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Spectrum Sensing and Allocation In Cognitive Radio Networks

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ABSTRACT: With the increasing of communication applications in recent years, the demand for radio spectral resources has in- creased significantly. Cognitive radio scenario was proposed to improve spectrum efficiency in wireless communication systems. Sensing/monitoring of spectrum-availability has been identified as a key requirement for spectrum allocation in cognitive radio networks (CRNs). In this paper a framework model is designed to detect Primary and Secondary users and each spectrum is characterized by jointly considering primary user activity and spectrum sensing operations. In the final step the decision model is proposed to allocation the spectrum to the cognitive users without affecting the Primary Users. Spectrum decision is the ability of a cognitive radio (CR) to select the best available spectrum band to satisfy secondary users' (SUs') quality of service (QoS) requirements, without causing harmful interference to licensed or primary users (PUs).

KEYWORDS: Cognitive Radio, Primary Users (PUs) detection, Secondary Users (SUs) detection, Spectrum Selection, Spectrum Allocation.

I. INTRODUCTION

Recent advancements in wireless technologies, such as software defined radios (SDRs), promise to address some of the major limitations experienced in legacy wireless communication systems. One of these limitations is inefficient utilization and management of the radio frequency (RF) spectrum in both licensed and unlicensed bands. Recently, because of the increase in spectrum demand, this policy is faced with spectrum scarcity at particular spectrum bands. On the contrary, a large portion of the assigned spectrum is still used sporadically leading to underutilization of the significant amount of spectrum. Hence, dynamic spectrum access techniques have recently been proposed to solve these spectrum inefficiency problems. The key enabling technology for dynamic spectrum access techniques is the cognitive radio technology, which provides the capability to share the wireless channel with licensed users (or primary users) in an opportunistic manner. Cognitive radio (CR) networks are envisioned to provide high bandwidth to mobile users via heterogeneous wireless architectures and dynamic spectrum access techniques. CR networks, however, impose unique challenges because of the high fluctuation in the available spectrum as well as the diverse quality-of-service (QoS) requirements of various applications. To address these challenges, first, CR networks are required to determine which portions of the spectrum are available, called spectrum sensing. Furthermore, how to coordinate multiple CR users to share the spectrum band, called spectrum sharing, is another important issue in CR networks. Generally, CR networks have multiple available spectrum bands over a wide frequency range that show different channel characteristics, and need to support applications with diverse service requirements. Therefore, once available spectrum bands are identified through spectrum sensing, CR networks need to select the proper spectrum bands according to the application requirements. This process is referred to as spectrum decision, which constitutes an important but yet unexplored topic in CR networks. According to the PU activities, total capacity in CR networks varies over time, which makes it more difficult to decide on spectrum bands while maintaining the service quality of other CR users. Thus, the CR network should perform spectrum decision adaptively.

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II. LITERATURE REVIEW

Most of the research on spectrum sharing in CR networks has mainly focused on how to efficiently allocate either spectrum or power among CR users subject to interference constraints. Then four main challenges of spectrum management are discussed: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility [1]. The control channel plays an important role in exchanging information regarding sensing and resource allocation. Several methods described in [2] are assumed to be used as the common control channel in our proposed method. For spectrum allocation, a global optimization scheme is developed based on graph theory where a general framework is defined which solves the spectrum access problem and maintains overall system utility [3]. However, when the network topology changes according to the node mobility, the network needs to be completely recomputed spectrum assignment leading to a higher computational and communication overhead. To solve this problem, a distributed spectrum allocation based on local bargaining is proposed in [4]. For the resource-constrained networks such as sensor and ad hoc networks, a rule-based spectrum management is proposed, where CR users access the spectrum independently according to both local observation and predetermined rules [5]. In [6] a dynamic channel selection scheme is developed for delay-sensitive applications based on a priority queuing analysis and a decentralized learning algorithm. In [7] issues related the designs of wide band signal path are discussed. In [8] an optimal power allocation scheme is proposed to achieve ergodic and outage capacity of the fading channel under different types of power constraints and fading models. In [9] joint beam-forming and power allocation techniques are presented to maximize the user capacity while ensuring the QoS of primary users. Game theory provides an efficient distributed spectrum sharing scheme by describing the conflict and cooperation among CR users and hence allowing each user to rationally decide on its best action. Thus, it has been widely exploited for both channel allocation [10] and for power allocation [11].A survey of spectrum sensing methodologies for cognitive radio in [12] covers various aspects of spectrum sensing problems are covered and co-operative spectrum sensing concept is discussed. In [13] an overview of the problem of spectrum assignment in cognitive radio networks is given and most basic approaches to overcome this problem have been analyzed. Various aspects of Cognitive radio in [14] discuss the salient features of CR as highly reliable communication and efficient utilization of radio spectrum. In [15] a survey on growing demand of cognitive radio is focused which covers important aspects like spectrum sensing and spectrum allocation for unlicensed users.

