Chapter 3
Spectrum Sensing in Cognitive Radio Sensor Networks

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ABSTRACT
In this chapter, the authors provide a comprehensive review of spectrum sensing in cognitive radio sensor networks. Firstly, they focus on general techniques utilized for spectrum sensing in wireless sensor networks. To have good understanding of core issues of spectrum sensing, the authors then give a brief description of cognitive radio networks. Then they give a thorough description of the main techniques that can be helpful in doing spectrum sensing in cognitive radio sensor network. The authors conclude this chapter with open research issues and challenges that need to be addressed to provide efficient spectrum sensing in order to minimize the limitations in cognitive radio sensor networks.

INTRODUCTION
Frequency spectrum is a natural resource which like any other naturally occurring resource is regulated. The use of this resource is under the assignment of regulatory authorities who under the globally fixed spectrum management assign fixed chunk of spectrum inflexibly to the licensed users. Although these bands have already been allocated to the users still the analysis shows that these bands are underutilized. While on the other hand the demand of frequency spectrum is increasing day by day in wireless communication. This inefficiency of spectrum underutilization can be overcome by use of Cognitive radio technique with the help of which those portions of spectrum that are not under the usage of any user can be accessed dynamically. A secondary user which do
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not have any royalty, can take the advantage of this unused frequency bands under the conditions of, not causing any interference to the primary user. Therefore it is very critical for the cognitive radio user to sense these spectrum holes reliably and efficiently to get rid of interference. The obstacle in achieving this goal is fading, shadowing and time dependency of wireless channels, resulting in low signal to noise ratio at the input of Cognitive Radio (CR) user that leads to activity of false detection of spectrum hole while actually there exist a primary user who is confronting this interference. In this chapter, the spectrum sensing concepts will be estimated by taking into considerations various aspects of the spectrum space. It is assumed that having better understanding of spectrum space will lead us to produce new openings and challenges. Also different facets of the spectrum sensing will be enlightened in detail and quite a few spectrum sensing schemes will be elaborated. Wireless Sensor Networks (WSN) solely works in unlicensed bands. So in those areas of applications where the same bands of frequencies are in use of another application, the coexistence problem exists. In order to cope with such problem, extra feature must be added in WSN to combat the interference incurred by the other applications.

A promising solution is to use the Cognitive Radio (CR) technology to arm the sensor nodes with opportunistic spectrum access (OSA) capability. Towards this end, cognitive radio sensor network (CRSN) is a recently emerging paradigm that aims to utilize the unique features provided by CR concept to incorporate additional capabilities to WSN. A CRSN is a network of scattered wireless cognitive radio sensor nodes that catch an event signal. It then collaboratively transfers their accumulated data to accommodate the application specific requirement in a multi-hop fashion on dynamically present spectrum bands. OSA enables the use of the most suitable channel for application-specific requirements. This adaptability can also be employed to adjust transmission parameters to reduce power consumption. The existing schemes developed to obtain spectrum awareness for cognitive radios almost never consider power consumption problem, which is clearly a critical issue for CRSN. Reduced power consumption via OSA not only extends battery-constrained life-time of sensor nodes, but also limits overall energy consumption by sensor network. Thus, natural gaseous emission and dissipated heat by sensor network can be significantly reduced with the help of OSA to lead green distributed sensing networks.

Today, the world is getting short of available radio spectrum due to emergence of new radio access technologies. These technologies have high bit rate and thus their bandwidth requirements increase many fold as compared to earlier typical applications. To fulfill this high bandwidth constraint, spectrum sensing techniques are incorporated in cognitive radio networks. Since frequency spectrum is a natural resource, which is regulated like any other naturally occurring resource. The use of this resource is under the assignment of regulatory authorities who under the globally fixed spectrum management scheme assign fixed chunk of spectrum inflexibly to the licensed users. Although these bands have already been allocated to the users still the analysis of these spectrums shows that these bands are underutilized. While conversely the demand for frequency spectrum is increasing day by day in wireless communication. This inefficiency of spectrum underutilization can be overcome by use of Cognitive radio technique through which, those portions of spectrum chunks that are not under the utilization of any user, can be accessed dynamically. A secondary user which do not have any license can take the advantage of this unused frequency bands under the conditions of not causing any interference to the primary user. Therefore it is very critical for the cognitive radio user to identify these spectrum holes reliably and efficiently to get rid of interference. The obstacle in achieving this goal is fading, shadowing and time dependence of wireless channels which
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