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Modelling and analysis of Cooperative Spectrum sensing potential by

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Abstract — Cognitive radio is a promising technology which provides a novel way to improve utilization of available spectrum. Spectrum sensing is a fundamental problem for cognitive radio. Cooperative spectrum sensing is an efficient way to detect spectrum holes in cognitive radio network. In this paper we review that in cooperative sensing for data and decision fusion we conduct some hypothesis test and on the basis of that we detect the presence of primary user.

Index Terms — Cognitive radio (CR), Spectrum holes, Primary user (PU), Energy detection, Centralized spectrum sensing, hard data and decision fusion.

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INTRODUCTION

The radio spectrum which is very essential for wireless communication is a nature limited resource. Fixed Spectrum Access (FSA) policy has traditionally been adopted by spectrum regulators to support various wireless applications. According to FSA each part of spectrum with definite bandwidth will be hand over to one or more dedicated users also known as licensed user's. Only these users have right to use the allocated spectrum and other users are not allowed to use it. On the other hand, recent studies of spectrum utilization measurements shows that a large segments of licensed spectrum experiences less utilization, i.e, most of the time spectrum is in ideal condition and is not used by licensed users. To overcome this situation Dynamic Spectrum Access (DSA) [1], was introduced. It allows radio spectrum to be used in a more effective manner. According to DSA a small part of spectrum can be allocated to one or more users, which are called primary users (PUs); however the use of that spectrum is not fully granted to these users, although they have higher priority in using it. Other users, which are referred to as secondary users (SUs), can also access the allocated spectrum as long as the PUs are not temporally using it. This opportunistic access should be in a manner that it does not interrupt any primary user in band. Secondary users must be aware of the activities done by the primary user so that they could spot the spectrum holes and the ideal state of the primary users in order to utilize the free band and also rapidly evacuate the band as soon as the primary users becomes active.

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The rest of the paper is organized as follows.In section II, we revealed cognitive functionalities which include cognitive cycle.

Spectrum Sensing is being examined in Section III, section IV Formulation of system model in systemvue. Results in Section V and Conclusion in section VI.

II. COGNITIVE RADIO FUNCTIONALITIES

According to S.Hykin "Cognitive Radio" is an intelligent wireless communication system that is aware of its surrounding environment [2] (i.e. outside world), and uses the methodology of understanding by building to learn from the environment and adapt its internal states to statistical variations in the incoming RF stimuli by making corresponding changes in certain operating parameters in real-time, with two primary objectives in mind:

- Highly reliable communications
- Efficient utilization of the radio.

From the above mention definition two characteristics of cognitive radio can be summarized as cognitive radio can be summarized as cognitive and reconfigurability. The first one enables the cognitive radio to interact with its environment in a real-time manner, and intelligently determine based on quality of service (QoS) requirements. Thus these tasks can be implemented by a basic cognitive cycle: Spectrum sensing, spectrum analysis and spectrum decision as shown in Fig. 1

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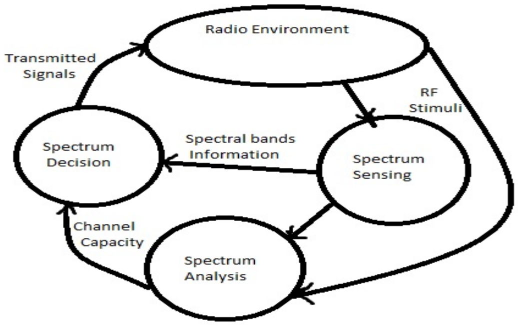


Fig.1. Cognitive Capability of cognitive radio enabled by a basic cognitive cycle.

III. SPECTRUM SENSING

We consider a CR network composed of K CRs (secondary users) and a common receiver, as shown in Fig.1. We assume that each CR performs spectrum sensing independently and then the local decisions are sent to the common receiver which known as Fusion Center [8] which can fuse all available decision information to infer the absence or presence of the PU. The essence of spectrum sensing is a binary hypothesis-testing problem:

*H*0: primary user is absent;
*H*1: primary user is in operation.

