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Dynamic and Cooperative Spectrum Sensing in Social Internet of Things and Cognitive Radio

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ABSTRACT: IoT network comprising disaster management, public safety and online multi-user gaming, and femtocells, and social applications. The main idea to apply social networking concepts within the IoTs network to permit objects to independently create social associations and it is in recent time's shows fast popularity. A CR is a novel method mainly applying technologies that agree for obtaining information of its geographical and operational environment. CR signifies the accurate technical key in circumstance of radio resources availability and scarcity of shared channels. Appropriate sensing techniques for constantly checking the accurate status of the channels are required for deployment of CR. IoT and CR have very composite functionalities because of sophisticated procedures. For this cause new solutions to avoid working on unnecessary functionalities need to be designed. Cooperative spectrum sensing is improved than conventional spectrum sensing systems as it overcomes reduces false alarm, unseen node problem, and provides added precise signal discovery. We proposed soft decision weighted distributed cooperative spectrum sensing through the support of PSO method in cognitive radio. Experimental results shows that our system is best appropriate for distributed cooperative sensing.

KEYWORDS: IoT, SIoT, Cognitive radio, Spectrum sensing, Soft decision, Cooperative sensing

I. INTRODUCTION

All IoT [1] resources will have to receive/send information from/to the Internet. Most of the time IoT network uses wireless communications, which may contributing to spectrum congestion complications. Initially in the early year 2000 the licensed-free Industrial, Scientific and Medical i.e. ISM band seem like to be very effective technology to provide emerging communication services however it is nowadays overloaded and serious coexistence concerns. Due to huge traffic in Internet information upload become more costly in terms of performance and resources. There should be an alternate approach to improve the performance and less resource utilization. TVWS "TV White Spaces"[2] is a free channels in UHF spectrum usage during digital switchover of broadcasting services in TV communication. The TVWS can be exploit with the help of CRs and innovative spectrum allocation methods. CR is more reliable and provide effective utilization of the radio spectrum

CR[3] signifies the accurate technical key in circumstance of radio resources availability and scarcity of shared channels. Appropriate sensing techniques for constantly checking the accurate status of the channels are required for deployment of CR. A CR is a novel method mainly applying technologies that agree for obtaining information of its geographical and operational environment. CR recognized internal state and its policies, to autonomously and dynamically amend its protocols and operational parameters conferring to its acquired knowledge to fulfill its predefined objectives. The basic spectrum management guidelines of CRs is simple that every new users in lieu of the spectrum are SUs[5] secondary cognitive users capable to avoid and detect PUs primary licensed users by modifying functional parameters, like transmission power, carrier frequency, and modulation type. Initially CR is a radio communication technology but in 2012 World Radio Conference [6] included CR is set of technologies.

However, in IoT perfect observations of the resources prominence can be accomplished with the help of the cooperation of numerous sensing devices. IoT network works on the principle always commented concept. In IoT

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network different things i.e. devices are connected to provide communication in the Internet. The IoT is anticipated to represent a huge number of smart things recognized by unique addressing arrangements providing facilities to end-users with the help of standard communication methods. It composed of trillions of devices cooperating [7] in a tremendously heterogeneous method in term of behavior, capabilities and requirements. Due to huge traffic [8] in Internet information upload become more costly in terms of performance and resources. There should be an alternate approach to improve the performance and less resource utilization. Most of the research use simple ON/OFF prototypes for PU actions. Though, in actuality there are numerous types of PUs because to heterogeneous IoT networks In the multi-hop IoT and CR scenario, there is the necessity to address the concern of neighbor discovery. In this circumstance, the open transmitter and concealed receiver difficulties essential to be solved. IoT and CR have very composite functionalities because of sophisticated procedures. For this cause new solutions to avoid working on unnecessary functionalities need to be designed. Afterward sensing techniques, the IoT and CR assignment strategy of radio resources necessities to be proficiently performed.

