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Power Allocation of OFDM Based-Cognitive Radio Networks using PSO and IPSO

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Abstract: The massive development in wireless communication, the lack of wireless spectrum resources is one of the main factor oblige. The unlicensed spectrum bands reserved spectrum resources are incompetent to fulfilment of increasing service requirement based on the current spectrum management policy. For that, cognitive radio (CR) bear a best solution to ameliorate resource efficiency and dynamic spectrum allocation technology. Resource efficiency and dynamic spectrum allocation technology which can be ameliorate by using the CR. CR provides a good concept for extensively magnifying the spectrum utilization and solving this problem. Orthogonal Frequency Division Multiplexing (OFDM) is suitable for CR based on the transmission system which provide spectrum efficiency due to its flexible dynamic resource allocation. Spectral efficiency is useful for CR network because subcarrier is very closely placed and are overlapping hence OFDM used. Multicarrier modulation technique that is OFDM which chop the data into chunk are modulated using closely placed. A distributed algorithm is an algorithm designed to run a computer hardware constructed from interconnected processor. In this paper, compare the parameters as throughput and power by using the three different methods used such as Distributed, Particle Swarm Optimization (PSO) and Improved Particle Swarm Optimization (IPSO). In that, IPSO algorithm used to minimize the power or optimum value of power is calculated. And for maximizing the throughput, the CR technology is used.

Keywords: Cognitive radio, OFDM, Distributed algorithm, PSO, IPSO.

I. INTRODUCTION

With the development in wireless communication, due to because of increases different services the radio spectrum becoming congested. Also, the in new wireless devices in technology has guarantee that more and more bandwidth to be utilized. And hence the high level of interference among the spectrum bands which are operated to each other. Interference mainly depend upon the time and place operated. The utilization of spectrum depends upon day, time and places. The result of this is incompetent use of the frequency band. The primary users that is licensed users which use the spectrum at fixed time and remaining time, they are free. So we can utilize this spectrum when primary users are not using at that time. For use those spectrums, we need to introduce such technology which has dynamically operated the parameter whenever sense the unused spectrum. Cognitive radio working on intelligent radio technology which can observe radio environments and according to that changes its transmission parameter. Cognitive Radio (CR) is an autonomous and controlled by software hence CR is Also called as smart radio. Without the involvement of the user, CR can change its characteristic dynamically. Cognitive Radio used to sense the environment and this is the main function of the cognitive radio. CR is also used to manage the sensing environment for data transfer, to focus for the disturbances in the sensing environment and if so, then again sense the environment for nominal disturbances. Here, the sensing environment nothing but sensing the free and unused band of frequency. The detection of free spectrum from the wireless band that result in minimal interference with other users. The free or unused frequency bands are known as spectrum holes. After sensing the proper spectrum hole, the main problem arrives as management of a spectrum. It needs the allocation of various parameters on which data transmission take place. Parameters are power, throughput, number of bits per symbol, etc.

A multicarrier transmission technology known as orthogonal frequency division multiplexing (OFDM) is one of the most widely used technology in current wireless communication systems. OFDM adaptive modulation technique to form a possible as its versatile ' spectral idle for a co-existence may fill gaps has been known as Thanksgiving. However, due to the non-orthogonality, introducing both the primary and secondary system transmit signals mutual interference and interference from all that does not exceed the total allowable limit subcarriers is important. OFDM play an important role in CR network by providing a manifest, scalable, and adaptive technology for wireless communication. In OFDM, the symbol stream is split into lower rate stream. This symbol stream which bear data. And the lower rate stream is transmitted on different carriers. Hence, this splitting increases the symbol duration or time interval with the help of the orthogonally overlapping subcarriers. The inter-symbol interference is removed by OFDM technology with a cyclic prefix. OFDM has spectrum shaping capabilities and sensing with its flexibility and additivity. It makes OFDM is best transmission technology for the CR system. Spectrum sharing and all of these separately is pus range of knowledge of applied mathematics intervention. Broadcasting standards, such as

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different OFDM broadband wireless, digital video broadcasting (DVB), digital audio broadcasting (DAB), etc. several attractive options, such as exploits multipath delay spread tolerance, high spectral efficiency, frequency selective fading channels

The main problem is that, PSO or IPSO methods used to find out the optimal value of the parameters. But at the time of the calculation of throughput these algorithms are not useful. So for maximizing the throughput of the system used the concept of the cognitive radio network. The cognitive radio network used to find out maximize the throughput.

In this paper, we compare the output parameter as power using the three algorithms as distributed (without PSO), PSO and IPSO. The article arranges in the following manner, in section II, Description about the IPSO and PSO and comparison between them. In section III, discuss the system model and flowchart. In section IV, discuss the simulation result and at last section conclude the article.

II. IMPROVED PARTICLE SWARM OPTIMIZATION

For solving difficult multidimensional optimization problems in the various field, the PSO algorithm is used. The PSO algorithm is an evolutionary algorithm. At the time of search for the optimal solution, the PSO algorithm depends on the social interaction between independent particles. The main function of the PSO is that optimal solution by starting from a group of random solution and then searching repeatedly. Aim of the PSO is to obtained the global optimal value of the real-value function. PSO depend on social behavior of the swarm to look for food.