III. PRIMARY USERS DETECTION IN SPECTRUM

In order to allocate the spectrum to primary and secondary users, first the users need to be generated and sensed in a spectrum. Fig1 (a) and fig2 (a) is a simulink model developed to generate primary users in a spectrum. The method of generation of primary users is different in both the figures mentioned.

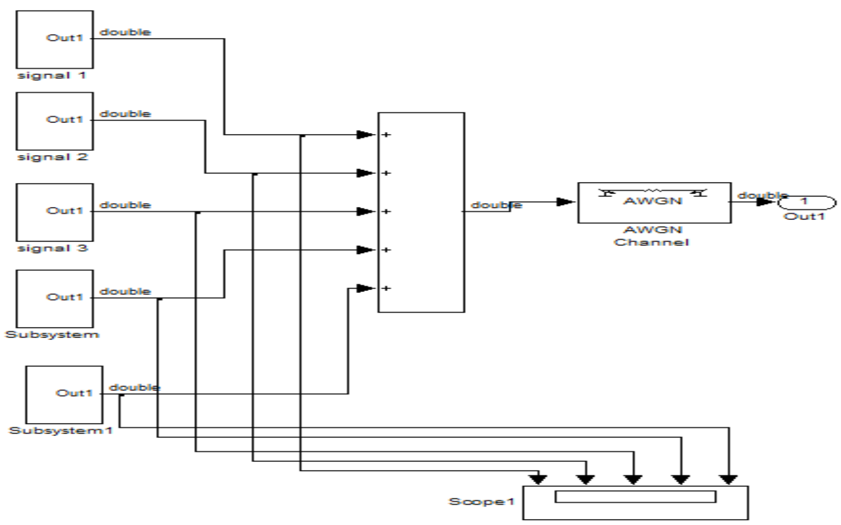

Fig 1(a) Detection of Primary Users using Binary Number series

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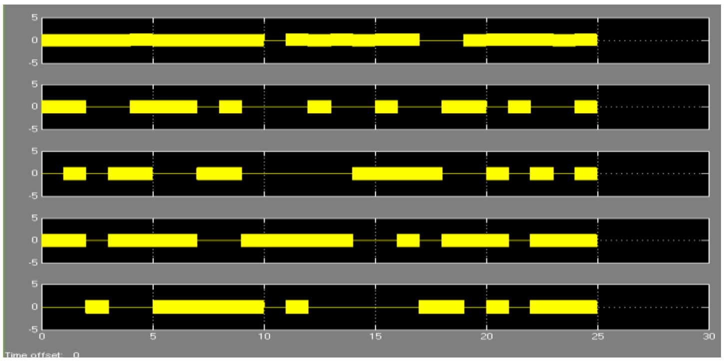

