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Dynamic Spectrum Sensing Scheduling in Cognitive Radio Networks - Effective Utility

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ABSTRACT

when the multiple primary channels exist in psychological feature radio networks, the cooperative spectrum sensing scheduling deviated from the existing analysis our work focuses on a circumstances during which every secondary user (SU) has the liberty to come to a decision whether or not or to not participate in cooperative spectrum sensing; if not, the SU becomes a free rider who will listen in the call regarding the channel standing created by others. Such a mechanism can conserve the energy for spectrum sensing at a risk of scarifying the spectrum sensing performance. We propose a framework as a biological process game in that every SU makes its call supported its utility history, and takes an action a lot of oft if it brings a comparatively higher utility. We conjointly develop AN entropy based mostly coalition formation algorithmic rule, where every SU invariably chooses the coalition (channel) that brings the most info concerning the standing of the corresponding channel. All the SUs choosing the same channel to sense kind a coalition. Our simulation study indicates that the proposed theme will guarantee the detection likelihood at a low warning rate

Keywords :- Cognitive radio networks; cooperative spectrum sensing free rider; evolutionary game; coalition formation.

I. INTRODUCTION

Spectrum sensing is an essential operate in psychological feature radio networks for secondary users (SUs) to spot the quickly It exploits unused licenced radio frequencies, normally selected as spectrum holes or white areas. If the spectrum is not employed by the first Users (PUs), then the Cognitive Users (CUs) have the chance to access it for his or her secondary communications supported the metal technique. Due to the uncertainty factors resulted from the channel randomness like shadowing and fading, the detection performance of spectrum sensing may be considerably compromised. Fortunately, the uncertainty problems will be alleviated by permitting the spatially distributed secondary users to collaborate and collaboratively build a choice relating to the standing of the licenced bands [1]. This procedure is termed cooperative spectrum sensing, which has recently been actively studied in [2], [3], [4], [5], [6] due to its attractive performance.

The existing literature survey mostly focuses on a characteristic circumstances wherever all the secondary users contribute to spectrum sensing, for each secondary user to perform spectrum sensing at whenever slot as long because the sensing performance meets sure needs. Spectrum sensing consumes a certain quantity of energy which will as an alternative be entertained to knowledge transmissions. Moreover, secondary users in emerging mobile and ad hoc applications might tend to behave selfishly and cash in of others to conserve energy for his or her own knowledge transmissions. Therefore, it is of great importance to check the dynamic behaviours of selfish users in cooperative spectrum sensing.

We propose a novel cooperative framework, in which secondary users will decide whether or not to participate in spectrum sensing or do nothing to avoid wasting their own energy. This framework is modelled as an biological process game [7], [8], which provides associate glorious means that to handle the strategy uncertainty that a user/player might face once exploring totally different actions. For those SUs that do nothing, we take them as free riders that will listen the final choices regarding the standing of the first users. By making totally different decisions, SUs will get totally different utilities determined by their achieved revenue/throughput and energy consumption. Each SU selects its action primarily based on its utility history, and a rational user should opt for a strategy a lot of oftentimes if that strategy brings a better utility. Since there exist multiple primary channels, each contributory secondary user wants to confirm that channel to sense.

To answer this question, we propose associate “entropy” primarily based coalition formation rule, where a SU chooses to be a part of the coalition that brings the foremost info regarding the channel standing distribution. As a result, all the SUs sensing the same channel kind a coalition to collaboratively build the final call relating to the standing of the first channel. Since entropy is a measure of the uncertainty of the channel standing, each contributory secondary user joins the coalition that results in the biggest entropy reduction. This algorithm ensures that the contributory mammal genuses autonomously collaborates and self-organize into disjoint coalitions; and spectrum sensing of every channel is performed among the corresponding coalition severally.

We assess the performance of the planned theme in terms of detection likelihood and false alarm likelihood for every channel via simulation study. Our results demonstrate the effectiveness of the proposed theme in police work the presence of primary users, while maintaining a nice property of low warning likelihood.

The rest of the paper is organized as follows: Section II presents our system model, and Section III details the proposed system. Our simulation results are reported in Section IV. We summarize our work and conclude the paper in Section V.

II. SYSTEM MODEL

We take into account M primary channels and N secondary users in a psychological feature radio network, denoted by M= {1, 2... M} and N = {n1, n2... nN}, respectively. Let consider the system is time-slotted. At each time slot, M primary channels are perceived synchronously. In this paper, we style Associate in Nursing biological process game to facilitate every SU decide whether or not to participate in spectrum sensing or not, and partition all the contributing SUs into M coalitions, with each sensing one channel. The decision is formed by the coalition head supported majority vote, and is broadcast to all members within the same coalition. The problem of spectrum sensing may be developed as a binary hypothesis testing [2]:

$$x(t) = \begin{cases} n(t), & H_0 \\ hs(t) + n(t), & H_1, \end{cases} \quad (1)$$

Where x(t) is the signal received by the secondary user, s (t) is the primary users' transmitted signal, n(t) is the additive white Gaussian noise (AWGN), and h is the amplitude gain of the channel. Here H0 and H1 denote the hypothesis of the absence and presence, respectively, of the primary user within the considered channel. According to [9], the received signal x (t) will be reworked into a normalized output Y by energy detector. Then Y is compared to a detection threshold θ to decide whether the element is gift.

