ENHANCING PERFORMANCE OF 4G COGNITIVE RADIO USING GENETIC ALGORITHM

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Abstract— The evolution of various mobile generation from 1G to 4G is characterized by an increasing number of users with ever high bandwidth demands. These ever high bandwidth requirement calls for very high spectrum efficiency requirement. The increased spectrum efficiency comes at the cost of increase complexity. The spectrum efficiency is more scared in 4G. The proposed work increases spectrum efficiency keeping all other parameters such as amount of spectrum and cell-site spacing constant and at some load per user. Improvement of spectrum efficiency in 4G will make it more advanced and flexible. In order to improve spectrum efficiency, an ideal way is used to cognitive radio. The proposed work enhances the cognitive radio waveform using genetic algorithm (GA). The main advantage of GA is its multi-objective optimization technique. In GA, the cognitive radio defines as a chromosome and genes. This paper focus on improving spectrum efficiency in 4G using GA in cognitive radio.

Index Terms— cognitive radio, spectrum efficiency, 4G, genetic algorithm (GA)

I. INTRODUCTION (HEADING 1)

Wireless communication from generation to generation is continuously developing at a booming speed. As the wireless technology are expanding, there are bigger challenges for huge data transfer at higher speed. The new generation technologies such as 3G and 4G are more spectrum congestion. the efficiency of any generation is depend on such parameters like data rate, channel capacity, energy efficiency, coverage ,spectrum efficiency, etc. spectrum efficiency is the optimized use of spectrum so that maximum data can be transmitted with fewest transmission errors. Many studies have found that spectrum is already allocated but result is poor spectrum utilization. To address this problem, the cognitive radio is proposed to address the spectrum efficiency scarcity problem.

Cognitive radio is the radio system which is autonomously co-ordinate the internal environment of the communication system.it is programmable device that are capable of learning environment and sensing interfearnce.it is done by allowing unlicensed (secondary) users to co-exist with the licensed (primary) users without interfering and degrade the quality of licensed users. The cognitive radio network (CRN) provide the programmable and reliable wireless communication network.

In cognitive radio networks, there are so many techniques are introduced. There are expert systems, artificial neural networks, fuzzy logic, and genetic algorithms [1].all these techniques gives different optimal solution. But each has severe limitations which are reduce the real optimal value in cognitive radio. Expert systems are limited in their requirement of complete knowledge about the environment [1].Fuzzy logic permits approximate solutions to be found in uncertain inputs which do not allow proving that the system has an optimal behavior [1]. Neural networks are most applicable in this field but their computation remains complicated [1]. Genetic algorithms have been known for their rapidity to cover a large space of possible configuration, and thus find the most suitable solution [1].

In this paper, the proposed genetic algorithm technique in cognitive radio network is use to improve the spectrum efficiency. Genetic algorithms have so many application like mathematics, physics, chemistry, computer, engineering, biometrics etc.it will focus on spectrum allocation in secondary users with quality of service. Genetic algorithm is a multiobjective optimization technique in cognitive radio networks which gives the multiple solution over a large search space. Fast convergence, ease of implementation as well as optimization of discrete and continuous radio parameters render GA as an excellent optimization tool for making resource management decision in CR network [2].the genetic algorithm starts with chromosome. This chromosome is a sets of genes. There are so many genes like frequency, power, BER, spectrum efficiency, modulation. Each gene gives the particular solution. Genes are considered from CRN parameters. Objectives are combined to multi-objective. And give the fitness function. Each fitness function using weighted sum approach.so each objective can represented by rank which gives the importance of objective.

II. COGNITIVE RADIO

Cognitive radio are the radio system that autonomously coordinate with the usages of radio band. Cognitive radio is programmable device which is aware of their internal environment.it can detect the communication channel which are in use or not and instantly move into unused channels.it Can optimized use of available radio spectrum without interference to others. Cognitive radio would follow the cognition cycle to implement the operation. This cycle gives outline of the cognitive radio's general mode of operation.Fig.1 shows that the adaptive mode of operation in spectrum