Fig 1(b) Generation of Random Primary Users Signals

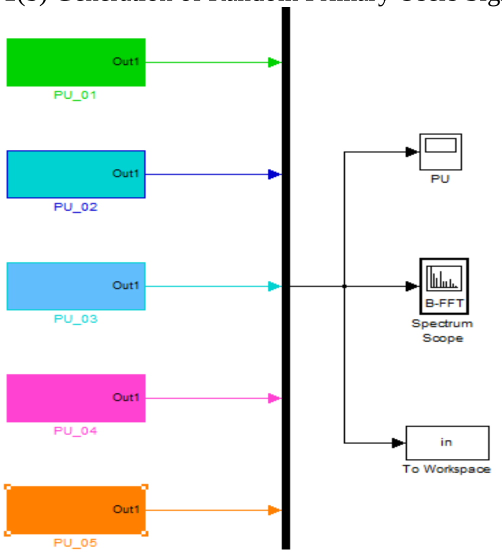

Fig 2(a) Detection of Primary Users Using Bernoulli Random Number Series

The main system for detection of PUs using Binary number series is shown in fig1 (a) and detection of PUs using Bernoulli series is shown in fig2 (a).

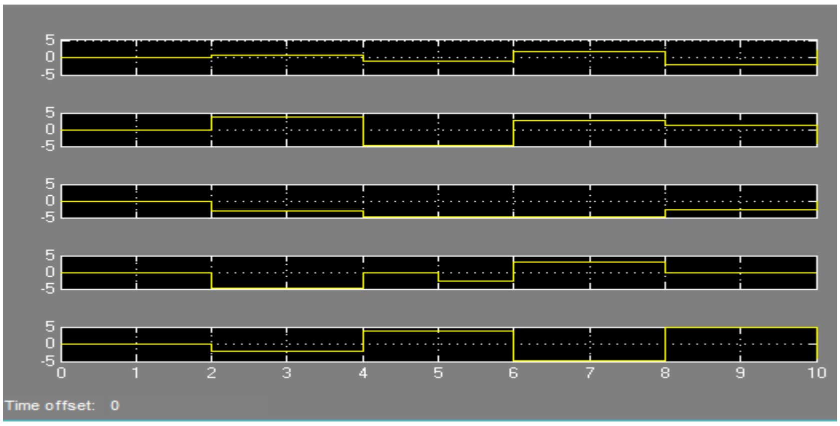

Fig 2(b) Generation of Primary Users Signals Using Bernoulli Random Series

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The Bernoulli series generates the non-repetitive sequence of signals. The main difference between fig1(b) and fig2(b) is that the earlier graph is generated using QAM technique whereas the other signal is generated using Bernoulli series. Further these five random signals are combined together and given to the workspace for comparing it with the Secondary Users or unlicensed users signal. The PUs signal is fed to the spectrum sensing block.

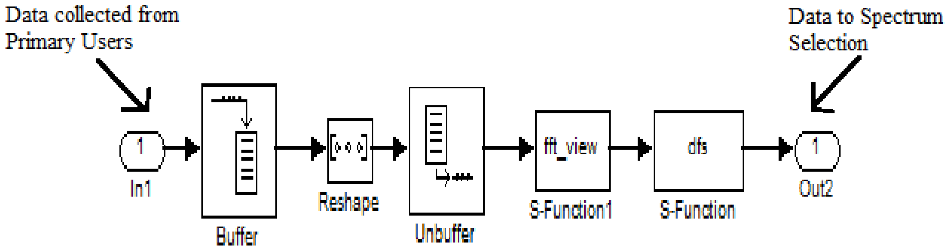

Fig 3(a) Spectrum Sensing Model

Data collected from multiple Primary Users is given to the spectrum sensing model as shown in fig 3(a). Spectrum sensing model consists of various blocks with different functions. The Buffer block redistributes the input samples to a new frame size. It collects the primary users' signals and sends the signals to the reshape block. The Reshape block changes the dimensionality of the input signal to a 2-D signal. The unbuffer block adjusts the output rate so that the sample period is the same at both the input and output.