In a Rayleigh weakening atmosphere, the detection likelihood and false alarm probability of SU i sleuthing the standing of primary user/channel j square measure, respectively, given by Pd,i,j and Pf,i,j as follows [2]:

$$\begin{aligned} P_{d,i,j} &= P\{Y_{i,j} > \theta_j | H_1\} \\ &= e^{-\frac{\theta_j}{2}} \sum_{n=0}^{m-2} \frac{1}{n!} (\frac{\theta_j}{2})^n + (\frac{1+\overline{\gamma}_{i,j}}{\overline{\gamma}_{i,j}})^{m-1} \\ &\quad \times [e^{-\frac{\theta_j}{2(1+\overline{\gamma}_{i,j})}} - e^{-\frac{\theta_j}{2}} \sum_{n=0}^{m-2} \frac{1}{n!} (\frac{\theta_j \overline{\gamma}_{i,j}}{2(1+\overline{\gamma}_{i,j})})^n] \quad (2) \\ P_{f,i,j} &= P\{Y_{i,j} > \theta_j | H_0\} = \frac{\Gamma(m, \frac{\theta_j}{2})}{\Gamma(m)} \quad (3) \end{aligned}$$

Where Yi, j is the normalized output of SU I sensing the status of primary users j, θj is the detection threshold for primary user j, m is the time bandwidth product, $\overline{\gamma}_{i,j}$ denotes the average SNR of the received signal from the PU to SU, which is defined as $\overline{\gamma}_{i,j} = \frac{P_j h_{j,i}}{\sigma^2}$, with Pj being the transmit power of PU j, σ2 being the Gaussian noise variance, and $h_{j,i} = \frac{\kappa}{d_{j,i}^{\nu}}$ being the path loss between PU j and SU i; here k is the path loss constant, v is the path loss exponent, and d i,j is the distance between PU j and SU I, Γ(., .) is the incomplete gamma function and Γ(.) is the gamma function.

III. PROPOSED SYSTEM

There are two major stages in our cooperative spectrum sensing scheduling scheme. First, each SU decides whether to be a contributor or a free rider based on their utility history. Second, each contributor makes a decision on which channel to sense, i.e., which coalition to join.

Assume that all the secondary users are rational and selfish and they are all interested in maximizing their own utilities. To decide which action to take, the SUs perform the following update algorithm:

Initially, each SU (each player) has two choices (C-contributor, or F-free rider), and selects each choice with a probability of 50%.

At each time slot t:

Each player ni selects the action e ∈ {C, F} With probability pni (e, t);

Each player computes the utility Uni (e, t) for the selection of action e at time slot

Each user ni approximates the average utility for the action e within the past T time slots (including the slot t), which can be expressed as Ui (e); each user ni also approximates the average utility of the mixed actions (all the actions) U ni are less than T − 1 slots in the past, all slots need to be considered.

The probability of user ni selecting the action e ∈{C, F } for the next time slot can be computed by:

$$p_{n_i}(e, (t+1)) = p_{n_i}(e, t) + \eta_{n_i}[U_{n_i}(e) - U_{n_i}]p_{n_i}(e, t)$$

With ηni being the step size of adjustment determined by ni.

Algorithm: Cooperative Spectrum Sensing Scheduling

1. Initialization:

∀ni ∈ N selects a proper step size ηni ;
∀ni ∈ N, e ∈ {C, F}, pni (e, t) = 50%.

2. ∀ni ∈ N selects an action e with probability pni (e, t).
For each contributor Si ∈ C
Calculates the entropy for each channel j; Selects channel ˆj that brings in the largest entropy reduction; receives the utility determined by
U (nV) = R(nV) − E(nV) = μΔH (nV) – ωξ

3. After each contributor joins a coalition, each free rider Gets the largest entropy of the M channels Hmax; Receives the utility determined by
U (nV) = R(nV) − E(nV) = μΔH (nV) – ωξ

4. Each user updates the probability of each action for the next time slot by
t=t+1, go to Step 2

IV. SIMULATION RESULT

In our simulation study, we consider a network that consists of two PUs deployed in a 3km × 3km square area with SUs surrounding the PUs. We set the parameters following the simulation setup in [11], which are listed in Table I.

