PROGRAMME

The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(Department of Electrical and Computer Engineering)

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| 2010 | Monash University | MSc |
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"Location Aware Resource Allocation for Cognitive Radio Systems and Compressed Sensing based Multiple Access for Wireless Sensor Networks"

Thursday, March 5, 2015
11:00 AM
Engineering Office Wing, Room 430

Supervisory Committee:
Dr. Xiaodai Dong, Department of Electrical and Computer Engineering, UVic (Supervisor)
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Dr. Daniela Constantinescu, Department of Mechanical Engineering, UVic (Outside Member)

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Dr. Kimberly Kerns, Department of Psychology, UVic

Abstract

In this thesis, resource allocation and multiple access in cognitive radio (CR) and compressed sensing (CS)-based wireless networks are studied. Energy-efficiency oriented design becomes more and more important in wireless systems, which motivates us to propose a location-aware power strategy for single user and multiple users in CR systems and a CS-based processing in wireless sensor networks (WSNs) which reduces the number of data transmissions and energy consumption by utilizing sparsity of the transmitted data due to spatial correlation and temporal correlation.

In particular, the work on location-aware power allocation in CR system gives a brief overview of the existing power allocation design in the literature and unifies them into a general power allocation framework. The impact of the network topology on the system performance is highlighted, which motivates us to propose a novel location-aware strategy that intelligently utilizes frequency and space opportunities and minimizes the overall power consumption while maintaining the quality of service (QoS) of the primary system. This work shows that in addition to exploring the spectrum holes in time and frequency domains, spatial opportunities can be utilized to further enhance energy efficiency for CR systems.

Then the work of resource allocation is extended to finding the power strategy and channel allocation optimization for multiple secondary users in an OFDM based cognitive radio network. Three different spectrum access methods are considered and utilized adaptively according to the different locations of the secondary users, and we unify these spectrum access methods into a general resource allocation framework. An interference violation test is proposed to decide the parameters in this framework that indicate the set of licensed channels to be sensed. The proposed scheme intelligently utilizes frequency and space opportunities, avoids unnecessary spectrum sensing and minimizes the overall power consumption while maintaining the quality of service of the primary system. The uncertainty of channel state information between the SU users and the PU users

is also taken into account in the study of power and channel allocation optimization of the SUs. Simulation results validate the effectiveness of the proposed method in terms of energy efficiency and show that enhanced performance can be obtained by utilizing spatial opportunities.

The work on CS-based wireless sensor networks considers the application of compressed sensing to WSNs for data measurement communication and reconstruction, where N sensor nodes compete for medium access to a single receiver. Sparsity of the sensor data in three domains due to time correlation, space correlation and multiple access are being utilized. A CS-based medium access control (MAC) scheme is proposed and an in-depth analysis on this scheme from a physical layer perspective is provided to reveal the impact of communication signal-to-noise ratio on the reconstruction performance. We show the process of the sensor data converted to the modulated symbols for physical layer transmission and how the modulated symbols being recovered via compressed sensing. This work further identifies the decision problem of distinguishing between active and inactive transmitters after symbol recovery and provides a comprehensive performance comparison between carrier sense multiple access and the proposed CS-based scheme. Moreover, a network data recovery scheme that exploits both spatial and temporal correlations is proposed. Simulation results validate the effectiveness of the proposed method in terms of communication throughput and show that enhanced performance can be obtained by utilizing the sensed signal's temporal and spatial correlations.

Awards, Scholarships, Fellowships

2010 – 2011 UVic Fellowship, *University of Victoria*

Presentations

1. Tong Xue, Xiaodai Dong and Yi Shi, "*A multiple access scheme based on multi-dimensional compressed sensing*" IEEE International Conference on Communications, Ottawa, Ontario, Canada. June 2012 (poster)

Publications

1. T. Xue, X. Dong, and Y. Shi, "Resource Allocation Strategy for Multi-user Cognitive Radio Systems: Location-Aware Spectrum Access", submitted to IEEE Transactions on Vehicular Technology.

2. T. Xue, X. Dong, and Y. Shi, "Multiple access and data reconstruction in wireless sensor networks based on compressed sensing", IEEE Transactions on Wireless Communications, vol. 12, no. 7, pp. 3399–3411, July 2013.

3. T. Xue, Y. Shi, and X. Dong, "A framework for location-aware strategies in cognitive radio systems", IEEE Wireless Communications Letters, vol. 1, no. 1, pp.30–33, February 2012.