Editorial

Advances in Cognitive Radio Sensor Networks

Hyung Seok Kim, Waleed Ejaz, Khalid Al-Begain, Al-Sakib Khan Pathan, and Najam ul Hasan

1 Sejong University, Seoul 143 747, Republic of Korea
2 University of South Wales, Pontypridd CF37 1DL, UK
3 International Islamic University Malaysia (IIUM), 53100 Kuala Lumpur, Malaysia
4 National University of Computer and Emerging Sciences, Islamabad 44000, Pakistan

Correspondence should be addressed to Hyung Seok Kim; hyungkim@sejong.ac.kr

Received 22 January 2014; Accepted 22 January 2014; Published 9 March 2014

Copyright © 2014 Hyung Seok Kim et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Advances in wireless communication have changed the customs and the living style of people today, and the demand for wireless communication with high speeds and ubiquitous connectivity continues to increase. Currently a number of different wireless networks, for example, cellular networks and wireless local area networks, are in place to support mobile services but still new emerging applications require more support to meet communication requirements. Cognitive radio (CR) networks have emerged in response to the demand of these emerging applications as one form of several new wireless networks. A variety of new challenges and issues have also arisen with these new networking technologies, which have created many new research opportunities. While designing these emerging networks, it is not only important to realize innovative applications, but also crucial to investigate how to achieve the optimum bandwidth and energy efficiency, due to the scarcity of the network resources (bandwidth, channel, energy, storage, and so on). Such investigation requires a multidisciplinary effort that encompasses areas of signal processing, communication, control, and information theory. The major focus of this special issue is investigating how to achieve efficient use of spectral resources with low power consumption in the cognitive radio networks.

Increasing demand for spectral resources has introduced the issue of efficient spectrum utilization. CR technology indeed allows opportunistic access to the spectrum. CR employs the concept of dynamic spectrum access (DSA) to improve spectrum utilization efficiency and communication quality. In addition to many other wireless systems taking advantage of DSA, several challenges and requirements of a wireless sensor network (WSN) can be met by using CR; therefore, some proposals suggested embedding CR within such networks. That gives rise to a new term, known as cognitive radio sensor network (CRSN).

Despite the advantages offered by CRSN, embedding CR in sensors has also introduced several challenges. In addition to the challenges inherited from WSN, there are some unique challenges related to CRSN including definitions of channel, channel availability, channel heterogeneity channel quality, control channel assignment, and transmission channel assignment. This motivates the design of a new medium access mechanism for CRSN that can cope with all these challenges. Currently, WSNs have been used in a number of different applications ranging from surveillance and remote monitoring to healthcare; thereby, while designing protocol suite for CRSN, the underlying application also needs to be taken into consideration.

CRSN mainly is composed of two parts: sensing and access policy. Briefly, sensing policy determines the set of channels to be sensed, the order in which the channels should be sensed, and duration of each sensing. After identifying the spectrum holes, access policy determines access related issues as to whether to access the band or not.
Sensing Policy. Spectrum sensing is the prerequisite of DSA. In DSA, the sensors opportunistically access the spectrum; hence, they need to gather the spectrum usage information via a spectrum sensing process prior to transmission. For spectrum sensing in CRSN, a sensing policy needs to be defined that answers the following questions.

(i) Which set of channels is the most suitable to be sensed?
(ii) What should the schedule be for sensing the channels?
(iii) Which technique will be the most suitable for sensing?
(iv) What should be the duration of sensing?
(v) Should the sensor sense collaboratively or not?
(vi) How should the sensor collaborate?
(vii) In collaborative sensing, how many sensors should sense a channel?

Access Policy. In CRSN, when a node senses an event signal, it communicates its reading using DSA over an available spectrum band (determined based on sensing policy) to satisfy the application specific requirement. As multiple CRSNs are sharing the available spectrum without harming the licensed user communication, an access policy needs to be defined. In CRSN, the access policy needs to answer the following questions.

(i) Which channel (control channel) should be used for the exchange of control messages?
(ii) Which channels should be used for data?
(iii) How should data channels be assigned to users?
(iv) How should channel switching be ensured in case of licensed user appearance?
(v) What should the maximum transmission frame length be?
(vi) What should the transmission parameter be, such as power, modulation, and error coding mechanisms?
(vii) How can the Quality of Service (QoS) of the different applications be ensured?

