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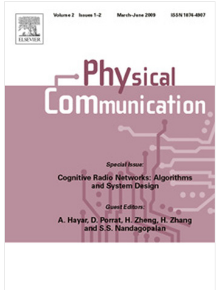

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Sensor Selection for Extending Lifetime of Multi-channel Cooperative Sensing in Cognitive Sensor Networks

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Abstract

Wireless cognitive sensor networks (WCSNs) are composed of tiny, low-power and low-cost sensors. An important function of these networks is to sense the channels in order to find the spectrum holes. Sensors cannot sense more than one channel simultaneously because they do not have high-speed Analog-to-Digital-Convertors (ADCs) which need high-power batteries. Therefore, it is a challenging issue to select cooperative sensors to sense different channels so that all the channels can be sensed simultaneously. On the other hand, lifetime extending in a WCSN is an important issue; it has attracted the most attention recently. In this paper, a tuneable receiver is used for sensors so that they can sense different channels in different sensing periods. To reduce energy consumption, node selection is proposed so that only sufficient nodes perform sensing the channels while the sensing quality constraints are met. A subset of nodes to sense every channel is selected in a way that the residual energy of sensors is balanced and the network lifetime is maximized. The problem can be solved based on the convex optimization framework. Closed form priorities of sensors to sense different channels are determined based on their residual energy, distance and detection probability. Then efficient dynamic sensor selection algorithms are proposed for multi-channel CSS. Simulation results show the advantages of the proposed algorithms in finding the efficient answer. In addition, in terms of network lifetime, success percentage, and energy consumption, the proposed algorithms are compared with the other sensor selection methods.

Keywords: Cognitive sensor network; Cooperative multi-channel spectrum sensing; Convex optimization; Detection probability; False alarm probability; Lifetime.

1- Introduction

Spectrum sensing is a functionality of cognitive systems, which is done to detect the spectrum holes, i.e. the frequency channels that are not utilized by the primary users (PUs) [1]. In a cognitive radio network (CRN), a secondary user (SU) cannot sense and transmit simultaneously if it does both sensing and transmission on detected idle channels, since it needs to parallel receiver and transmitter circuits, so that it reduces the opportunistic access efficiency. In addition, one SU might fail to sense all the sensing area due to improper positions. So wireless cognitive sensor network (WCSN) composed of tiny, low-power and low-cost frequency sensors is one of the solutions, where sensors are used for spectrum sensing [2] and then the sensing results are used by the SUs. Since the sensors might not be able to reliably detect weak PU signals due to fading or shadowing effects, cooperative spectrum sensing (CSS) schemes are proposed based on the combination of the detection results from spatially distributed multiple sensors [3].

Energy consumption in wireless cognitive networks is an important issue especially for CSS, with great overhead and large size of massages, which has been investigated in literature [4]. In WCSN, it is burdened with the limited energy of sensors due to their battery size and weight limitations. In addition, sensors energy utilization mechanism has a great impact on the network lifetime. Reducing number of sensing nodes is a main direction of possible energy conservation methods, which can be performed through node selection, censoring or voting schemes [4]. For example in [5], the number of SUs was determined to reduce the energy consumption and communication overhead. In [6], an adaptive probability of node selection was proposed which exploit historical observations of SUs and their receiving strength of PU signals. In [7], relay node selection for energy efficiency in cooperative sensing and transmission was proposed. In [8], using a numerical method the optimum number of SUs for CSS was determined over a general channel model, so that the CSS achieves to lower bounds of sensing error. In [9], based on the SUs-received-strength of PU signals, the number of cooperative nodes for CSS was determined via censoring method that is performed in two levels. First, a subset of nodes is selected for sensing and then a subset of the selected SUs is selected for performing their sensing results to the fusion center (FC). In [10], two methods for

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