The PSO algorithm works on the two term as population or called as a swarm and candidate solution or called as a particle. Energy particle has a fitness value. This fitness value is determined by the target functions. And it has velocity also for determining its destination and distance. In every iteration, two renew will follow as P_{best} is best position found for particle and G_{best} is best position found for whole swarm or group.

$$V'_{id} = \omega V_{id} + \eta_1 \text{ rand } () (P_{idb} - X_{id}) + \eta_2 \text{ rand } () (P_{gdb} - X_{id}) \quad (1)$$

$$X_{'id} = X_{id} - V'_{id} \quad (2)$$

In the above equation (1), ω represent inertia weight whose value as $0<\omega<1$, η_1 and η_2 are accelerating factors $\eta_1 = \eta_2 = 2$, rand () is a random number, X_{id} is a position of particle id and V_{id} is a velocity of particle id. P_{id} and P_{gd} are represents as a best position particle id and position of best particles in whole group respectively. According to velocity and position renewal formula, best individual in the group is trapped into a level optimum. According to the information sharing mechanism in PSO, as in the particles to approach this local optimal, velocity of the particles become zero. As the increase of iterations, the velocity of particles will gradually decrease and at last reach to zero. The IPSO algorithm which is used to avoid the trapped into local optimum based on new information sharing mechanism. In this algorithm, we can not only record the best position but also record the worst position of an individual and whole swarm have experienced. An individual particles move in the direction of avoid worst position which will surely expand the searching of global space particles. And this will help to avoid trapped into local optimum too early. The renewal formula for particle velocity and position are as follows.

$$V'_{id} = \omega V_{id} + \eta_1 \text{ rand } () (X_{id} - P_{idw}) + \eta_2 \text{ rand } () (X_{id} - P_{gdw}) \quad (3)$$

$$X_{'id} = X_{id} - V'_{id} \quad (4)$$

P_{idw} represent worst position particle and P_{gdw} represent worst position of swarm. The working flow of algorithm of IPSO is as follows.

- Step 1- the velocity and position of particles are initializing randomly.
- Step 2-fitness value of each particle evaluate.
- Step 3-for each particle, if fitness value is smaller than best fitness value $P_{idb,}$ the best position is renewing position is P_{idb} of the particle id. Or else, if fitness value is bigger than worst fitness value $P_{idw,}$ renew $P_{idw.}$
- As similar step 3, if its fitness value is smaller than the best whole group fitness renews value P_{gdb} of particle. Or else, if its fitness value bigger than the worst whole group fitness value $P_{gdw,}$ renew $P_{gdw.}$
- Step 5-1) new particle t will produce by applying formula (1) and (2). 2)new particle t' will produce by applying formula (3) and (4). 3)compare between t and t' and select better one into a next generation.
- Step 6-if all the above steps satisfy adjournment needs, suspend it; or tum to step 3.

III. SYSTEM MODEL

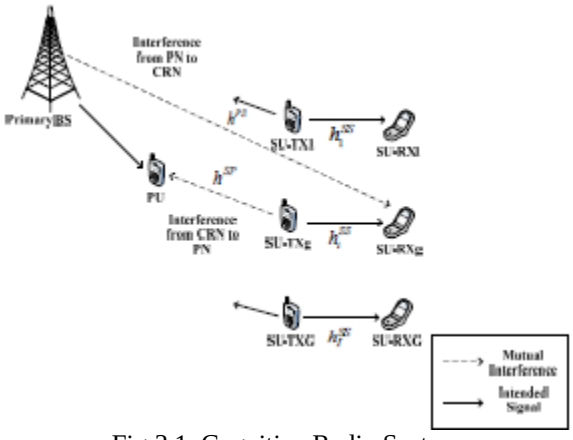

Fig.3.1. Cognitive Radio System

Consider a figure 3.1 cognitive radio network which consist of number of users i.e. multi-users. The above figure illustrates that there is primary base station (BS) that transmit the downlink traffic to primary users (PUs). The OFDM technique which is used in the communication of each secondary user (SU) and OFDM technique which divide the available bandwidth into frequency flat sub-channel.

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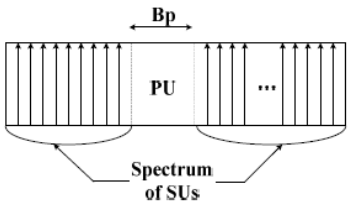

Fig. 3.2. Spectrum of SU and PU in a CR system

The figure 3.2 illustrate that, let us assume the spectrum bandwidth B_p and from the communication point of view, it may not require to transmit entire spectrum. So that SUs can exploit some part of the shared bandwidth and each SU user has perfect had perfect knowledge of aggregate interference from PU. There are three kind of channel gain in the network are used. These are $h^{ps,\ hsp}$ and h^{ss}which stand from channel gain from primary base station to secondary user receiver, the channel gain from SU the transmitter to PU. The corresponding channel power gain on the link between SU and transmitter receiver pair respectively.