In the following we only consider the spectrum sensing at CR *i*. The sensing method is to decide between the following two hypotheses,

$$xi(t) = \begin{cases} wi(t), & H0 \\ h(t)s(t) + wi(t), & H1 \end{cases} \qquad (1)$$

where $xi(t)$ is the received signal at the *i*th CR in time slot *t*, $s(t)$ is the PU signal, $wi(t)$ is the additive white Gaussian noise (AWGN), and $hi(t)$ denotes the complex channel gain of the sensing channel between the PU and the *i*th CR. We assume that the sensing time is smaller than the coherence time of the channel. Then, the sensing channel $h(t)$ can be viewed as time-invariant during the sensing process. Without loss of generality, we denote $h(t)$ as hi. Moreover, we assume that the status of the PU remains unchanged during the spectrum sensing process.

In cooperative spectrum sensing, each cooperative partner makes a binary decision based on its local observation and then forwards one bit of the decision Di (1 standing for the presence of the PU, 0 for the absence of the PU) to the common receiver through an error-free channel. At the common receiver, all 1-bit decisions are fused together according to OR logic rule [6].

$$Y = \sum_{i=1}^{k} Di \begin{cases} \geq n, H1 \\ < n, H0 \end{cases} \qquad (2)$$

where $\mathcal{H}0$ and $\mathcal{H}1$ denote the inferences drawn by the common receiver that the PU signal is *not* transmitted or transmitted, respectively. The threshold n is an integer.

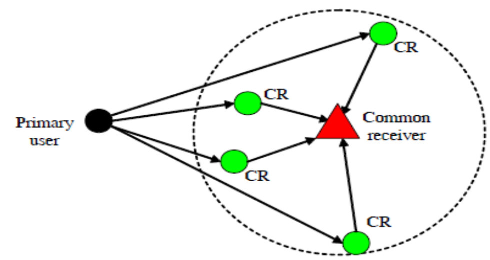
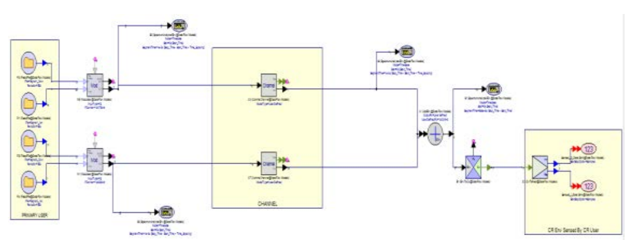


Fig. 1 Spectrum sensing structure in a cognitive radio network.

IV. FORMULATION OF SYSTEM MODEL IN SYSTEM VUE

SystemVue Model consist of "Cognitive spectrum sensing" to find spectrum holes (unutilized spectrum) using detect spectrum Algorithm and the "Hard data & decision Fusion" which gives the Cooperative decision for the presence or absence of the primary user.



(a)

(b)

Fig. 1 (a) Cognitive Spectrum sensing, (b) Hard Data & decision Fusion.