A novel archetype termed cognitive Internet of Things (CIoT) to improve the existing IoT with a brainy for very high-level intellect, has been presented in the last year. CR provides numerous benefits to IoT. It advances approachability to various services and network. It empowers an effective spectrum utilization. Because CR and IoT devices communicate by collaboration amongst neighbor IoT devices, the IoT network can scale with much greater amounts of users. It also autonomously adjust its operation to make tasks easier. Section III provides proposed work in CR and SIoT and dynamic cooperative spectrum sensing. Section IV provides simulation and result analysis. Section V concludes the paper..

II. LITERATURE SURVEY

M. Nitti et al. [9] propose the use of the Social Internet of Things (SIoT) prototype, conferring to which resources are capable of creating social associations in an independent method, i.e. with respect to the guidelines agreed through their owners. The method first refer to the common approach conferring to which participants of the SIoT work in partnership to interchange channel status information. The resultant social network facilitates trustworthy and faster service/ status/information finding method. The proposed method implemented a distributed methodology for less-complexity scalability and cooperation technique in IoT networks. Simulations outcomes represents the benefits in terms of decreased interference probability and increased capacity. Relating with conventional network connections, the connections which are direct between proximity IoT devices are most at risk because of inadequate computational capability of mobile devices for safety interrelated computations, and independent security administration, like key arrangement, mutual authentication, and so on. The main inspiration in SIoT is that a social-oriented methodology is anticipated to provide the selection, discovery, and composition of information and services delivered by distributed networks and objects. The main idea to apply social networking concepts within the IoTs network to permit objects to independently create social associations and it is in recent time showed fast popularity. According to Social IoT model, a group of procedures of socialization amongst objects is present. The hierarchical relationship called POR parental object relationship is created amongst related objects constructed in the identical period through the similar manufacturer where the main role of family is performed by the production group. This type of relationship is constructed when entities come into connection, continuously or sporadically, for causes purely associated to relationships amongst their owners like sensors/devices belonging to friends and it is called as SOR social object relationship. The entities can create CWOR co-work object relationship and CLOR co-location object relationship, similar to humans perform while they communicate public like work and personal like experiences or cohabitation. This type of relationship is well-defined for objects maintained by the same user like game consoles, mobile phones, etc. which is defined as OOR ownership object relationship The applicability of radio resources deviously by the manipulation of CR is estimated to increase the reliability and efficiency in Device to Internet and D2D communications. The author [10] represents guiding principle for giving information about the accessibility of TV channels.

A powerful research movement around the probable uses of CR methodology in the IoT network is being formed in the last few years. A latest research work assessments on various CR uses for IoT network comprising disaster management, public safety and online multi-user gaming, and femtocells, and social applications [11].

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VANET (vehicular ad-hoc networks) communications are also benefit with the help of the opportunistic spectrum applicable with CR technology and by applying additional spectrum opportunities with TV bands permitting to the QoS requirements of the applications.

In reality, VANETs required the IEEE 802.11p guidelines operating in 5.9 GHz ISM band mainly reserved for vehicle-to-roadside and inter-vehicular BS wireless communication. It is for the security and traffic information systems and monitoring systems in metropolitan environments. The performance and efficiency of VANETs functioning in TVWS has been appraised in [12]. Here is unsatisfactory spectrum for trustworthy exchange of security information over overcrowded metropolitan circumstances by the application of cooperative spectrum sensing provided by vehicles, applied to discover white channels in ISM bands. The authors in [13] surveys new methodologies and talk over various research challenges in CR and IoT.

The CR solutions that worked on standard problems of IoT network including challenges of energy efficiency, autonomicity, heterogeneity and scalability, in terms of complexity, user equipment capabilities, and operating environments and representing a common background on IoT and CR with many potential applications. The open research CR and IoT related challenges to be addressed. The D2D Devices to Devices communication is new and emerging technology. D2D as a significant methodology permitting a direct communication amongst devices, avoiding the network infrastructure [14]. D2D safety architecture and additional analysis safety requirements and issues depends on application scenarios. Some use cases related to safety issue have been explored in [15]. Researcher is also considering D2D uses for vehicular communications [16] specifically to address mobility concerns in smart parking and cities.

