNs with adjacent primary networks.

Resource allocation is of two types, dynamic and adaptive resource allocation. Conventional mobile communications systems are moving towards faster digital wireless technologies based on advances in semiconductor devices as described below.

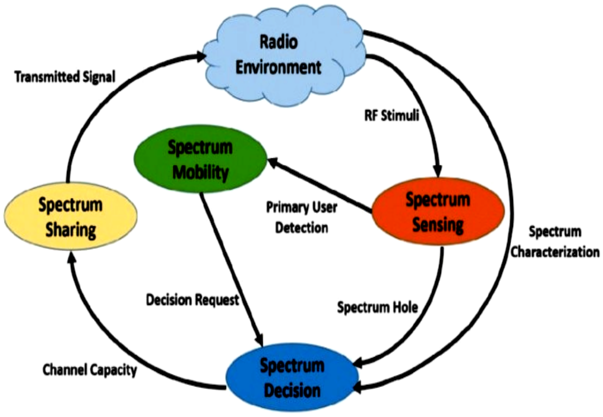

Figure 1: Cognitive radio architecture

Daily increasing demand for new wireless services with higher data rate and QoS level makes the upgrade of the physical layer modulation techniques inevitable. OFDMA is a common multiple access multicarrier modulation technique that is usually used in cognitive radio (CR) systems.

II. METHODOLOGY: The optimization problem is first formulated to assign primary users, then the unused power allocation using secondary user using linear cooperative spectrum sensing techniques. In order to guarantee that each user is able to achieve its target data rate, the optimization will include nonlinear constraints of proportional fairness. It is important to point out that by using the proportional fairness constraint, once the minimum rates for all users are satisfied, the remaining resources will also be allocated in a proportional manner. Such approach is important to maintain fairness in distributing the radio resources among these users and to ensure that the weak users have enough power to decode their own data from the received signal while treating the stronger users as noise, and to ensure that the stronger users have enough power to apply SIC and cancel the effect of the weak users and detect their own data.

$$P_{RB} = P_s^{(L)} + P_s^{(H)} = \frac{P_t}{S}.$$

Without this constraint, the maximum sum rate could simply be achieved by allocating all the bandwidth and power to one user or a few users who have the best channel conditions and not all users will be allowed to transmit. In addition, another important property of this constraint is that it can utilize the potential advantage of OFDMA over previous. The minimum rate requirement is assigned to each user based on the large scale fading factor (the distance based path loss and the Log-normal shadowing factor) experienced by that user in addition to the small scale fading effects. Since path loss and shadowing is more dominant and vary slowly, the proportionality constraint is therefore effectively more long term rather than short term.

$$P_s^{(H)} = -\frac{\left(|h_s^{(H)}|^2 + |h_s^{(L)}|^2\right) B_s N_0}{2|h_s^{(H)}|^2 |h_s^{(L)}|^2} + \frac{\psi_3 \sqrt{B_s N_0}}{2|h_s^{(H)}|^2 |h_s^{(L)}|^2 \sqrt{\Gamma_1}}$$

Solving the formulated problem in to requires a numerical solution or some iterative algorithm for suboptimal solution. Therefore, we first propose a low complexity sub-optimal approach that allocates the power equally among all the RBs. In other words, the total transmission power in each RB is set to be Using this assumption along with the optimization steps that are depicted in Appendix A, the sub-optimal power for the strong user is found to be

$$P_s^{(L)} = \frac{2|h_s^{(H)}|^2 |h_s^{(L)}|^2 P_{RB} + \left(|h_s^{(H)}|^2 + |h_s^{(L)}|^2\right) B_s N_0}{2|h_s^{(H)}|^2 |h_s^{(L)}|^2} - \frac{\psi_3 \sqrt{B_s N_0}}{2|h_s^{(H)}|^2 |h_s^{(L)}|^2 \sqrt{\Gamma_1}}$$

It is worth mentioning that the superscripts and are included just to distinguish the parameters of the users with the better channel gain from those with weaker channel gains at the s-th RB and not over all RBs. It also does not necessarily mean that is higher than, where it could be less than or equal to depending on the final values from the proposed closed form solutions.

III.SIMULATION RESULT:

Proposed work is simulated using MATLAB environment. Input parameter which is taken to implementation is following.