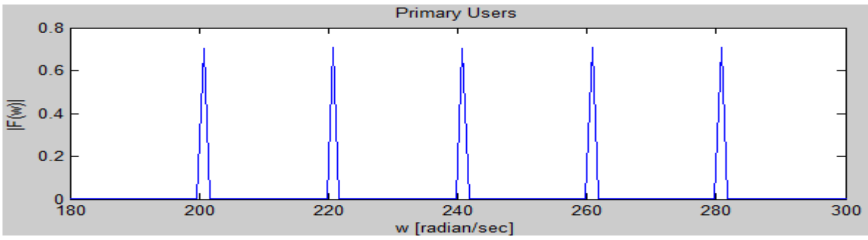

Fig 3(b) PUs sensed for Random Number series Generator

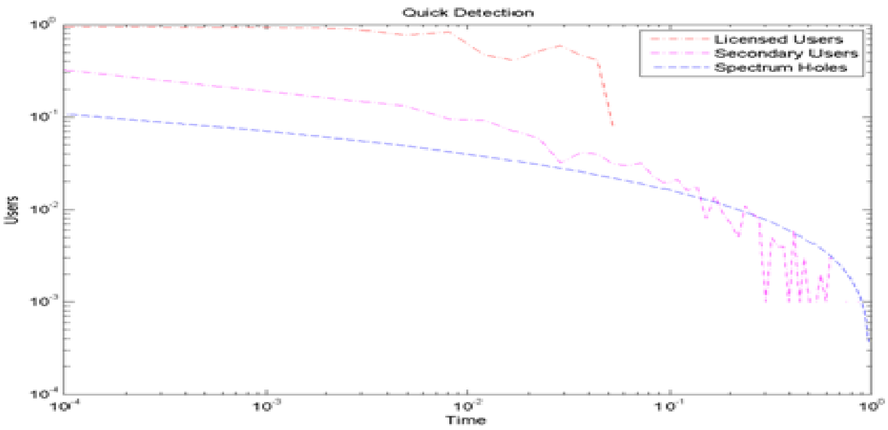

Fig 3(c) PUs sensed by Bernoulli Number Series Generator

The fig3(c) consist of PUs , SUs and Spectrum holes whereas fig3(b) consist of PUs sensed in spectrum for generation of Secondary Users uniform random number series generator is used which takes value from -1 to 1 as shown in fig 4(a).

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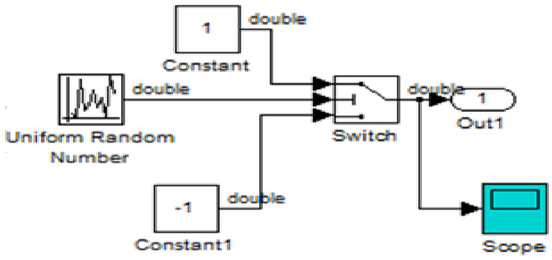

Fig 4(a) Secondary Users detection in Spectrum

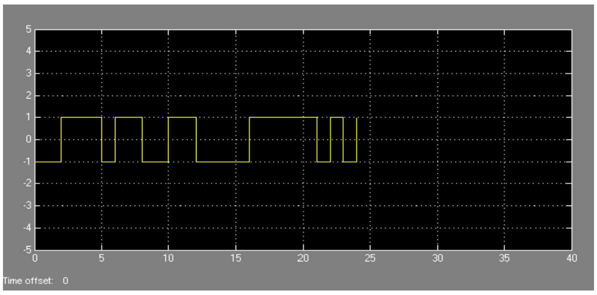

Fig4(b) Random signals for Secondary Users

IV. RESULT AND DISCUSSION

The Secondary Users signal and the Primary Users signals which are sensed in a sensing model are fed to the frequency selection block shown in fig5 (a) and further the product of Primary and Secondary Users is taken and Spectrum allocation is done as per the presence of users in a spectrum in fig5 (b) and (c).

