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DTSS-Double Tier Spectrum Sensing Techniques for Cognitive Radio Communications

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Abstract: In this proposed system, considering the fascinating scenario for the cognitive radios spectrum sensing, where the power and distance of the primary user treated as an important parameters for the detection. With prior knowledge of the accurate distance and power level, we propose the new technique so called Double Tier Spectrum Sensing (DTSS) which can be categorizes as the one of the blind spectrum sensing techniques in cognitive radio networks. In this mechanisms, Genetic Algorithm (GA) based estimator has been implemented and the simulation results confirms that the estimation are accurate.

Keywords: DTSS, Spectrum sensing, Cognitive Radio networks, Genetic Algorithms (GA).

1. INTRODUCTION

Due to the increase in demand of High Quality of service applications, severe shortage in frequency spectrum arises. To manage this issue, cognitive radio has been proposed as an attractive technique to improve spectrum utilization for future wireless systems. Therefore, cognitive radio [1], [2] arises as a realistic solution to the mentioned spectral congestion problem by introducing the opportunistic usage of the frequency bands that are not heavily occupied by licensed users [3], [4].

Cognitive radio (CR) is one that provides more reliable communication by permitting secondary users to utilize the unused spectrum segments. In order to achieve this, spectrum management has to be done efficiently in cognitive radio networks. There are four steps involved in the spectrum management, are defined in [5]: sensing, decision making, sharing, and mobility. Among these, the spectrum sensing and decision making are the most important steps for the establishment of cognitive radio networks. Cognitive users or secondary users should detect the primary user networks to discover the spectrum holes or the unused spectrum to exploit them efficiently for cognitive access. By that time, CR users should prevent interference to the primary users due to their cognitive access of the channels.

A number of spectrum sensing algorithms such as the energy detection [6]–[8], the eigenvalue-based detection [9]–[11], the covariance-based detection [12], [13], and cyclostationary-based (or feature-based) detection [14]–[16] are reported in the literature to detect the primary transmitter. Pros and cons of these different techniques are discussed in [16]–[18].

2. RELATED WORK

Tao Cui: proposed blind spectrum sensing methods in the sense that both the signal power of the primary user and the noise variance are estimated, which is a nontrivial task before knowing the status of the primary user. Three different algorithms, direct estimator, approximate maximum likelihood (ML) estimator and pseudo linear minimum mean square error (MMSE) estimator, are proposed based on the moments of received signals

Zhi Quan: analyzed the effect of the spectral features on the spectrum sensing performance. Through the optimization analysis, he obtains useful insights on how to choose effective spectral features to achieve reliable sensing. In that , Simulation results show that the proposed sensing technique can reliably detect analog and digital TV signals at SNR levels as low as −20 dB.

Amir Mahram proposed a novel method to sense the spectrum. They used sample Entropy as a complexity criterion to detect the primary user's signal in the spectrum. In this proposed method, blind in the sense that it doesn't require any information from the primary user's structure, noise and channel. If the estimated complexity of the signal is higher than a pre-defined threshold, then it will be treated as a noise signal, otherwise, it will be treated as primary user's signal. simulation results show that this proposed method can be employed in lower values of SNR and has better performance in comparison with other detection methods.

3. PROPOSED WORK

3.1. Background Work

Genetic algorithm is the true optimization algorithm to find the solution for the various problems and having the advantage of multi object handling capability. The GA computation starts from the selection of the few randomly generated populations of individuals known as chromosomes that reveal definite characteristics and follows during the generation. The fitness of each individual in a population is evaluated based on the crossover and the mutation, thus producing the new population which with expects the population of new generation is evaluated based on crossover and mutation.