III. PROPOSED WORK

The key benefits of a Social IoT methodology is that the established social network able to be modelled as necessary to assure the network persistence, so that the detection of information is accomplished proficiently. Furthermore, by managing the degree of collaboration amongst friends, it is probable to accomplish a high level of reliability, in order to maintain the ambiguity of the services expected. The information related to the spectrum availability and usage in CR is considered as a sensing extent in the similar method of other physical entities, like temperature or humidity. This type of information is then referred to the Social IoT as a result that it can be applied by some other object who necessities it. The weighted average distributed consensus-based combination allows each SU to pick out a weight permitting to the measurement situation, and the comprehensive attached measurement is a soft weighted linking reflecting the measurement superiority without consolidated fusion point. Swarm optimization Particle is a population based technique basically used for optimization purpose.

PSO algorithm uses population of neighbours which can be subset of global best value, value can be smaller. First we have applied Swarm Optimization algorithm to discover best weight values from available weights. When an element takes part of the populace as its topological neighbours, the finest value is a local best. This native finest significance called L_{best} . The best weight value is then applied to cognitive radio to find available spectrum. The value is compared with the target value. In each repetition, each element is updated by subsequent two best values. We proposed soft decision weighted distributed procedures using Swarm Optimization method in CR. PSO is initialized using a collection of random elements (solutions).

The first best solution is called P_{best} . Additional finest value a global best it is termed as G_{best} . When an element takes part of the populace as its topological neighbours, the finest value is a local best. This native finest significance called L_{best} . Select randomize weight value Fixed the primary value for the weight value.

Determine the weight data value for initial of the procedure. Over a number of repetitions, a cluster of variables have used their values. In each repetition, each element is updated by subsequent two best values. The value is compared with the target value. If value is nearer than the data value is updated accordingly. Determine the value of the conqueror as of the iterated steps. Accurate the data value of neighbourhood and weight. Fixed the data value of P as of best data value to existent value. Fixed the data value of Q as universal best. First we have applied Particle Swarm Optimization algorithm to find best weight values from available weights. The best weight value is then applied to cognitive radio to find available spectrum. N as the number of sensing nodes and as the energy output of the k_{th} sensing node (SU's), the average weight linear cooperative spectrum sensing algorithm is as follows:

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$$\bar{T} = \begin{cases} \frac{1}{N} \sum_{k=1}^N T_k < \eta, H_0 \\ \frac{1}{N} \sum_{k=1}^N T_k \geq \eta, H_1 \end{cases}$$

On increasing the weight factors of the sensing nodes with higher received SNR can improve the performance of CSS. For weight based SNR above equation will be written as

$$\bar{T} = \begin{cases} \frac{1}{N} \sum_{k=1}^N T_k \cdot w_k < \eta, H_0 \\ \frac{1}{N} \sum_{k=1}^N T_k \cdot w_k \geq \eta, H_1 \end{cases}$$

Where,

$$w_k = \frac{SNR_k}{\sum_{i=1}^N SNR_i}$$

Where SNR is Signal to Noise Ration, N is number of sensing nodes. K is the sensing node. Wk is the weight of K node. PSO algorithm uses population of neighbours which can be subset of global best value, value can be smaller.

IV. SIMULATION AND RESULTS

For implementation we used i3 3.0 GHz machine with 8GB RAM. The program is developed in MATLAB language. Various parameter used have value shown in following table-

Table 1: Simulation Parameters

Sr. No	Parameter	Description	Symbol
1.	Threshold	Predefined value for hypothesis test	Eta
2.	Signal to Noise Ratio	-30 dB to 30 dB	SNR(dB)
3.	Number of Monte Carlo simulations	10000-50000	M
4.	Number of samples	1000-50000	N
5.	Number of CR users	1-10	CRNs
6.	Time Bandwidth product	5-10	U
7.	Decision or Test Statistics	If $T > \text{Eta}$, then H_1 , otherwise If $T < \text{Eta}$, then H_0	T
8.	Primary Signal	Transmitted signal	S_{tx}
9.	Gain of channel	Channel response in the cognitive network	H
10.	Received signal	Signal received by the receiver	RSS
11.	Probability of Miss Detection	0(ideal value)	P_m
12.	Probability of False alarm	0(ideal value)	P_{fa}
13.	Probability of Detection	1(ideal value)	P_d
14.	Fading Channel	Rayleigh & Nakagami- m	R & N-m
15.	Probability of Error	Probability of system for occurring errors	P_e
16.	Noise	Additive White Guassian Noise	AWGN

