

Chapter 2

Cepstrum–Based Spectrum Hole Search in Different Fading Scenario in Cognitive Radio Network

Srijibendu Bagchi

RCC Institute of Information Technology, India

ABSTRACT

Cognitive radio is now acknowledged as a potential solution to meet the spectrum scarcity problem in radio frequency range. To achieve this objective proper identification of vacant frequency band is necessary. In this article a detection methodology based on cepstrum estimation has been proposed that can be done through power spectral density estimation of the received signal. The detection has been studied under different channel fading conditions along with Gaussian noise. Two figures of merit are considered here; false alarm probability and detection probability. For a specific false alarm probability, the detection probabilities are calculated for different sample size and it has been established through numerical results that the proposed detector performs quite well in different channel impairments.

INTRODUCTION

Due to proliferation of diverse state-of-the-art wireless applications, spectrum demand is excessively high over a couple of decades. However, static spectrum allocation (SSA) policy has been revealed as a bottleneck to meet this huge requirement and consequently frequency band has become a scarce resource. Recent studies of different spectrum regulatory bodies such as FCC in USA or Ofcom in UK disclose that a significant amount of the allocated frequency band below 3 GHz is utilized intermittently thus leading to underutilization of the natural resource (FCC, 2003). Assigned spectrum utilization has been experienced to vary from 15% to 85% on temporal and geographical basis (Akyldiz et al., 2006). For example, the UHF digital TV spectrum commonly known as TV white space (TVWS) is available on a geographical basis. Medical Body Area Networks (MBAN) of 2360-2400 MHz bandwidth is also

DOI: 10.4018/978-1-5225-1785-6.ch002

obtainable in this regard (Wang et al 2011). In order to facilitate the optimum usage of available spectrum resource, dynamic spectrum access (DSA) (Shellhammer et al., 2009; Liang et al., 2011; Shin et al., 2011; Geirhofer et al., 2007) was later proposed where an unlicensed spectrum user opportunistically exploits vacant licensed frequency band (or spectrum hole) in negotiation with the licensed user or primary user (PU). In this context, the unlicensed or secondary user (SU) transmits its own data without affecting the PU transmission process. All SUs make use of cognitive radio (CR) technology to avail unutilized spectrum through DSA. A CR is proposed to be a reconfigurable device that can adjust its various parameters via intelligent sensing of its surroundings as well as maintain seamless communication. So, it may be believed that CR technology is envisioned to cater large number of unlicensed users thus facilitating proper spectrum usage. This technology really can introduce a new paradigm in the next generation wireless networks (Haykin, 2005).

Proper detection of spectrum hole (i.e. spectrum sensing) is the key necessity in this context (Tandra et al., 2009) along with other functionalities like spectrum management, spectrum sharing and spectrum mobility. On the other hand a CR is also required to be reconfigurable that necessitates:

- **Frequency Agility:** Capability of a CR device to change its operating frequency,
- **Dynamic Frequency Selection:** Dynamic detection of signals from the RF frequency band and avoiding significant co-channel interference,
- **Adaptive Modulation:** Proper modification of transmission characteristics and waveforms,
- **Transmission Power Control:** Switching capability of the device within a number of transmission power options, and
- **Dynamic Network Access:** Capability of accessing several communication networks that use different protocols.

A CR should also sustain good spectrum resource management, mobility management as well as security management. A CR device can be practically realized by software defined radio (SDR). This employs a cognitive engine for controlling different SDR based activities. The engine is responsive of hardware resources and different input parameters and it endeavors constantly to meet the radio link requirements of higher layer functionalities or user with existing resources for example spectrum and power. An SDR supports a flexible radio platform that can handle different frequency bandwidths along with various modulation techniques.

In the present article, focus is kept on the detection of vacant frequency band of a CR user. It enables a CR user to understand the existence of a licensed user in a frequency band. A CR is expected to identify vacant frequency bands correctly in spite of different channel impairments. Various techniques have been proposed so far in different literature. These techniques generally involve binary hypotheses testing where the hypotheses are framed regarding the absence or presence of PU. Here a decision is taken in favour of any one hypothesis and a CR device acts accordingly. Two types of errors may be committed in this decision making process. Firstly, a CR may falsely identify a frequency band occupied by PU when it is actually vacant. This is known as false alarm problem. In the second case, a CR may falsely identify an occupied frequency band as vacant. In this case, a CR tries to access the frequency band thus disrupting the PU transmission process. The second problem is more serious and is known as misdetection problem. A good detection technique should try to minimize both of these error probabilities but unfortunately both of them cannot be restricted simultaneously. So, one usually try to fix the false alarm probability to a certain value and minimize the misdetection probability.

12 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/cepstrum-based-spectrum-hole-search-in-different-fading-scenario-in-cognitive-radio-network/173239

Related Content

Mapping the Research Landscape of Deep Learning in Knee Osteoarthritis

Shivangi Pathania, Navjyot Trivedi, Chander Prabha, Shashikant Patil, Meena Malik, Varsha Arya, Vincent Shin-Hung Panand Brij B. Gupta (2025). *International Journal of Intelligent Information Technologies* (pp. 1-16).

www.irma-international.org/article/mapping-the-research-landscape-of-deep-learning-in-knee-osteoarthritis/394248

Digital Twin-Driven TD3 Reinforcement Learning for Welding Path Optimization and Deformation Control of Large Mechanical Components

Bin Duan (2026). *International Journal of Intelligent Information Technologies* (pp. 1-19).

www.irma-international.org/article/digital-twin-driven-td3-reinforcement-learning-for-welding-path-optimization-and-deformation-control-of-large-mechanical-components/411388

The Virtual Twin: A Socialization Agent for Peer-to-Peer Networks

Alexandre Gachetand Pius Haettenschwiler (2005). *International Journal of Intelligent Information Technologies* (pp. 56-67).

www.irma-international.org/article/virtual-twin-socialization-agent-peer/2384

Failed IPO Stories: Stories of Initial Public Offering

Swarnasree Vutharkar, C. A. Narasimha Swamyand Krishna Hitesh (2023). *AI-Driven Intelligent Models for Business Excellence* (pp. 112-123).

www.irma-international.org/chapter/failed-ipo-stories/315397

AI, Mindfulness, and Emotional Well-Being: Nurturing Awareness and Compassionate Balance

Ranjit Singha (2024). *AI and Emotions in Digital Society* (pp. 47-74).

www.irma-international.org/chapter/ai-mindfulness-and-emotional-well-being/335332