TELEMÁTICA
REVISTA DIGITAL de las Tecnologías de la Información y las Telecomunicaciones

Editorial

Special Issue on Cognitive Radio Technologies

Dear readers,

This special issue publishes several selected papers of interest on the implementation of different functionalities on cognitive radio devices for a variety of applications. Papers on this issue appear after a call announcement previously advertised on conference CITTEL to the Cuban community on cognitive radio development. The objective of the current issue is to gather works presented by researchers during CITTEL with the newly submitted papers after the call.

Electromagnetic spectrum is the most important resource in wireless communications. With the emergence of new wireless applications/services, most of the available spectrum has been already allocated, resulting possibility of spectrum scarcity in the near future. On the other hand, it has been reported from several measurement studies that the allocated spectrum bands are underutilized. These two scenarios motivate the concept of dynamic spectrum access, which allows secondary users to opportunistically utilize the same radio spectrum originally allocated to the primary (licensed) users. Cognitive radio is an enabling technology for dynamic spectrum access. Unlicensed cognitive radio users adaptively adjust their radio parameters to the network environment, resulting in improved spectral efficiency. In a hypothetical future overlay policy, cognitive radios (referred to as secondary users) may temporarily use spectrum as long as they do not interfere with primary users that own the license to that spectrum.

The research in cognitive radio technologies is interdisciplinary involving several areas including signal processing, information theory, communications theory and engineering, networking and protocols, hardware implementations, energy management, as well as game theory based approaches. Some of these areas of research have been addressed in this special issue.

In the selected papers, we have topics related to spectrum sensing methods, constellation recovery techniques, signal parameter estimation, energy management of receivers based on spectrum sensing operations, FPGA designs for transceivers and, survey studies on the fundamentals of cognitive radio. These works illustrate a variety of applications on this field including secure communications by spread-spectrum signals, optimization of the channel use on the frequency domain, and self-operation of receivers by implementing automatic recognition methods on cooperative environments. Besides, reported implementation methods include feature detectors by means of cyclostationary properties of signals, the energy distribution of signals, the detection of the modulation order by artificial intelligence techniques as well as signal processing methods on filter design. Furthermore, the special issue articles deal with RF and digital technologies to illustrate proof of concepts with their specific results, such as the use of Xilinx's FPGA for families six and seven, and the use of RTL-dongles.

Broader and specific topics are addressed by journal papers on the current issue. Three surveys are presented to discuss main trends on energy detector for spectrum sensing, automatic modulation recognition format, and cognitive engines. The paper "FPGA design of spectrum sensing techniques based on energy harvesting techniques" illustrates detailed concerns regarding the performance of energy detector, in addition to a broad summary and discussion on several other spectrum sensing techniques. Additionally, a second paper "Worldwide progress in automatic modulation classification for cognitive radios" surveys the automatic modulation classifiers to support the self-identification of modulation format based on data and non-data -aided approaches. Finally, artificial intelligence techniques to run the cognitive engine facility on cognitive ratio as well as main architectures to implement these functionalities are provided in "Panoramic vision of the state of the art of cognitive engine for cognitive radios".

Current issue also offers a variety of specific topics in the field of advanced constellation design and the recognition of modulation format. Two articles are related to the detection of modulation order for QAM signals and a study related to the design of non-uniform constellation for DTV system applications. The article "New modulation order detector for M-QAM through the method of k-means" proposes a new method to implement automatic modulation recognition format for 16, 32 and 64 QAM constellations to reduce computational time. Furthermore, the journal paper "Implementation of non-uniform constellation in 1D in Matlab for the optimization of the DTMB standard"

discusses and analyses the use of non-uniform constellation for DTV standards. Bit error rate validation is conducted using an implemented optimization algorithm to illustrate performance. Besides, further processing of the received signal is illustrated in the article “Instantaneous detection and estimation of parameters on cognitive radio signals” for detecting and identifying signal parameters in realtime. A flow graph is proposed to detect amplitude, carrier frequency and phase of received frequency-hopped signal.

Related to technology concerns, detailed design on FPGA and real time functioning is provided to implement a transceiver for frequency hopped signals in “Intellectual property module design to receiving spread spectrum signals”. In a similar fashion, articles “FPGA implementation of a cyclostationary feature detector for OFDM modulated signals” and “FPGA design of spectrum sensing techniques based on energy harvesting schemes” present detailed descriptions on Sysgen software for FPGA designs. The cyclostationary detector is tested through the detection of OFDM patterns commonly used on DTV systems. In addition, energy harvesting solutions and the proper scheduling of spectrum sensing operations are discussed and a proposal of FPGA implementation design is presented. In addition, the article “Description of dynamic partial reconfiguration for cognitive radio applications” provides a survey on the allowable solutions to implement the dynamics demanded by cognitive solutions. The article also presents and discusses common technologies to develop dynamic partial reconfiguration to support realtime cognitive radio features. Furthermore, a practical system in a cooperative environment is devised in the article “Cooperative spectrum sensing application using RTL-Dongle technology” in order to communicate results between nodes when detecting a signal of interest. The authors implemented a fusion center and local controllers on C/C++ application to manage a network of RTL-dongles to have improved detection performance.

On the current issue we expect to deliver useful reports to contribute to the development of cognitive radio technologies. Future networks will demand the proper assessment of self-managed solutions, their further study and development are demanded to be of constant and laborious work by researchers and developers.

Rajesh Kumar Sharma

Department of Signal Processing
School of Electronics and Informatics
Technical University of Chemnitz, 09126 Chemnitz, Germany
e-mail: rajesh.sharma@ieee.org