Public Abstract
First Name:Mohannad
Middle Name:Hamed
Last Name:Al-Ali
Adviser's First Name:Dominic
Adviser's Last Name:K. C. Ho
Co-Adviser's First Name:
Co-Adviser's Last Name:
Graduation Term:SP 2017
Department:Electrical Engineering
Degree:PhD
Title:Transmit Precoding and Bayesian Detection for Cognitive Radio Networks with Limited Channel Sate Information

Cognitive radio (CR) is a technique that enables coexistence among different networks. It is considered as a potential solution for the problem of the spectrum huge demand in communication systems. This thesis investigates the underlay and interweave modes for the coexistence of a CR network that has secondary users (SUs) with a primary network of primary users (PUs). The underlay mode means that both networks communicates at the same time using the same resources available. Under the interweave mode, SU is able to communicate as long as (some) PUs are not active. Performance of the CR network under either mode depends on the amount of channel state information (CSI) available about the different communication links. In practice, uncertainty appears in the obtained CSI and it should be accounted when designing the precoding schemes for SU such that the interference on primary networks is under a certain limit. This dissertation considers two cases about CSI availability: CSI is imperfect and CSI is completely not known.

For the underlay mode, we investigate two aspects. The first one addresses the problem of maximizing the information rate of a multiple-input multiple-output SU when CSI of the interference link to PU is completely unknown or partially known. We study the rates for SU under two different quality of service (QoS) requirements for the PU: The interference temperature and leakage rate metrics. When CSI is unavailable, we develop an algorithm that satisfies the required QoS through exploiting the side-information in the primary communication network. When CSI is inaccurate, we model the uncertainty using a generic norm and design the precoder by following the worst case formulation. We further investigate the relation between the two developed solutions.

In the second aspect, we optimize the SU rate when there is uncertainty in the SU intended link for communication as well as in the interference link from SU to PU. We find the worst uncertainty error in the set that describes the uncertainty in each link. We further develop an algorithm to find the best precoding scheme. Simpler solutions are derived under some special cases.

For the interweave mode, we assume there is no CSI available at SU and derive a Bayesian detector for the proposed problem. We propose a conjugate prior for the unknown covariance matrix under the noise model, while a new class of priors under the data model. We introduce the fractional Bayes factor approach to enhance the detection capability of the Bayes factor.