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Title of Thesis:

Spectrum Sensing in Cognitive Radios using Distributed Sequential Detection

Synopsis:

Cognitive Radios are emerging communication systems which efficiently utilise the unused licensed radio spectrum called spectral holes. They run *Spectrum sensing algorithms* to identify these spectral holes. These holes need to be identified at very low SNR (≤ -20 dB) under multipath fading, unknown channel gains and noise power. Cooperative spectrum sensing which exploits spatial diversity has been found to be particularly effective in this rather daunting endeavour. However despite many recent studies, several open issues need to be addressed for such algorithms. In this thesis we provide some novel cooperative distributed algorithms and study their performance.

We develop an energy efficient detector with low detection delay using decentralized sequential hypothesis testing. Our algorithm at the Cognitive Radios employ an asynchronous transmission scheme which takes into account the noise at the fusion center. We have developed a distributed algorithm, DualSPRT, in which Cognitive Radios (secondary users) sequentially collect the observations, make local decisions and send them to the fusion center. The fusion center sequentially processes these received local decisions corrupted by Gaussian noise to arrive at a final decision. Asymptotic Bayes optimality of the proposed algorithm with respect to the optimal centralized test, which does not consider fusion center noise, is proved. We also theoretically analyse its probability of error and average detection delay. Even though DualSPRT performs asymptotically well, a modification at the fusion node provides more control over the design of the algorithm parameters which then performs better at the usual operating probabilities of error in Cognitive Radio systems. We also analyse the modified algorithm theoretically.

DualSPRT requires full knowledge of channel gains. Thus we extend the algorithm to GLRSPRT where the imperfections in channel gain estimates are taken into account.

We also consider the case when the knowledge about the noise power and channel gain statistic is not available at the Cognitive Radios. This problem is framed as a universal sequential hypothesis testing problem. We use easily implementable universal lossless source codes to propose simple algorithms for such a setup. Asymptotic performance of the algorithm is presented. A cooperative algorithm is also designed for such a scenario.

Finally, decentralized multihypothesis sequential tests, which are relevant when the interest is to detect not only the presence of primary users but also their identity among multiple primary users, are also considered. Using the insight gained from binary hypothesis case, two new algorithms are proposed.