Spectrum Sensing In TVFF Channels for Cognitive Radios with Combined Sensing Technique

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Abstract: Cognitive radios are indispensable to shift paradigm from conventional exclusive spectrum assignment to dynamic spectrum access. They can boost up spectrum utilization significantly, by dynamically accessing unused primary spectrum while bringing no harm to primary users. The envisioned radio calls for fast and accurate spectrum sensing. Researchers are focusing on cooperative spectrum sensing to improve reliability but still there is room for improvement in local spectrum sensing. In cooperative spectrum sensing, it will be hard to cooperate with local network nodes in a short time as cognitive radio has to operate in heterogeneous wireless networks. Most of the renowned local spectrum sensing technique in the literature up to now is matched detection, although it is reliable but computationally complex. Other well-known local sensing techniques are energy detection and matched filter detection. This paper proposes an adaptive local spectrum sensing scheme, in which cognitive radio can adopt one-order matched filter or energy detector for spectrum sensing on the basis of estimated SNR, which is calculated in advance for available channels. Simulation results indicate that we can achieve reliable results equal to one-order matched filter detection with less mean detection time.

Keywords: Cognitive radio networks, Spectrum sensing, Energy detection, Matched filter detection.

INTRODUCTION

With the increase of customers in wireless network services, the demand for radio spectrum is also increasing significantly. The trend of new wireless devices and applications is expected to continue in coming years which will increase the demand for spectrum. The conventional fixed spectrum assignment policy is a big hurdle in the innovation of new technologies. In 2008, the Federal Communication Commission (FCC) allowed the unlicensed fixed and personal/portable devices in rural and urban area [1].

Cognitive Radio (CR) is a key technology that can help mitigate scarcity of spectrum. The most essential task of CR is to detect licensed user/Primary User (PU); if PU is absent, then spectrum is available for cognitive radio user/Secondary User (SU) and is called spectrum hole/white space. The process of detection of PU is achieved by sensing radio environment and is called spectrum sensing [2-4]. The prime concerns of spectrum sensing are about two things first, the primary system should not be disturbed by Communication and secondly, spectrum holes should be detected efficiently for required throughput and quality of service (QoS) [5].

RELATED WORK

Here in this thesis we are considering the main two spectrum sensing techniques for cognitive radios which are energy detection and matched filter detection. Energy detection is a simple technique that has short sensing time, but its performance is poor under low Signal to Noise Ratio (SNR) conditions [12]. The firmness on whether the signal is present or absent on the channel can be expedited if we pass the signal through a filter that will accentuate the useful signal and suppress the noise signal [11]. A Matched Filter will peak out the signal component at some instant of time and suppress the noise amplitude at the same time. If Signal is present on the channel, a large peak at this instant will occur and if the signal is absent, no such peak will appear. This prearrangement will make it possible to decide whether the signal is present or not in the channel. A matched filter detection technique is the optimal linear filter used to maximize the signal to noise ratio (SNR) in the presence of additive white Gaussian noise [9]. Cooperation among CUs are established to estimate the PU's presence or absence, fusion Centre (FC) is used to take the overall resolution about the PU's.

ENERGY DETECTION METHOD

Figure 1 depicts the block diagram of the energy detector. The elementary approach behind the energy detector is the estimation of the power of the received signal r(t)[8]. To evaluate the power of the received signal, the output of the band pass filter of bandwidth W is squared and integrated over an interval T. Finally, the integrated value is compared with a threshold λ1 to decide whether the PU is present or not .

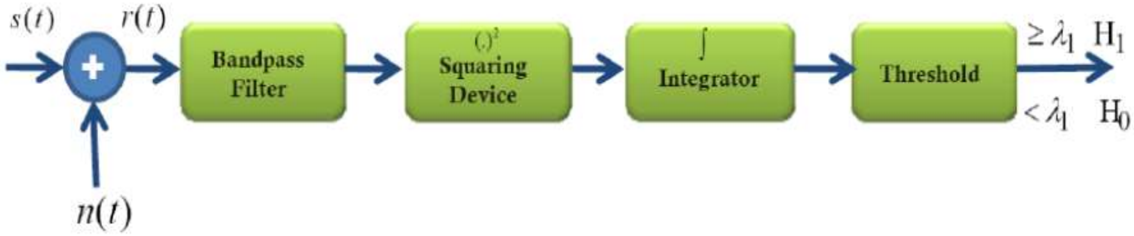

Fig 1: Block diagram of energy detection

The block diagram for the energy detection technique is shown in the Figure 1. In this method, signal is passed through band pass filter of the bandwidth W and is integrated over time interval. The output from the integrator block is then compared to a predefined threshold. This comparison is used to discover the existence of absence of the primary user [7]. The threshold value can set to be fixed or variable based on the channel conditions. The ED is said to be the Blind signal detector because it ignores the structure of the signal. It estimates the presence of the signal by comparing the energy received with a known threshold ν derived from the statistics of the noise. Analytically, signal detection can be reduced to a simple identification problem, formalized as a hypothesis test,

y (k) = n(k)........................H 0

y (k) = h ∗ s(k) + n(k).........H1

Where y(k) is the sample to be analysed at each instant k and n (k) is the noise of variance σ2. Let y (k) be a sequence of received samples k ϵ {1, 2....N} at the signal detector, then a decision rule can be stated as,

H 0 ....if ε < v

H 1 ....if ε > v

Where ε=|E y(k)|2 The estimated energy of the received signal and v is chosen to be the noise variance σ2 [10].