First, we analyze the performance of Energy detection under AWGN (Additive White Guassian Noise) and fading environment mainly Rayleigh channel and Nakagami-m channel through complementary ROC (P_m vs P_{fa}) curve or probability of miss detection vs probability of false alarm curve, ROC curves (P_d vs P_{fa}) or probability of detection vs probability of false alarm curve, spectrum utilization and SNR requirements for various conditions of interest. Also we evaluated the Energy detection for the hypothesis test under AWGN and Rayleigh channel. Second, we analyze the

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performance of Cooperative spectrum sensing with hard combination under AND rule. Rayleigh parameter is used in communication systems. Parameters like threshold, signal to noise ratio, number of sample, number of CR user, gain of signal, AWGN (Additive White Guassian Noise) are used to simulate the overall system. First we have applied Swarm Optimization algorithm to discover best weight values from available weights.

- Iteration 1 : Best Cost = 71.9612
- Iteration 2 : Best Cost = 22.4578
- Iteration 3 : Best Cost = 14.8541
- Iteration 4 : Best Cost = 6.8564
- Iteration 5 : Best Cost = 6.1245
- Iteration 6 : Best Cost = 5.3541
- Iteration 7 : Best Cost = 3.7574
- Iteration 8 : Best Cost = 3.1975
- Iteration 9 : Best Cost = 2.9452
- Iteration 10 : Best Cost = 1.1584

Fig 1: Result for PSO best cost calculation

The figure 1 above shows the optimized values using particle swarm optimization. In first iteration of particle swarm optimization we get a very large value 71.9612, in the second iteration we get a smaller value with compare to first iteration. In every iteration the value reduced . After the tenth iteration we get a very small value 1.1584.

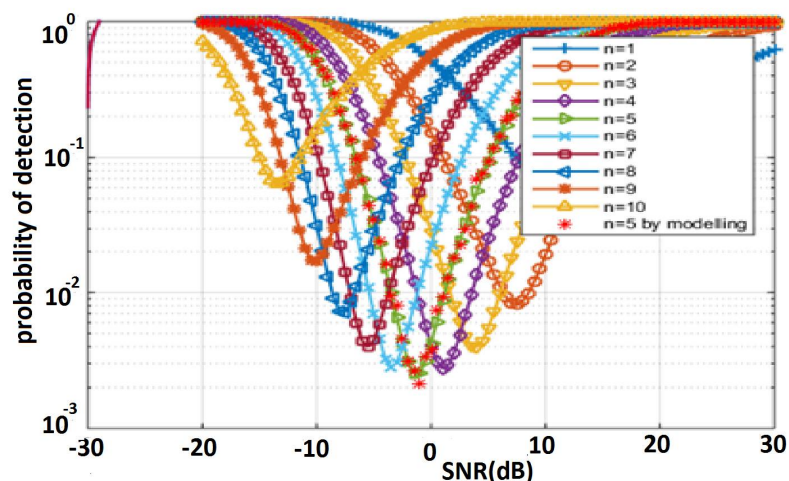


Fig 2: Probability of detection Vs SNR (-30 to 30 dB)

Figure 2 shows probability of detection versus signal to noise ratio plot for SNR values -30dB to 30 dB .We plot probability of detection versus signal to noise ratio plot for SNR values -30dB to 30 dB. For low value of SNR the probability of detection is low and for higher values of SNR the probability of detection becomes very high. At very high value of SNR like 30dB the probability of detection value reaching nearly one . If we consider all the above figures we found that the probability of error becomes zero as SNR is high having very high positive value which means that it is easy to identify the existence of SU under more SNR nevertheless of the fading environment.

