

Spectrum Sensing Using CSMA Technique

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Abstract — Cognitive Radio is an emerging frontier to tackle the ever increasing demand of spectral needs. The most important function of CR is to search for spectrum holes or white spaces in the spectrum. Many techniques has been introduced and researched to increase the efficiency and accuracy of Spectrum Sensing. With the introduction of more complex methods cost of the whole process also increases. The following paper suggests a new idea of involving CSMA technique for spectrum sensing. This paper will give an insight on working of CR and CSMA technique. Later it will put forward the criterion for spectrum sensing and how CSMA can be used for investigate the presence of primary user in the spectrum vicinity.

I. INTRODUCTION

Joseph Mitola-III first coined the term “Cognitive Radio”. According to him “*Cognitive Radio (CR) is a type of Software Defined Radio which continuously monitors its RF environment for Spectrum holes and provides this unused frequency band to another user*”^[1]. The original licensed user are called primary user whereas the users to whom the spectrum holes are provided for usage are termed as secondary user. The CR uses various Spectrum Sensing methods to detect the spectrum holes in the RF spectrum. It then estimate the timing for which spectrum would be allotted, then use Dynamic spectrum management techniques to allocate the unused frequency to secondary user through different Power Control methods to communicate between its users undisturbed. The term spectrum holes may be defined as ‘*The spectrum holes is a band of frequencies assigned to a primary user, but, at a particular time and specific geographic location, the band is not being utilized by that user*’. Because of its high awareness about its environment CR uses the methodology of understanding- by-building to learn from the environment and adapt to statistical variations in the input stimuli, with two primary objectives in mind:

- A trustworthy system for communication whenever and wherever needed;
- Well-organized utilization of the radio spectrum.

II. SPECTRUM SENSING

The main objective for CR network to achieve is to grant extremely trustworthy communications whenever and wherever needed and to exploit the radio spectrum resourcefully. To utilize the radio spectrum the CR needs to search for the spectrum holes within the spectrum and provide it to secondary user. Here, the term “Spectrum holes” stands for those sub bands of the radio spectrum that are not used by PU at a particular instant of time and specific geographic location (Fig. 1.). Spectrum Sensing, defined as the process of searching spectrum holes in the radio spectrum in local neighborhood of the cognitive radio receiver. It facilitates the cognitive radio to continuously monitor a licensed frequency band and smartly transmits whenever it doesn’t detect a primary signal. With ability of parallel detection and reaction to the spectrum usage, these types of secondary users can be considered as the basic forms of cognitive radio. The basic prerequisites for spectrum sensing are the full awareness of its radio environment and acquaintance of its geographical location. The responsibilities executed spectrum sensing unit involves^[2]:

- 1) Recognition of possible spectrum holes;
- 2) Spectral resolution of each spectrum hole;
- 3) Estimation of the spatial directions of incoming interferes;
- 4) Signal classification.

III. CSMA

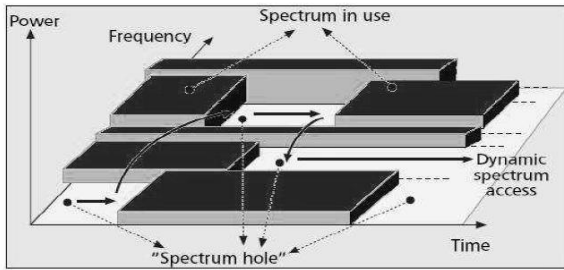


Fig.1. Spectrum Holes [2]

Multiple access methods are the techniques of allowing multiple users to use a transmission medium or channel for transmission and reception purposes. Media Access Control (MAC) provides addressing and channel access control mechanisms that make it possible for users to use channel in multiple access.

Carrier Sense Multiple Access (CSMA) is a MAC protocol in which user first validates about the channel whether it is pre-occupied by any other user or not before transmission. It is based on the principle “Sense before Transmit” or “Listen before Talk” [4].

IV. CSMA with Cognitive radio

CR make use of spectrum sensing techniques for searching the spectrum holes which are nothing but free channels in the dedicated spectrum. CSMA techniques also verify that channel is free for use or it is pre-occupied. Thus we can combine CR technology with CSMA. The simplest way for spectrum sensing is by using Energy Detection (ED) technique. The Energy Detection technique is based on the principle that if a primary user is present in the spectrum then there will exist a finite amount of energy in the associated channel. If we analyze the whole spectrum measuring the energy level at each level we can estimate the presence of primary user. But the ED technique has a major flaw that when the signal is continuous in nature the energy of the signal become infinite. So for this purpose we are measuring the power content in the channel instead of energy. For this purpose we are making use of Power Spectral Density (PSD) graph for estimating the power in different channels.

V. EXPERIMENTAL

For the simulation of above idea we are using MATLAB simulation software. We have taken exponential test signal as an input and 5 channels through which test signal will be transmitted after modulation. The carrier frequency for each channel is different and here it is 1KHz for channel 1, 2KHz for channel 2, 3KHz for channel 3, 4KHz for channel 4 and 5KHz for channel 5. At the receiver end, the signals from different channels are combined and their FFT is taken. Through the FFT result we obtain PSD for the combined signals.

VI. RESULT AND DISCUSSION

When simulated the PSD graph thus obtained when all channels are occupied is shown in fig.2. Here we can see that PSD curve has some positive finite power when curves get near to carrier frequencies and decreases there after.

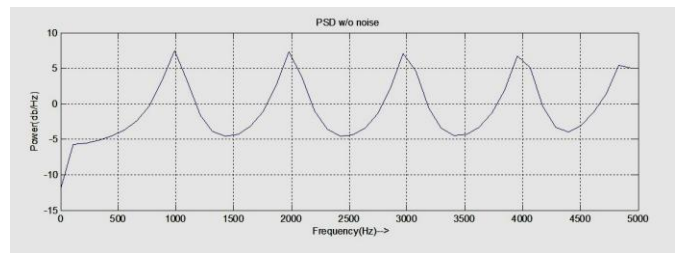


Fig.2. PSD graph when all channels are occupied

So we can conclude that the system will detect primary user at these carrier frequencies.

When some of the channels are unoccupied there will be zero power measured in that channel as no signal will be flowing through that channel. There will be absence of some peaks in the PSD graph of fig.2. As shown in fig.3, upon comparing with fig.2 we see that there will be no peaks for channel 1 and 4 indicating the absence of PUs in that channel.

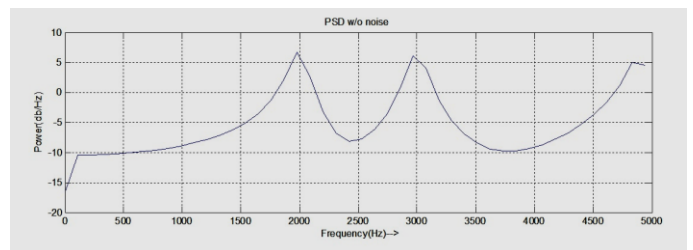


Fig.3. PSD graph when 2 channels are absent.

The information thus generated by the receiver can be fed back to transmitter to determine whether another transmission is in progress before initiating any transmission.

VII. CONCLUSION AND FUTURE WORK

In this paper, we had proposed a method for spectrum sensing with the help of CSMA MAC protocol and energy detection using PSD. We had simulated the method using MATLAB to get the desired result. For further improvement of the process presence of noise and attenuation could be taken into consideration. Also the problem of 'hidden terminals' and 'exposed terminal' had to be dealt with so as to improve the performance of the system.

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