In a nutshell, there is indeed some critical benefits of cognitive radio based wireless sensor networks like opportunistic channel usage for bursty traffic, dynamic spectrum access, deployment of multiple sensor networks without hampering each other’s operation on the same area, adaptive reduction of power consumption, conformity to different spectrum regulations in different locations, and so on. That is why this research field has attracted many researchers in the recent times. The challenges, however, are many; some of which are explored and analyzed in the accepted articles in this special issue, with some interesting solutions and proposals.

Contributions of Accepted Papers. A. Raza et al. in their paper entitled “Consensus-based distributed cooperative spectrum sensing for mobile ad hoc cognitive radio networks” proposed a consensus-based distributed cooperative spectrum sensing scheme (CDCSS) in CR mobile ad hoc networks which is inspired by novel biological mechanisms. CDCSS works on mobile nodes in distributive network without using a centralized entity to improve the sensing performance in cognitive radio mobile ad hoc networks.

F. Ye et al. in their paper entitled “The user requirement based competitive price model for spectrum sharing in cognitive radio networks” analyzed the competitive price game model for spectrum sharing in CR networks with multiple primary users and secondary users and proposed a user requirement based competitive price game model for the calculation of the shared spectrum size of cognitive user in Bertrand game.

W. B. Tessema et al. in their paper entitled “Channel hopping sequences for rendezvous establishment in cognitive radio sensor networks” proposed two channel hopping sequences to establish a link in CRSNs with and without the assumption of global clock synchroniztion. Under the assumption of global clock synchronization, authors first propose synchronous channel hopping sequence in which the sequences can overlap with each other in all available channels at different time slots and the rendezvous spread out over. Next, under the assumption that CR users are not synchronized with each other, authors proposed asynchronous channel hopping sequence in which CR users can get a rendezvous channel within a bounded time, although they start hopping at any time slot.

J. Kim et al. in their paper entitled “A rendezvous scheme for self-organizing cognitive radio sensor networks” proposed a hopping sequence algorithm to achieve a successful rendezvous within a single period in a CR network. With the proposed algorithm, called hopping sequence guaranteeing rendezvous within a single period, CR nodes can rendezvous in a single period and reliably exchange control message with each other.

M. O. Mughal et al. in their paper entitled “Energy detection in multihop cooperative diversity networks: an analytical study” presented a study of detection performance of energy detector in relay based multihop cooperative diversity networks operating over independent Rayleigh fading channels. In particular, upper bound average detection probability expressions are obtained for three scenarios: (i) multihop cooperative relay communication; (ii) multihop cooperative relay communication with direct link and maximum ratio combiner at destination; and (iii) multihop cooperative relay communication with direct link and selection combiner at destination.

E. Romero et al. in their paper entitled “A game theory based strategy for reducing energy consumption in cognitive WSN” presented a new game theory based strategy to optimize energy consumption in WSNs. This strategy takes advantage of a new opportunity offered by cognitive wireless sensor networks: the ability to change the transmission and reception channel.

S. M. Kamruzzaman et al. in their paper entitled “Channel-slot aggregation diversity based slot reservation scheme for cognitive radio ad hoc networks” proposed a channel-slot aggregation diversity based slot reservation scheme, called
channel-slot aggregation diversity based slot reservation, for CR ad hoc networks. Power control mechanism along with doze mode operation is adopted to improve the spectrum and energy efficiencies. Furthermore, the proposed method efficiently utilizes the channel bandwidth by assigning unused slots to new CR users and enlarging the frame length when the number of slots within the frame is insufficient to support the demand of neighboring CR users. An effective frame recovery method is also presented that shrinks the frame length in an efficient way.

We hope that the papers in this special issue would be beneficial for the research community to get some ideas to find future research topics related to this area.

Hyung Seok Kim
Waleed Ejaz
Khalid Al-Begain
Al-Sakib Khan Pathan
Najam ul Hasan
Submit your manuscripts at
http://www.hindawi.com