

Spectrum Sensing Strategies for the Cognitive Cycle in Cognitive Radio

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Outline

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5. Spectrum Sensing : Limits and Challenges
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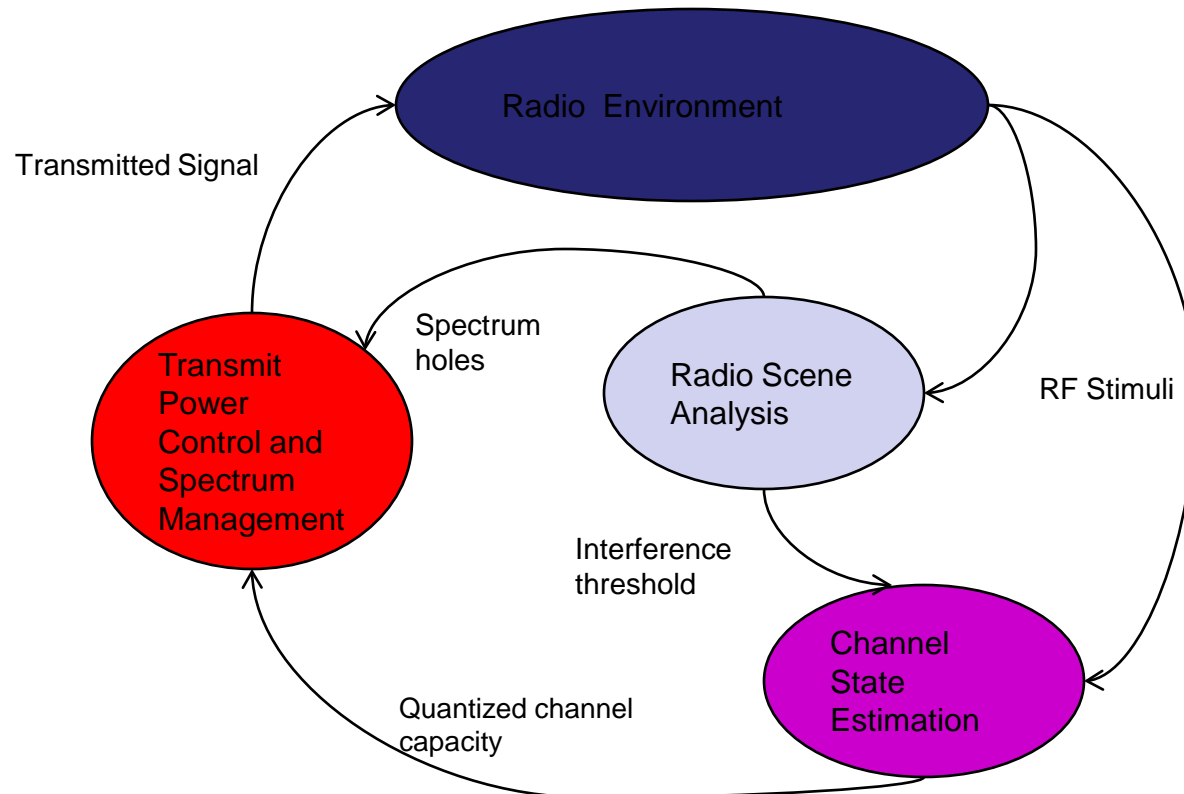
1. Cognitive Radio

- Cognitive Radio will bring phenomenal change in the way wireless communication worked.
- It can be seen as intersection between wireless technology and computational intelligence.
- The cognitive radio is defined as intelligent wireless communication system built on a software-defined radio, which is aware of environment and uses methodology of learning from the environment and adapt to statistical variations in the input signal to provide highly reliable ubiquitous communication and efficient utilization of radio spectrum.

Need and Importance of Cognitive Radio

- Spectrum Scarcity due to spectrum hungry wireless technologies.
- Present legacy based spectrum management and control structure which does not allow spectrum reuse or sharing.
- Numerous applications generate deluge of data.
- Importance of cognitive radio lies in the need for optimal use of scarce spectral resources.
- Emergence of reconfigurable systems is the prime motivation for cognitive radio.

The Cognitive Cycle



The Cognitive Cycle

- The cognitive cycle is an important component of the Cognitive radio which imparts the environment awareness and adaptability to radio.
- This consists of the functionalities such as
 1. **Spectrum sensing:** The signal transmitted by Primary user is detected and processed to detect the spectrum holes for opportunistic use by SUs.
 2. **Spectrum analysis:** Characteristics of the spectral holes are estimated.
 3. **Spectrum decision:** Data rate, modulation method and the bandwidth of the transmission is determined by the radio.

- Primary user protection from interference due to secondary transmission.
- Multipath fading.
- Hidden node problem.
- Secondary user receiver sensitivity.
- Limit on secondary transmit power

Spectrum Sensing: Challenges

- Exploiting the spectrum opportunity (frequency bands) at particular time and particular location without interfering legacy users.
- Sensing of signals having different formats.
- Sensing wide spectral band.
- Handling hidden node problem.
- Sensing within minimal time and frequency of sensing.
- To manage hardware requirements.

Detection and the State-of-the-art

The following are the enabling algorithms for sensing.

- Matched filter detection
- Energy detection (radiometry)
- Cyclostationary feature detection
- Radio identification based sensing
- Waveform based sensing

Cooperative Sensing

- Hidden node problem is major hindrance in sensing for cognitive radio.
- Cooperative sensing is an evident solution.
- Secondary users cooperate in sensing the transmission by primary user and the information is known to each user irrespective of its location.
- Cooperative sensing can limit the local interference threshold requirement.

My Focus

I am focusing on the cognitive cycle in cognitive radio.
Sensing problem will be at prime focus

- Novel method for detection.
- Addressing multipath signal fading
- Addressing legacy user protection
- Cooperative sensing for addressing hidden node problem.
- Limited focus on other parts of the cognitive cycle

My Focus

Limited focus on other parts of the cognitive cycle

- Spectrum Analysis will encompass
 - Estimation of Channel state information
 - Prediction of the channel capacity
- Spectrum decision will address transmission requirements
 - Decision on modulation method
 - Decision on Bandwidth requirement

Achievements at Aalborg and Future Research Direction

- Definition of the research problem and literature survey.
- Background studies related to the topic.
- One paper for conference on spectrum management scheme.
- Some theoretical clarifications in context to the research area.
- My direction of further research :
- Identification of spectral band
- Formulation of novel detection method for the selected band: feature detection at focus
- Game theoretic approach for cooperation in sensing.

**Thank you!!
Questions?**