Table 1: Input Parameters

Sr. No.	Parameter	Value
1	Cell Diameter (D)	300
2	Path loss Exponent (v)	3
3	Noise Power Density (N0)	-174
4	Total Bandwidth (WT)	5
5	No. of RBs (S)	25
6	Bandwidth per RB (Bs)	200
7	No. of subcarriers per RB(Nc)	12

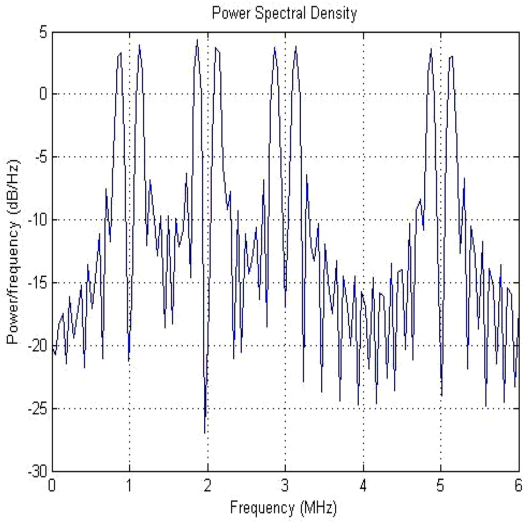

Figure 2: Power vs Frequency (Primary users)

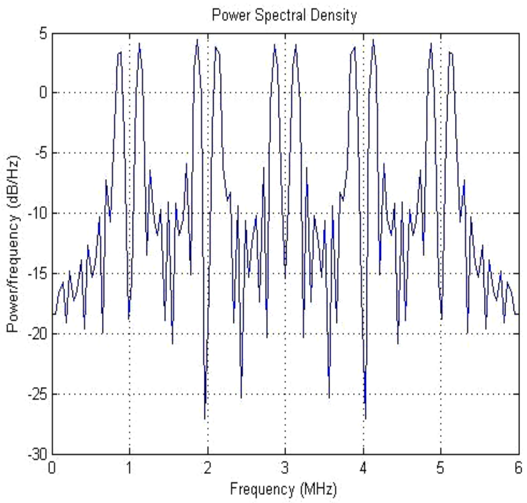

Figure 3: Power vs Frequency (Primary and secondary users)

Table 2: Input Parameter

Sr No.	Parameter	Value
1	Power max	24dB
2	Power min	-8dB
3	Bandwidth max	32 MHz
4	Bandwidth min	2MHz
5	Minimum time for transmitting	25sec
6	Maximum time for transmitting	100sec
7	Population size	50
8	Generation size	1000
9	Crossover rate	0.60
10	Mutation rate	0.001
11	Fitness value	1.34

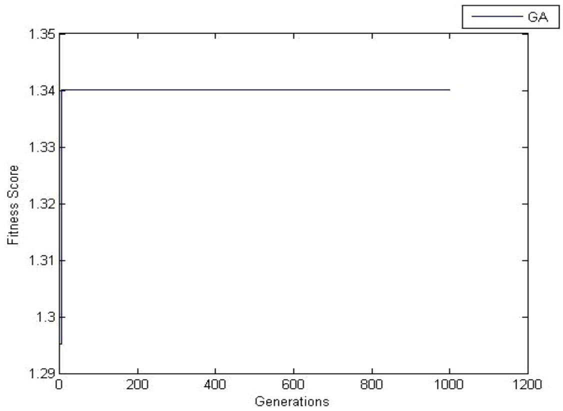

Figure 4: Fitness value vs generation using GA

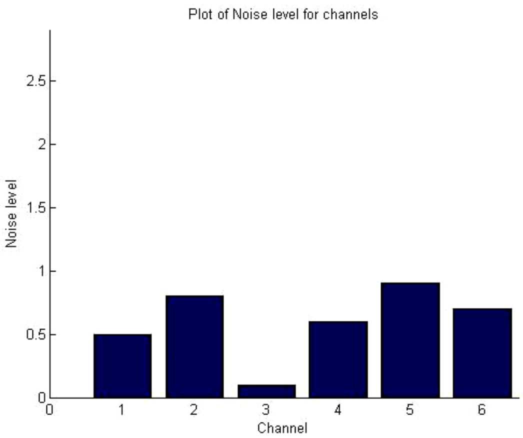

Figure 5: Noise level in allotted channel

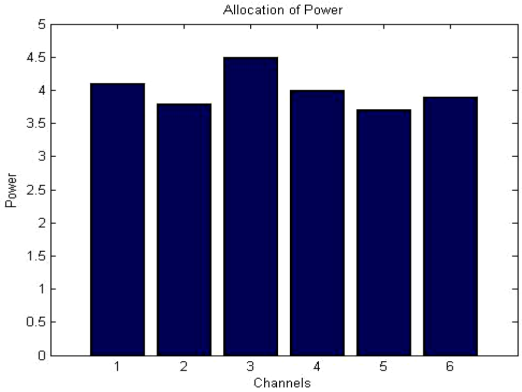

Figure 6: Power Allocation

IV. CONCLUSION: Thus the Resource Block was allocated using the GA algorithm. Due to this algorithm the power consumption gets reduced and the power allocation against the channel and frequency increased. In addition, to optimize the power for a large number of users, the proposed techniques are extended to a multi-user scenario by the vertical pairing concept. Simulation results show that GA provides better performance than others. In future this process will be extended to analysis of real time value with reduction of Signal to Noise Ratio with the Resource Block algorithm and Classification algorithm.

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