MATCHED FILTER METHOD

A matched filter (MF) is a linear filter designed to maximize the output signal to noise ratio for a given input signal [3]. When secondary user has a priori knowledge of primary user signal, matched filter detection is applied. Matched filter operation is equivalent to correlation in which the unknown signal is convolved with the filter whose impulse response is the mirror and time shifted version of a reference signal [6]. The operation of matched filter detection is expressed as:

$$Y[n] = \sum_{K=\infty}^{\infty} h[n-k]\,x[k] \qquad (3)$$

Where 'x' is the unknown signal (vector) and is convolved with the 'h', the impulse response of matched filter that is matched to the reference signal for maximizing the SNR [2]. Detection by using matched filter is useful only in cases where the information from the primary users is known to the cognitive users [10].

Fig 2: Block diagram of Matched Filter Detection

Figure 3.6 depicts matched filter based spectrum sensing method for primary user detection [5]. Considering that a complete signal information of the primary user signal is required in this case the matched filter method is not really recommended by the system designers to suit our purpose here unless when the complete signal information is known to the secondary user.

THE COMBINED SENSING TECHNQUE

Here we are combining the two well-known sensing techniques explained above for the better sensing results [1]. The block diagram representation of such an idea is shown below in Fig 3.

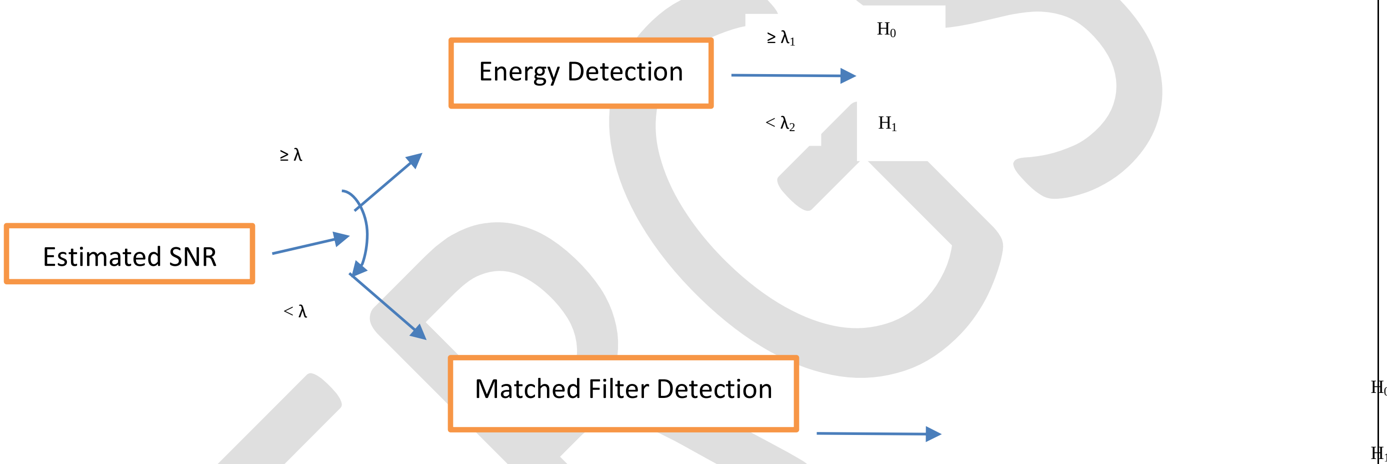

Fig 3: Block diagram of combined sensing technique.

In this method first we find the SNR from the environment and according to a threshold value the signal is fed to either Energy detection method or Matched filter method. If the value is less than or equal to the threshold we fed it to ED and if not then fed it to MF detector. By doing so the effective sensing efficiency is improved and we obtain a better probability of detection than if either of one is individually used[4].

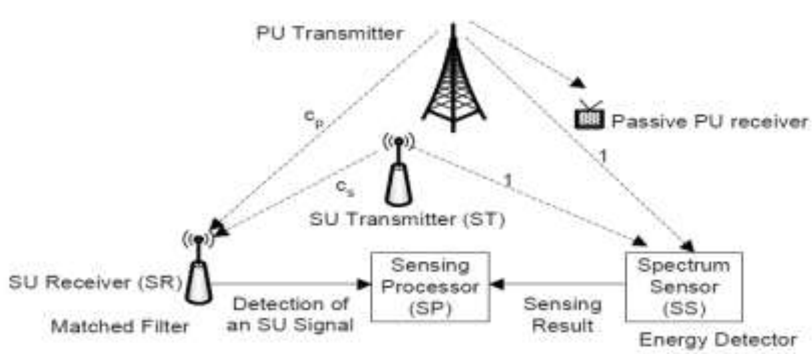

Fig 4: Working of combined sensing method.