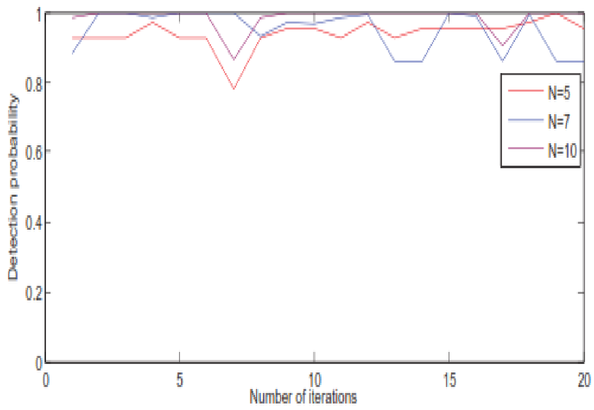
TABLE: 1, SYSTEM PARAMETER

Parameter	Semantic Meaning	Value
m	time bandwidth product	5
v	Path loss exponent	3
k	Path loss constant	1
ξ	energy consumption for spectrum sensing per slot	1
ω	equivalent revenue per unit energy	10
λ	the parameter to determine the value of penalty	10
μ	the parameter to determine the value of revenue	10
η	adjustment step size	0.06
H	entropy threshold	0.3
σ2	Gaussian noise variance	-90dBm
PP U	PU transmit power	100mW

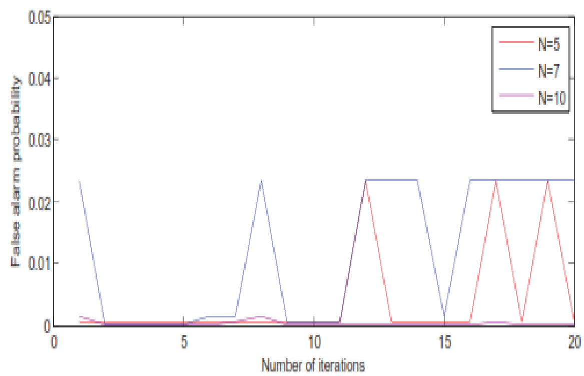
Since all the information required to create a call for every SU is its utility history, our algorithm is pure localized and distributed; therefore it scales well to massive networks. Therefore there is no got to simulate a network that contains several PUs/channels. Note that the results reported in this section are averaged over twenty runs

Since our algorithm allows some of the SUs to be free riders, apparently, the energy for spectrum sensing can be conserved. However, we also need to guarantee the detection performance for each channel. Figures 1a and 1b illustrate the detection probability and false alarm probability for channel 1, respectively. Similarly, the detection performance for channel 2 is shown in Figures 2a and 2b.

As depicted in Figure 1a and Figure 2a, our algorithm achieves high detection probabilities for both channels with different network scales. We also observe that a larger network results in a better detection probability. This improvement mainly comes from the fact that the increase in the network size implies more information could be used to estimate the channel status. Another nice feature of our algorithm is that the false alarm probabilities for both channels are effectively restrained. From Figures 1b and 2b, we can see that the false alarm probabilities are always below 0.025 for both channels.

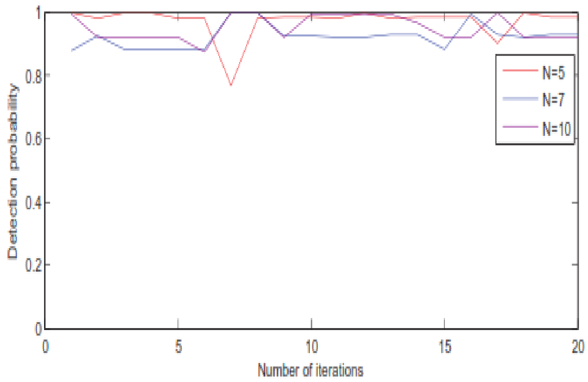


(a) Detection probability

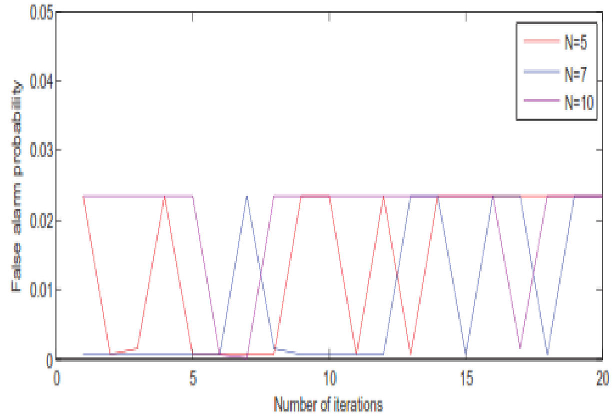


(b) False alarm probability

Fig. 1: Detection performance for channel 1.



(a) Detection probability



(b) False alarm probability

V. CONCLUSIONS

In this paper, we propose a novel plan of cooperative spectrum sensing programming once there are present M primary channels and N secondary users. Different from existing analysis focusing on cooperative sensing, the SUs in our thought have the freedom to settle on whether or not or to not contribute to spectrum sensing. Such a mechanism can facilitate to scale back the energy consumption for spectrum sensing. We additionally introduce the thought of entropy to estimate the channel standing distribution. The SUs build choices concerning that channel to sense based mostly on the entropy of every channel, and each contributor continuously selects to sense the channel that brings the foremost data of the standing distribution. This method effectively reduces the uncertainty of the channel status. According to the extensive simulation study, our scheme is verified to be effective and versatile. It achieves high detection likelihood and a low warning probability.

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