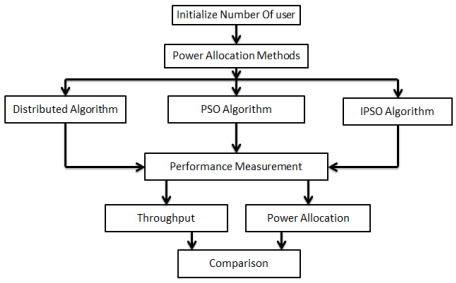

Fig. 3.3 Flowchart

In the above figure, working flowchart of the system is demonstrated. Three power allocation technique which is used in that as distributed algorithm (without PSO), PSO algorithm and the IPSO algorithm. These three algorithm used to find out the power and in that reduction of the power done. IPSO algorithm which is used to find out the optimum power as compared to the distributed algorithm and the PSO algorithm. The performance parameter measured as the throughput and power allocation. Power measured by these algorithm and throughput measured by CR technique. And at last the comparison between these techniques on the basis of these parameter.

IV. SIMULATION RESULT

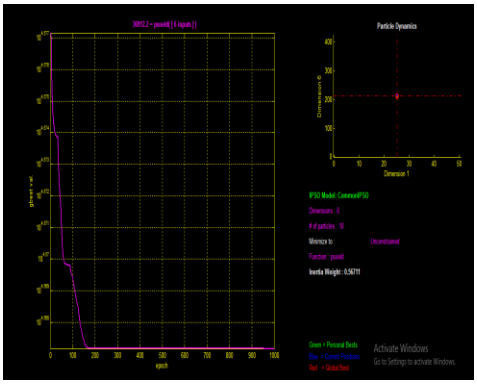

Fig. 4.1. Global Iteration of IPSO

In the above figure, it is shown that the G_{best} value with respect to the number of users. The optimum value of power achieved by using IPSO algorithm with respect to number of users.

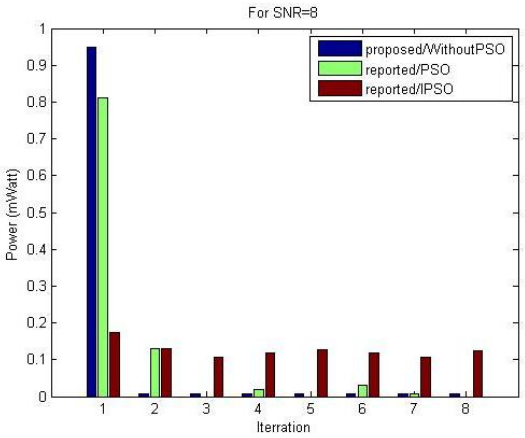

Fig. 4.2. Power allocation with respect to Distributed, PSO and IPSO algorithm

In fig.4.2. is shown that power on y-axis and iterations on x-axis. Iteration is nothing but the number of users. The first column among three columns which shows that power calculated by the without POS method similarly the second column shows that power calculated by PSO method and last column i.e. third column which shows that power calculated by IPSO. So in that we optimize the power using different algorithm. Power optimizes in PSO column is more as compared to without PSO method i.e. distributed algorithm method .and similarly power optimize more in IPSO as compared to PSO method. So more optimize power is achieved by using IPSO algorithm rather than PSO and distributed algorithm.

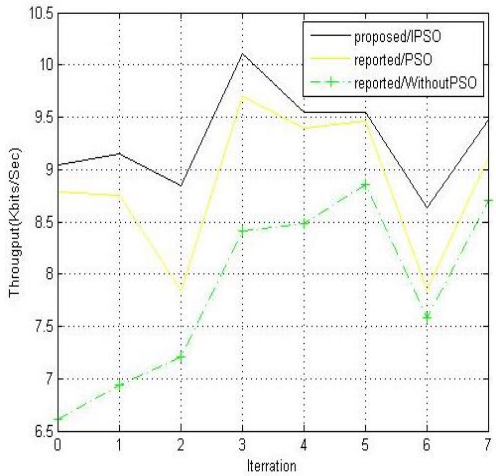

Fig.4.3. Throughput

In fig. 4.3. Calculation of the throughout shown. But this is achieved by using the cognitive radio(CR) technique. CR technique along with distributed algorithm, PSO and IPSO and we can maximize throughput. Throughput calculated by without PSO i.e. distributed algorithm is minimum shown in figure 4.3. and Maximum throughput achieved by using IPSO algorithm uses a CR technique together. Hence we get the maximum throughput as shown in figure.

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V. CONCLUSION

The cognitive radio network technology which enhance the access of frequency band and amended communication accommodation available to the number of user or we can say people. By using the CR technique and the different algorithm such as without PSO i.e. distributed algorithm, PSO algorithm and IPSO algorithm which is used to maximize the throughput of the system. But specially these algorithms used for the optimizing or we can say minimizing the any parameters such as power. IPSO algorithm optimizes the power allocation as compared to other algorithm such as PSO and without PSO i.e. distributed algorithm PSO algorithm calculated the best position of the particle and the whole swarm i.e. group also but IPSO algorithm calculated the both best and worst position of the particle and whole swarm. Hence IPSO algorithm used to more optimize the power allocation as compared to others algorithm.

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