Simulation Results

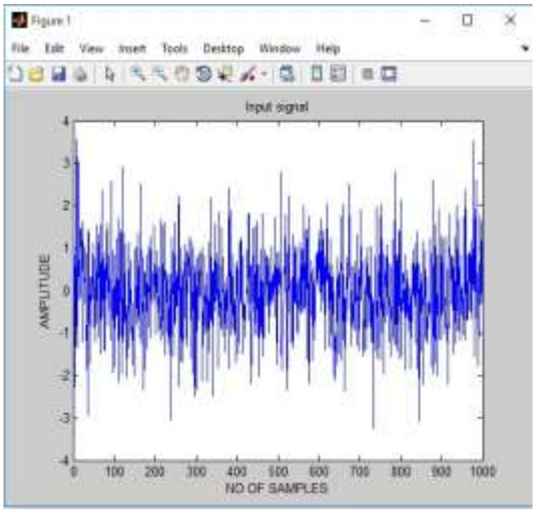

Fig 5: Input Signal

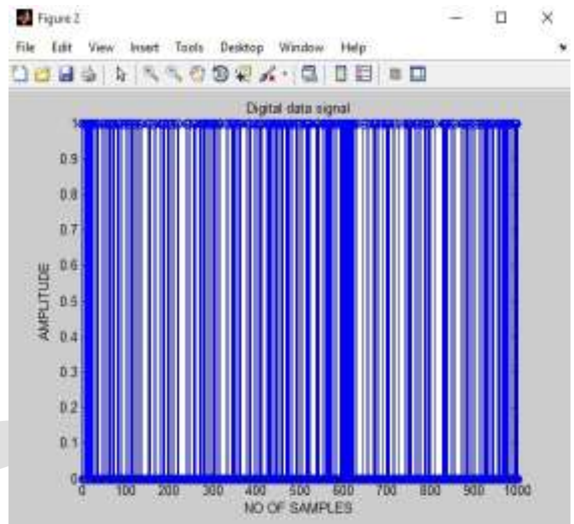

Fig 6: Digital Data Signal

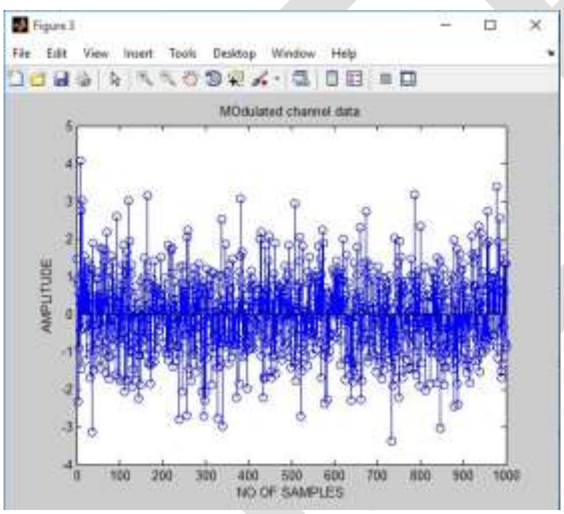

Fig 7: Modulated Channel Data

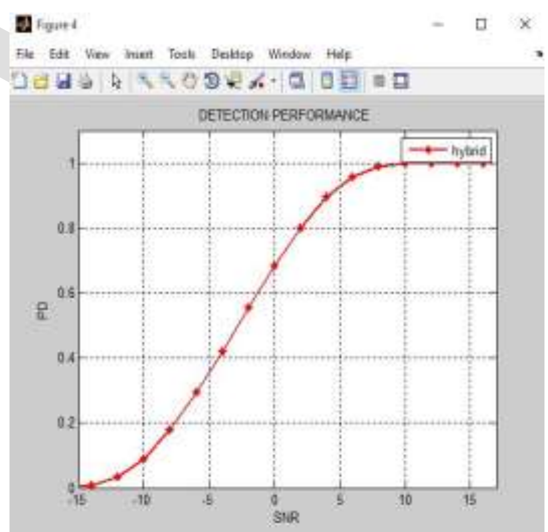

Fig 8: Detection Performance

Conclusion

In order to sense the spectrum holes consistently and resourcefully, in this paper we propose matched filter and ED method based cooperative spectrum sensing in CR networks. Here we adapt the advantages of both Energy detection methods and Matched Filter Detection method. Initially we are taking the signal data and fed it to both these detectors and by acting as a combined unit the resultant detection process stands out among the individual performances.

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