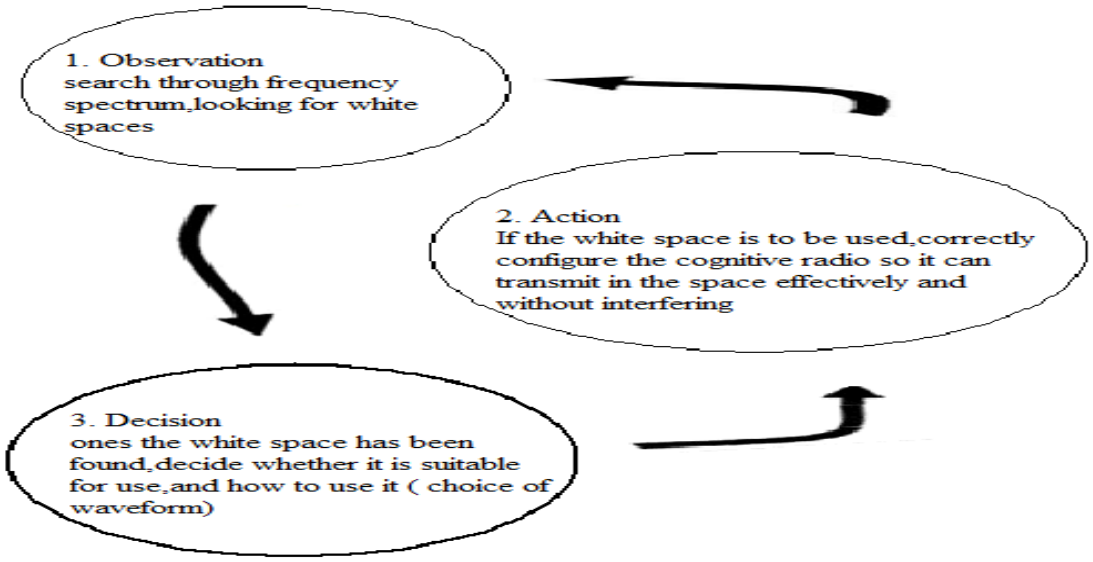

Figure 1 cognition cycle [2]

The main step of cognitive cycle is spectrum sensing, spectrum analysis, and spectrum decision.
Spectrum sensing: a cognitive radio identifies the portion of spectrum which are in use, empty spectrum, and information of environment by sensing spectrum.
Spectrum analysis: result of sensing spectrum analyzed to allocate the best frequency band to secondary user without degrade the quality of service. When the spectrum analysis carried out, the cognitive radio change its parameters according to allocate spectrum in secondary user.
Spectrum decision: the decision for best possible frequency band assigned to secondary user is taken on the basis of spectrum analysis.

Characteristics of cognitive radio is
Cognitive capability: it is the ability of radio technology is to sense the information from radio environment
Configurability: the radio programmed according their environment is due to configurability.
Comparison from survey related technologies shows that cognitive radio does not achieve the high data rate but comparatively vast areas of cognitive radio including spectrum policy, spectrum sensing, number of users, network discovery, self-organization is high.

Table I comparison of existing technology [5]

Technology	Data rate	Number of users/application	Interference Control	Spectrum agility	Spectrum policy measure
LTE	High	High	Medium	Low	None
WIMAX	High	High	Medium	Low	None
OFDM	Medium	Medium	Medium	Low	None
MIMO	Medium	Medium	Medium	Low	None
Smart antenna	Medium	Medium	Medium	Low	None
UWB	High	High	Medium	Low	None
SDR	Medium	Medium	Medium	Medium	None
XG	Medium	Medium	High	High	High
Cognitive radio	Medium	High	High	High	High

So that cognitive radio is stand to improve data rate and spectrum efficiency.

Table II comparison from 1G to 4G [7]

Generation	Spectrum Efficiency Bit/S/Hz/Cell	Coverage			Data Capacity & technology	Channel capacity
		Cellular network	Distance Covered (miles)	Data rate		
1G	0.0015	Cell	20	1 Kbps	2 kbps with analog wireless	3 user/ channel
2G	0.17	Macro	15-20	9.6 Kbps	9.6-14.4 kbps with digital wireless	8 user/ channel
2.5G	0.172	Macro	15-20	112 Kbps	64-144 kbps with GPRS	63 user/ channel
3G	0.24-0.51	Micro	5	2 Mbps	384kbps-2mbps with broadband IP technology	250 user/ Channel
4G	16.32-30	Pico	<1	30-50mbps	100mbps to 1Gbps with LTE WI-Max	Not specified

Wireless communication technology developing at a very high Speed.it become wider in very few years. From 1G to 4G, different cellular networks have been implemented. From 1G to 4G, data rate and range of distance covered are different. Journey of cellular network is from "cell" to "Pico cell". Each generation have a different technology and capacity. Channel capacity plays a vital role in wireless communication. Complete use of channel obtained high data rate. High channel capacity improve the spectral efficiency.in new generation, they are using less number of channels and maximum users.so The new generation provide a high channel capacity.comparitively from 1G to 4G data rate is high, but channel capacity is low. Therefore spectrum efficiency is less compared to other generation.