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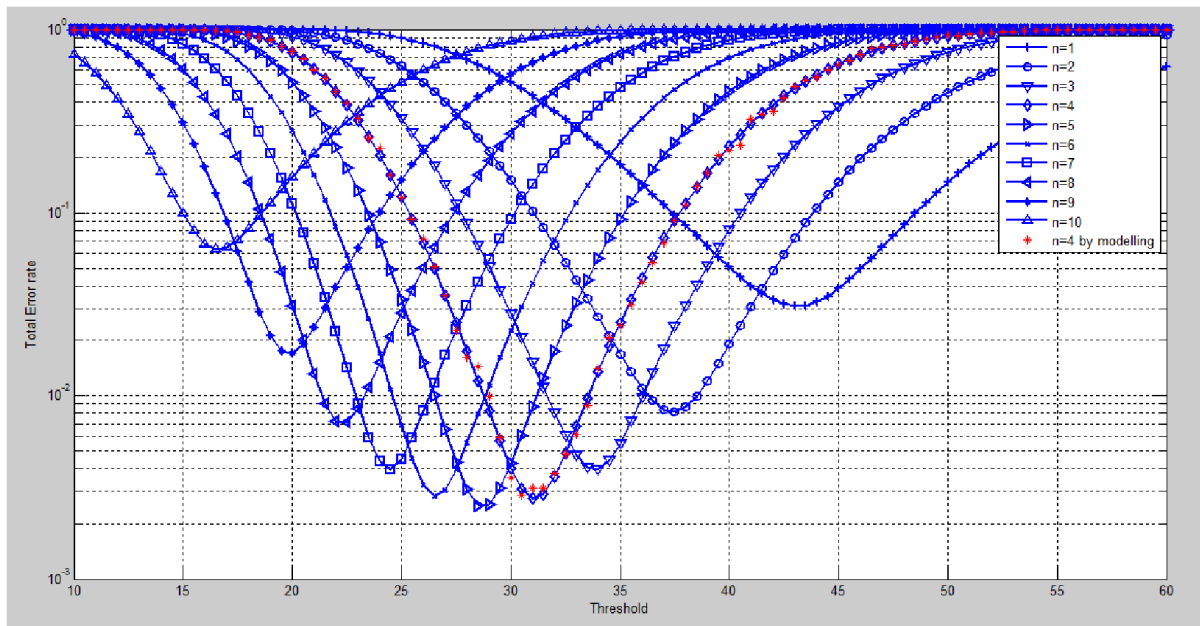


Fig 3: Total Error Rate Vs Threshold modelled at n=1 to n= 10 and finally described at n=4

Now, further we take some plots for Total Error Rate Vs Threshold in figure 3 for channel. We modelled Total Error Rate Vs Threshold at n = 1 to n = 10 and finally described at n=4 by modelling.

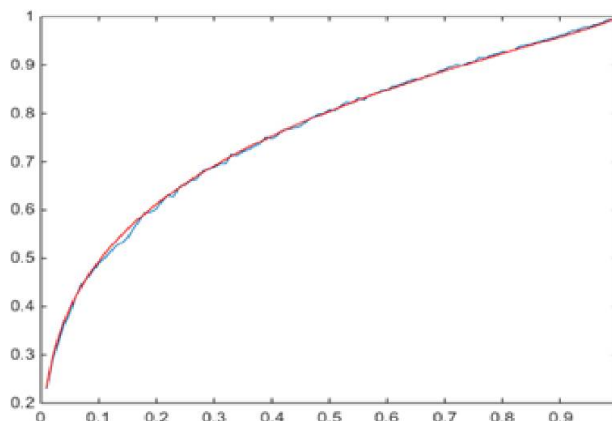


Fig 4: Probability of Detection vs. Probability of False Alarm at SNR = -5dB

Further we have performed the analysis for Probability of Detection vs Probability of False Alarm at SNR = -5 dB as shown in figure 4. We get poor performances of system because of less probability of detection values. We increase the SNR value and plot the curves in next figures in searching of a better result.

