Classified Index: TN929.5
U.D.C: 621.396

Dissertation for the Doctoral Degree in Engineering

COOPERATIVE SPECTRUM SENSING ALGORITHM OF COGNITIVE RADIO BASED ON UNSUPERVISED LEARNING ALGORITHM

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Academic Degree Applied for： Doctor of Engineering

Specialty： Information and Communication Engineering

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Date of Defense： August, 2011

Degree-Conferring-Institution： Harbin Institute of Technology

Abstract

The global communication industry is facing with an unprecedented era of expansion and challenges to its structure. There is a general belief among the scientists and academia in communication field that spectrum is scarce. Therefore the regulatory bodies around the world together with researchers, scientists, developers and service providers are initiating promising approaches towards a more flexible spectrum usage. Increasing new paralleled growth technology applications, devices and expansion of existing ones, are changes that are causing a shift in the communication industry which has led to an increase in the demand for radio spectrum and resulted into spectrum overcrowding and congestion of communication networks. In self-directed systems, there is an increasing need for a more accurate and reliable sensors to perform sensing as communication environment keep changing and new devices are continuously been developed in order to meet the demands for it. Cooperative spectrum sensing has been proposed in order to improve the capabilities of a sensing system.

The scarcity of bandwidth has always been the burden of high-speed wireless communication whose demand has been tremendously increasing over the years. Cognitive radio (CR) which has recently been proposed as a smart technology that allows unlicensed users to utilize licensed bands opportunistically and this intelligent radio device is believed to be the solution for spectrum overcrowding. Cognitive Radio (CR) has emerged as a leading technology because it can intelligently sense an unused spectrum without creating any harmful interference to authorized users. Cognitive radio networks is not introduced as a replacement nor compete but complement the existing wireless communication networks operating in licensed frequency bands in order to improve QoS to its users. Spectrum utilization and efficiency can be improved by making a secondary or unlicensed user to access a spectrum hole unoccupied by a primary user (PU) at the right location and time. Spectrum Sensing is a crucial step in Cognitive Radio,therefore for the system to be able to provide Quality of Service (QoS) to the users they need to have a valuable and trusted sensing techniques, in order to sense for the idle spectrum holes in the network.

This thesis is mainly built upon CR technology and aims to provide new approaches for spectrum sensing and sharing. We proposed a new algorithm called UCLASA (Unsupervised Cooperative Sensing Learning Algorithm in Spectrum Allocation), this algorithm is based on Kohonen's unsupervised learning process. We proposed that setting up a cognitive radio network with multiple sensors that work together as a team, not only improves QoS of the network but also improves to reduce if not eliminates the challenges faced by cognitive radios such as severe multipath and shadowing. Sensing a frequency environment, generally use lot of energy and time consumption. Cooperation among the sensors increase the sensing power of nodes, and also with

a relatively small number of nodes involves in the procedures e.g (2-8 nodes) are sufficient in providing and achieving the set goal expectations. With this reason in mind clearly it shows that with cooperative sensing procedures, the network will produce reliable results without an additional cost.

Our algorithm is a self-organizing cooperative spectrum sensing in cognitive radio network, with the following functions; Firstly, we used Bresenham's circle algorithm to plot a circle and to calculate distance between the base station and the nodes. Secondly, determine the energy consumption involved in the sensing process. Thirdly, we illustrate the benefits of co-operation in cognitive radio, when all nodes in the network share a common message, which is transmitted by one node or more nodes and received by the group of cooperating nodes will reduce the detection time and save energy consumption, reduce false detection and thus increasing their agility. Fourthly, we train the network with unsupervised learning of neural network, and lastly we then compared our algorithm with that of Kohonen's unsupervised learning to see which algorithm provides the best results. We also propose a practical algorithm which allows cooperation in random networks