III. GENETIC ALGORITHM

Nowadays genetic algorithm have many application like physics ,mathematics, computer, engineering, bio medical, chemistry etc.in cognitive radio system genetic algorithm is more suitable for multi-objective optimization solution. Genetic algorithm have a multiple solution to address the unknown environment. Genetic algorithm is use to solve the difficult problems like machine learning, programme evolution, non-deterministic problems etc. Cognitive radio is implemented using genetic algorithm.in cognitive radio, the main purpose of genetic algorithm is to accommodate the secondary users in best possible spectrum by interacting the radio environment. Genetic algorithm is use to improve spectrum efficiency in cognitive radio.

The genetic algorithm based on mechanism of natural selection and genetics. Some fundamental ideas use to construct search algoritrhm.and genetic algorithm is more suited to give the multiobjective optimization. This process is based on this genetic operators.

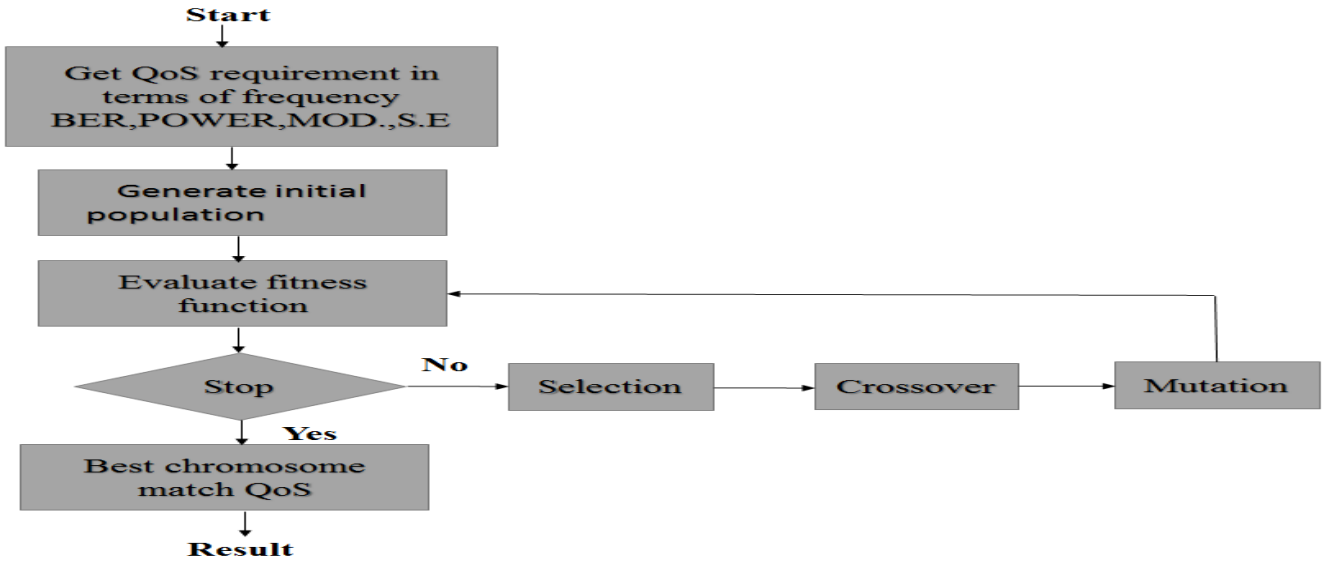

Figure 2 flow diagram of GA

Basic steps of genetic algorithm

1) Start with chromosome generation.intialize the population of chromosome.
2) After population initialization compute the fitness function. And give the rank of each chromosome.
3) Check the fitness function
4) Select the chromosome with their fitness function.
5) Check the crossover rate of the selected chromosome.
6) Check the mutation rate of selected chromosome.
7) If the criteria is achieved then terminate the GA otherwise start with step 2.

Brief explanation of each step of genetic algorithm.

Start: generate the i random population of chromosome which gives the solution of problem.

Fitness function: give the fitness of the randomly generated chromosome.