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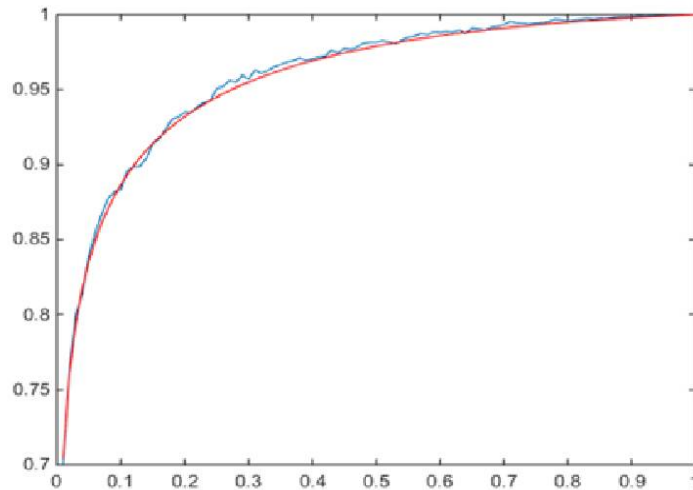


Fig 5: Probability of Detection vs. Probability of False Alarm at SNR =5dB

In above figure 5 the Probability of Detection vs Probability of False Alarm at SNR = 5dB is shown. We see that the curve is moving toward the high probability of detection at a less probability of false alarm which is good for reliable communication process.

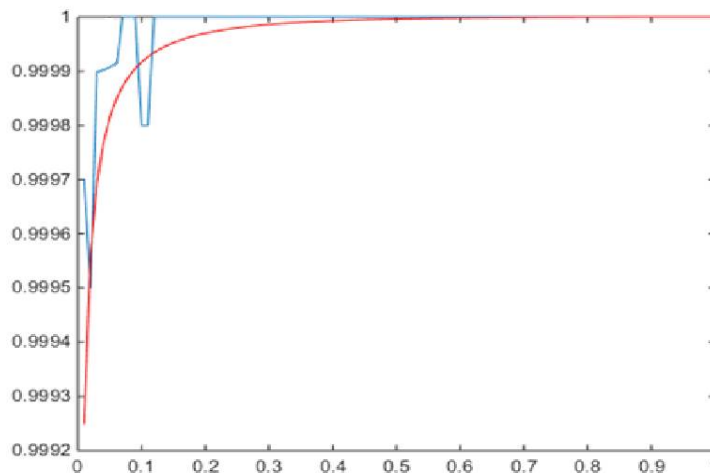


Fig 6: Probability of Detection vs. Probability of False Alarm at SNR = 10 dB

In the figure 6 result shows that the probability of detection is increased with increase of SNR values and results are quite different with the theoretical values. At SNR 10 dB or higher we get a very good probability of detection. In figure 6 probability of detection is very high at a very small probability of false alarm values, but the theoretical and practical values differ largely around $P_{fa} = 0$ to 0.2.

V. CONCLUSION

The IoT is anticipated to represent a huge number of smart things recognized by unique addressing arrangements providing facilities to end-users with the help of standard communication methods. The main inspiration in SIoT is that

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a social-oriented methodology is anticipated to provide the selection, discovery, and composition of information and services delivered by distributed networks and objects. Cognitive Radio is a distinctive system that can be potentially expand the utilization effectiveness of the radio spectrum. A cognitive radio network is a wireless scheme that can be configured dynamically and programmed to consume the finest wireless channels in its locality. The most essential procedures in cognitive wireless radio is spectrum identifying technique, which permits the secondary users to perceive the occurrence of a primary user into the spectrum. Deploying and building a system network of cognitive radios is a complicated task. Cognitive radios have the competency to monitor, detect and, sense the situations of their functioning environment, and enthusiastically reconfigure their specific features to finest match those circumstances. The paper proposed dynamic, distributed, soft decision and weighted cooperative spectrum sensing method using cognitive based Swarm Optimization in Social IoT and cognitive radio. Experimental results represented that proposed scheme is good for distributed dynamic cooperative sensing in Social IoT and CR.

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