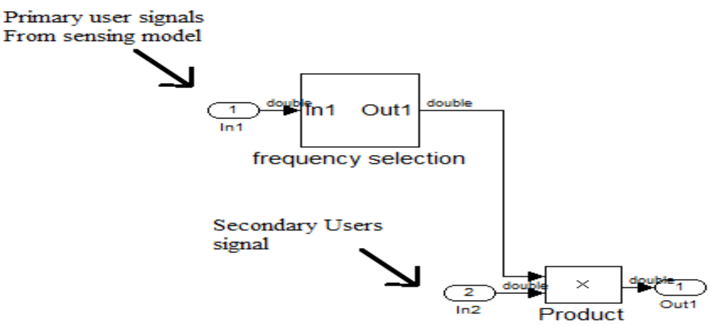

Fig 5(a) Frequency selection for PUs and SUs

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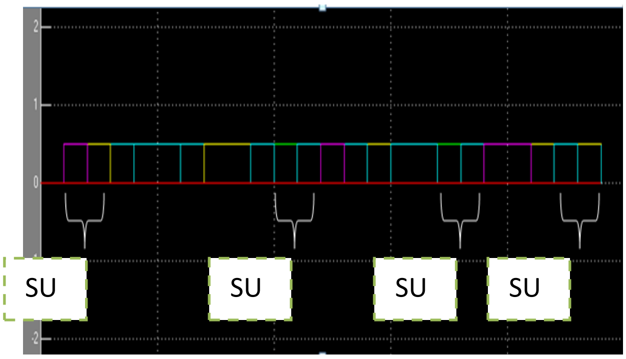

Fig 5(b) Spectrum allocation for PUs and SUs for Binary Number Series

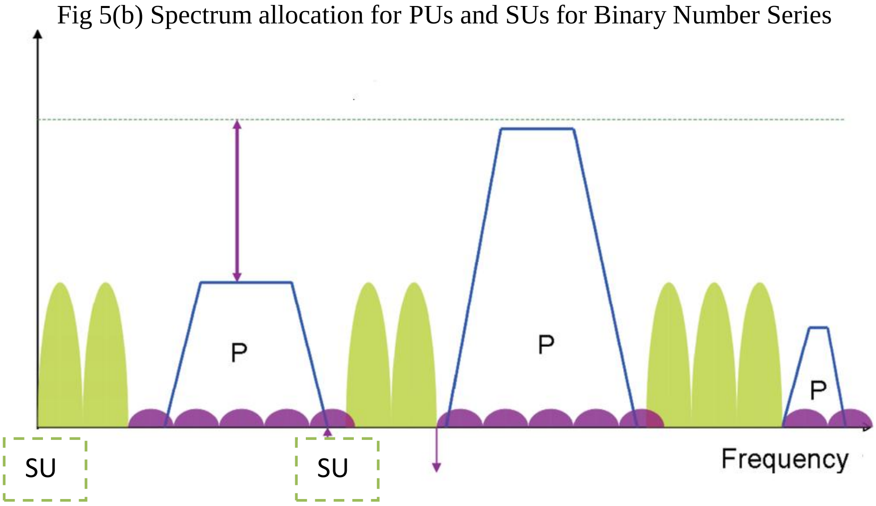

Fig 5(c) Spectrum allocation for PUs and SUs for Bernoulli's Series Generator

The main difference in spectrum allocation done is that in fig 5(b) the binary number series is used for signal generation where 0 means user is absent and 1 means user is present whereas fig 5(c) uses Bernoulli's series generator which generates series of non-repetitive signals using binary numbers

.

V. CONCLUSION

The main purpose of spectrum sensing and allocation is to utilize the spectrum efficiently. In this work a spectrum allocation scheme is proposed so that Secondary users or cognitive users can also use the unused spectrum when a licensed or primary user is absent in the spectrum. Cognitive radio is different from conventional radios as conventional radios sees vacant spectrum as interference whereas cognitive radio sees vacant spectrum as an opportunity.

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