Selection: according to fitness function, select the two chromosome of good fitness level among the population.

Crossover: two chromosome are selected and crossover. Created a new individuals. If bad individuals created, it is eliminated in next selection. And good one is used to select the next selection operator.

Mutation: mutation is also used to create a new individuals. Need of mutation in genetic algorithm is to keep diversity in population.

IV. COGNITIVE RADIO PARAMETERS

Cognitive radio interact with the radio environment to detect the frequencies. And take some decision related to new spectrum. The main function of cognitive radio is learning, optimization and decision.in CR system, information is used as an input and transmission is used as output. The relationship between environmental and transmission parameters are formed by fitness function that are defined as objective functions for GA used [5]. So, the environmental information is known, which is used to improve the quality of service of new behavior. This information includes several parameters such as power, bit-error rate, frequency, modulation, spectrum efficiency, signal-to-noise-ratio, throughput etc. genetic algorithm is used in 4G cognitive radio to improve spectrum efficiency

V. SIMULATION RESULT

For the evolution of proposed solution, several results are tested. The Qos requirement of application that a user wants to use is shown in table .these values are gives as an input in a simulation model.it has been stated in fig. I.that a communication link already exists the result are obtained which is shown in table

Table III QoS requirement by user

Frequency	Power	BER	Modulation scheme
45000	25	10^-3	2

Table IV resultant chromosome with their fitness function

SR NO.	Frequency	Power	BER	Modulation
1	41598	26.8586	0.0050	3
2	41470	27.4414	0.0060	3
3	41325	25.8798	0.0050	3
4	41803	25.5488	0.0040	3
5	41083	26.5838	0.0040	2
6	41636	27.4926	0.0040	3
7	41628	25.1748	0.0020	2
8	41584	27.1907	0.0030	2
9	41048	25.3990	0.0050	3
10	41730	25.8792	0.0030	3