V. RESULTS

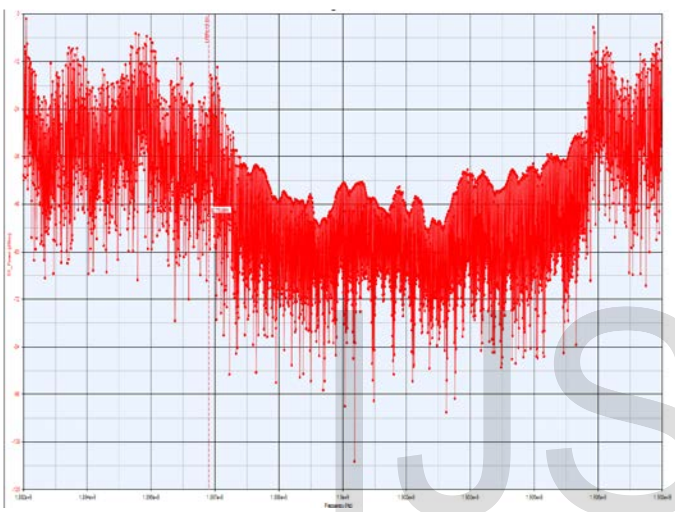
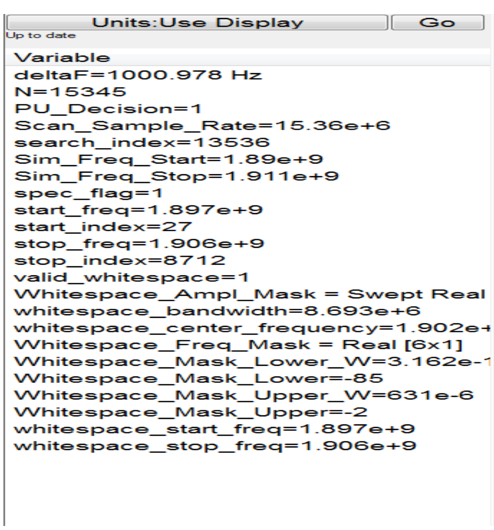


Fig. 1 Show two primary users at 1.907GHz and 1.895GHz.



Units:Use Display Go
Up to date
Variable
deltaF=1000.978 Hz
N=15345
PU_Decision=1
Scan_Sample_Rate=15.36e+6
search_index=13536
Sim_Freq_Start=1.89e+9
Sim_Freq_Stop=1.911e+9
spec_flag=1
start_freq=1.897e+9
start_index=27
stop_freq=1.906e+9
stop_index=8712
valid_whitespace=1
Whitespace_Ampl_Mask = Swept Real
whitespace_bandwidth=8.693e+6
whitespace_center_frequency=1.902e+
Whitespace_Freq_Mask = Real [6x1]
Whitespace_Mask_Lower_W=3.162e-1
Whitespace_Mask_Lower=-85
Whitespace_Mask_Upper_W=631e-6
Whitespace_Mask_Upper=-2
whitespace_start_freq=1.897e+9
whitespace_stop_freq=1.906e+9

Fig. 2 Data base of the current status of CR Environment.

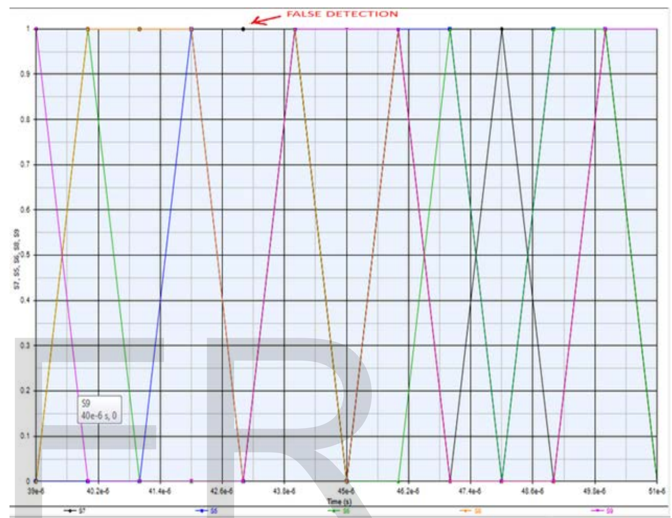


Fig. 3 Cooperative Decision on the presence of primary user by 4CR users.

VI. CONCLUSION

We have studied the performance of cooperative spectrum sensing with energy detection in cognitive radio networks. Basically the Cooperative sensing gives the advantage over the individual sensing when the SUs are in fading effect. As a motivation for future work, we intend to improve the algorithm and compare the implementation with real time environment.

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