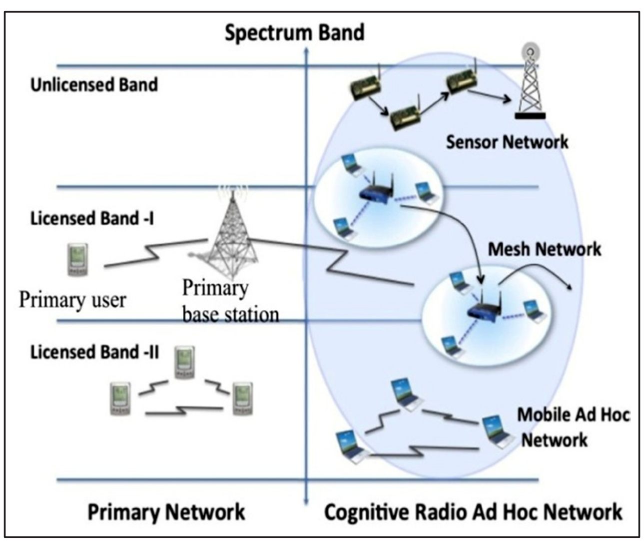

Figure 1: Spectrum Band in CR

3.2. DTSS Algorithm for Spectrum Sensing

DTSS algorithm works as two tier architecture as follow as

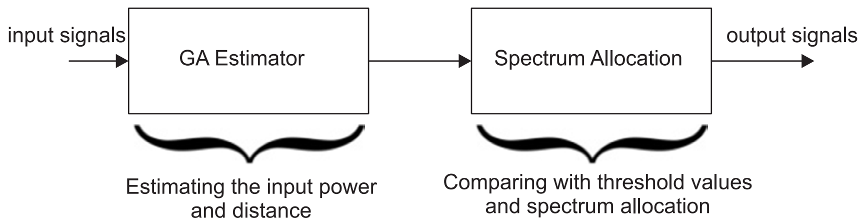

Figure 2: working of DTSS Algorithm for spectrum sensing

1. Estimation of the power levels and the distance between the users and cognitive station (Radio).

   In this work, both the power level and distance are taken as the important criteria for the estimation of the channel selection.

START BIT	SA	DATA	P	DIS	DA	STOP BIT

where, SA-Source address
P-Power level
DIS-Distance
PA-Destination address

Figure 2. Data frame format to be extracted

In above mentioned frames have been used for extraction of the details of the primary users.

Order	1	2	3
power (dB)	–2bBm	–4dBm	

Figure 3: Power gene representation

Order	1	2	3
Distance	1m	3m	5m

Figure 4: Distance gene representation

Considering the cognitive wireless networks with the operating frequency of 2.4GHz, one chromosome structure with two gene formation such as the distance and the power which are shown in figure 3 and 4 respectively.

4. OVERALL PERFORMANCE IN SENSING EVALUATION USING DOUBLE TIER ARCHITECTURE

In the previous method, the first generation populations of the chromosomes have been generated. Now next step is to obtain the fitness evaluation of each chromosomes in the population. In this paper assumptions have been made that fitness functions are equally dependent on two parameters which are defined above.

In the above equation, the results have been taken as the major role which has been calculated on the basis of cumulative sum of individual fitness of all genes.

$$f_i = \begin{cases} \dfrac{w_j \,.\, |x_j - x_j^d|}{x_i^d} & \text{if } |x_j - x_i^d| < x_j^d \\ w_j & \text{otherwise} \end{cases} \tag{1}$$

$$\mathrm{F} = \sum_{j=1}^{4} f_i \tag{2}$$

Second step includes the decision making process and also selects the best among the population of chromosomes and transfers to the next generation.

As the next step selection of the best chromosomes and to perform the cross-over operation. As the final step selecting the best chromosomes will be allocated with the spectrum for the user.

5. ALGORITHM MECHANISMS

Our research focuses on the spectrum sensing where two parameters are considered to be most important discussion for the spectrum management. The implementation of GA on this methodology makes to find the accurate level of the estimation.

1. Cognitive Radio (CR) Networks gets the signals and the extracts the power level and the distance along with the signal strength from the incoming signal using GA estimator.
2. Compare with the threshold set points. If it matches, the primary users spectrum will be allocated.

6. RESULTS AND DISCUSSION

Figure 5 shows the allocation of DTSS spectrum for the different users depends on the power and distance. The graph clearly shows the number of uses increases when the threshold limit has been set as the P = 1W, P = 20W, P = 30W and the performance remains to be maintained at th constant rate.