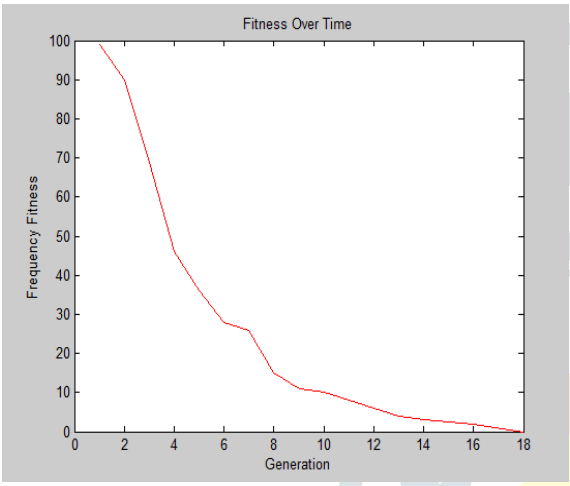

Figure 3 Generation vs Frequency Fitness

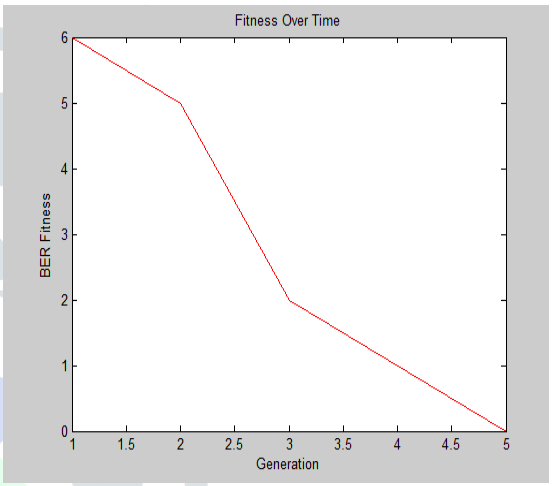

Figure 4 Generation vs BER Fitness

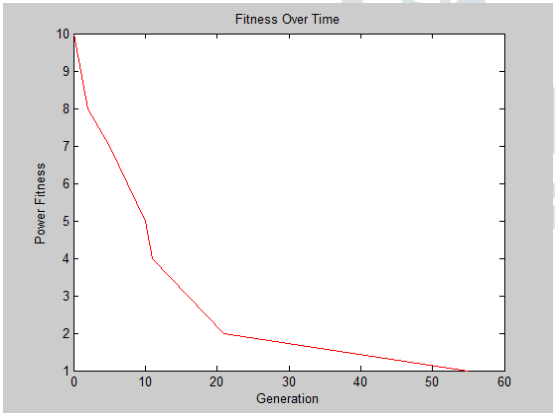

Figure 5 Generation vs power Fitness

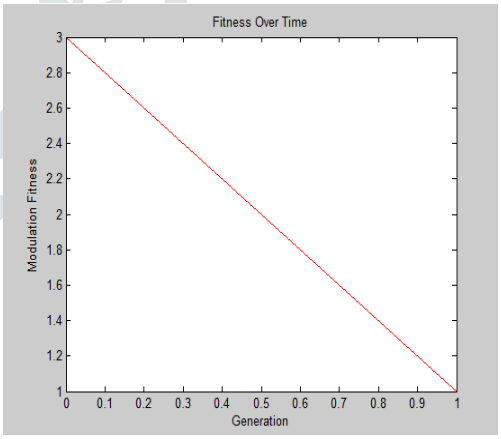

Figure 6 Generation vs modulation Fitness

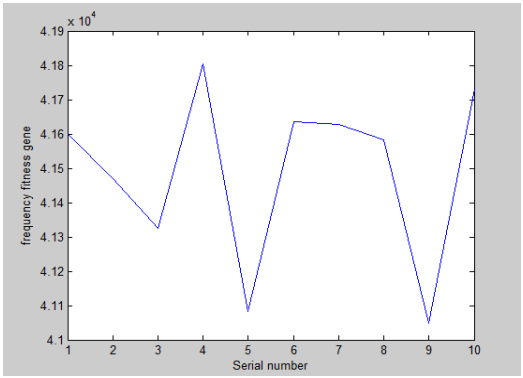

Figure 7 Frequency fitness gene

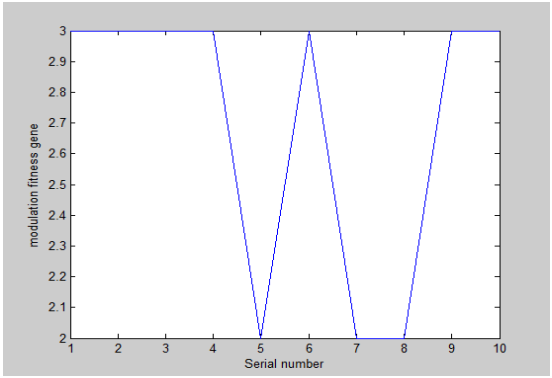

Figure 8 BER fitness gene

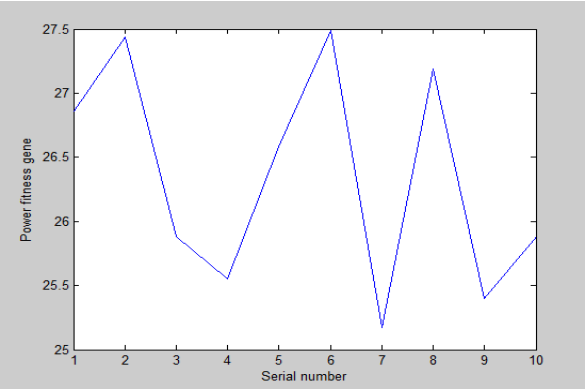

Figure 9 Power fitness gene

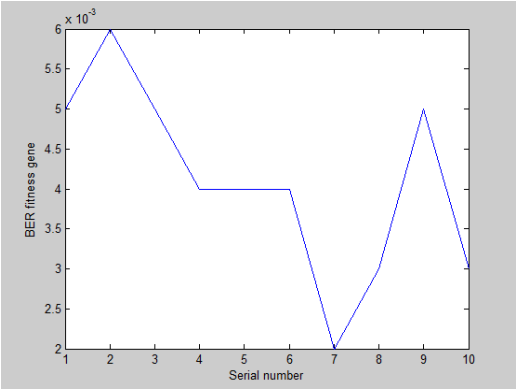

Figure 10 Modulation fitness gene

VI. CONCLUSION

The objective of my research was to show the usability of optimization technique in achieving the desired QoS requirement in 4G cognitive radio. The result presented shows the capability of proposed algorithm to achieve the desired goal with genetic algorithm, we are able to obtained the best solutions for the desired QoS requirement the solution can be utilized as a specifications to adaptively change the behavior of cognitive radio.in near future the work will be extended to have more parameters like spectrum efficiency and SNR.

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