Adaptive Two-stage Spectrum Sensing under Noise Uncertainty in Cognitive Radio Networks

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ABSTRACT

To utilize licensed spectrum bands efficiently, spectrum sensing needs to be accurate and fast. The occurrence of noise uncertainty and the lower in received PU signal power due to the distance between the transmitter and the receiver, path loss, are the main challenges that has a great impact on the accuracy of spectrum sensing.

In this paper, we propose a new scheme of two-stage spectrum sensing, "Adaptive Two-stage Spectrum Sensing (ATSS)", under noise uncertainty environment. ATSS is a modified of a conventional two-stage spectrum sensing where the decision threshold of both stages are adapted on the distance, estimated noise variance and calculated noise uncertainty interval. Therefore, ATSS improves the detection performance of the existing spectrum sensing and is robust to noise uncertainty.

The contribution of this paper is three-fold. First, an unreliable detection and wasted stage activation of a conventional two-stage spectrum sensing are reduced. Second, noise uncertainty is addressed. Third, a new parameter, critical distance (d_c), is proposed in order to reduce computational burden and sensing time of the first-stage.

Keywords: Cognitive radio, Spectrum sensing, Adaptive, Noise uncertainty, Path loss.

1. INTRODUCTION

Cognitive radio (CR) technology [1]-[4] is considered a new solution to improve an underutilization of existing spectrum resources. The licensed band becomes more utilized when a secondary user (SU) is allowed to dynamically use a licensed spectrum band provided the licensed band is not in used. The first standard for CR technology operates in TV White Spaces (TVWS) which is referred to IEEE 802.22 wireless regional area networks (WRAN) [5]. In IEEE 802.22, there are two types of licensed users including TV services and wireless microphone (WM) devices. The WM devices are considered as the lower priority licensed user (secondary licensed user) of the TV band. To achieve an efficient spectrum utilization, the SU is allowed to use a licensed band with harmless interference to licensed user (or primary user: PU). As soon as the licensed band is reclaimed by PU, the SU must stop its activity and vacates the band immediately. Thus, the SU needs to have a function to continually monitor the spectrum band. This function is called "spectrum sensing" [6]-[7].

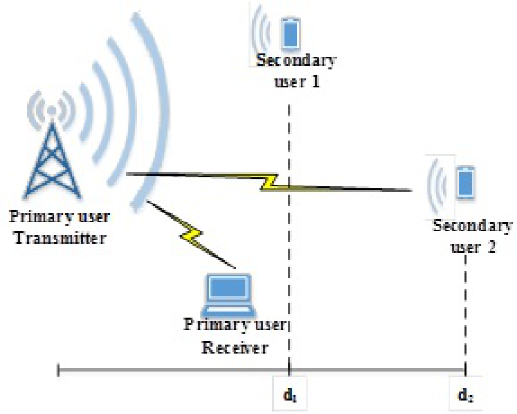

Fig.1: *Spectrum sensing problem.*

In a practical network, there are a PU transmitter and a PU receiver as depicted in Fig.1. Two secondary users, SU_1 and SU_2, are sensing the spectrum band at the same time. Assume that the distances between a PU transmitter and SU_1 and SU_2 are d_1 and d_2. If d_1 is less than d_2, chances are that SU_1 might be able to detect a primary user, while SU_2 cannot, because SNR at SU_2 is much lower than the SNR at SU_1. Therefore, SU_2 will cause harmful interference to the PU receiver.

Three critical parameters associated with the performance of spectrum sensing are probability of detection (P_d), probability of false alarm (P_{fa}) and sensing time (τ_s). P_d which is treated at the highest priority among these critical parameters, is the

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