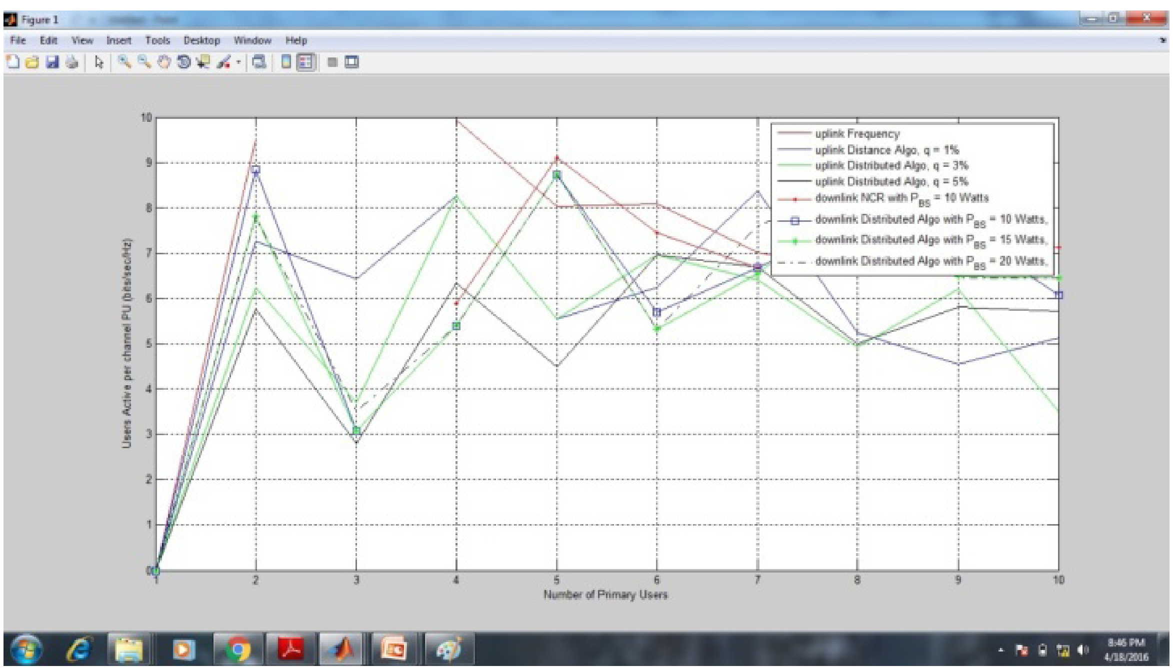

Figure 5

Figure 6 shows the implementing the GA for the spectrum sensing proves to be efficient method when compared to the other algorithms.

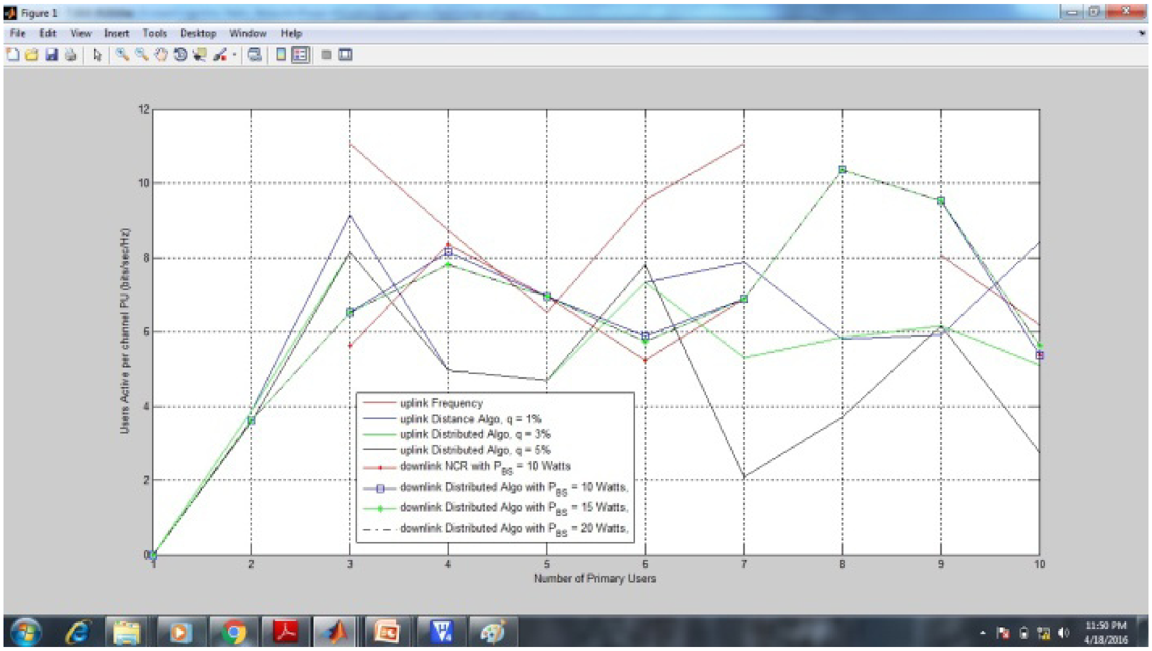

Figure 6

7. CONCLUSION

In this paper, we have proposed a Genetic algorithm estimator for spectrum sensing in cognitive radio networks, where the power and distance of the primary user treated as important parameters for spectrum detection. With knowledge of the accurate distance and power level we propose the new technique so called Double Tier Spectrum Sensing (DTSS) which takes best threshold level with the implementation of GA algorithms estimator for the spectrum detection and sensing. Better optimization can be obtained by when algorithm can be further improved in future.

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