Chapter 15
Cognitive Radio Network for E-Health Systems

Shashank Gupta
Jaypee Institute of Information Technology, India

Shikha Singhal
Jaypee Institute of Information Technology, India

Adwitiya Sinha
Jaypee Institute of Information Technology, India

ABSTRACT

The world is witnessing widespread roots of ubiquitous computing across disciplines and industries. It is equipped with the ability to monitor anything from anywhere with efficient, easy, and equitable goods that offer services for everyone. This has become possible through usage of wireless technologies, which possess an extensive scope in healthcare domain. However, despite various advantages, wireless technologies are faced with distinct challenges in hospital environment. For instance, wireless devices often tend to cause electromagnetic interference to critical medical devices resulting in malfunctioning. Further, with ubiquitous computing, sensitive data about health state of patients is constantly being shared remotely from one place to another. Therefore, systems in place must address requirements of data security, and thus privacy. For this purpose, the chapter presents a collaborative study on cognitive-radio-based healthcare system, including advantages, architecture, and challenges related to implementation of cognitive radios in hospital environment.

1. INTRODUCTION

In recent times, wireless systems have gained extreme eminence in the field of healthcare and medicine. These systems aid in providing timely and flexible medical services for improving patient safety. However, due to more number of wireless devices coming up every day the wireless healthcare facilities are susceptible to problems such as spectrum scarcity. Moreover, certain existing medical devices are prone to damage from the electromagnetic interference caused by wireless transmissions from these devices.

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To overcome these, and other similar, challenges posed by wireless communication systems this chapter suggests the use of cognitive radio networks in e-health applications. A cognitive radio system can operate on unlicensed as well as licensed bands thereby improving the utilization of radio spectrum and providing dynamic spectrum access.

This chapter aims to build an insight on the uses of cognitive radios in e-health applications. The chapter proceeds with a brief introduction on e-health in Section 3. This is followed by an overview of existing technological facilities in healthcare industry along with their shortcomings and limitations in Section 4. Section 5 talks about why there is a need for wireless devices and also mentions the challenges faced by wireless devices in a hospital environment. Further, in Section 6 the chapter details the requirements of such wireless devices and then finally moves on to explain how these requirements are well met by using cognitive radios for wireless communication in E-health applications in Section 7. Towards the end of Section 8, leveraging the advantages of cognitive radios, the chapter concludes by proposing an architecture for an E-health application. But firstly, next section presents some background literature which includes the work done by other researchers.

2. BACKGROUND STUDY

Use of cognitive radios in the healthcare industry is an intriguing topic. Many researchers have proposed various architectures for implementing a cognitive radio based e-health application. Phunchongharn, Hossain, Niyato, and Camorlinga (2010) addressed the technological requirements of a cognitive radio based wireless system in terms of electromagnetic compatibility, data security, and seamless connectivity. Further, they also put forward an architecture for implementing a cognitive radio based e-health application in which they divided the wireless devices into two categories viz. primary devices and secondary devices which use an EMI-aware handshaking protocol for accessing the wireless channel. Finally, performance evaluation of the system is carried out using simulations. Mamoon, Muzahidul-Islam, Baharun, Komaki, and Ahmed (2015) proposed an architecture for a cognitive radio based e-health application in which all the wireless devices are capable of dynamic spectrum access. They proposed a three layer model, where a cognitive base station (CBS) occupies the first layer, all the wireless devices and sink access control form the middle layer, and cognitive radio aided sensor network forms the bottom layer. Luan and Ren (2015) discuss the complete design of an e-health network including the design for the physical layer, MAC layer, and the transport layer. Some researchers have performed a detailed analysis of wearable body sensors and their wireless transmissions, and have suggested EMI-aware cognitive radio based architectures for Wide Body Area Network (WBAN) (Shen, Liu, Yu, Ma, Li, Shen, & Chen, 2013; Chávez-Santiago, Jankunas, Fomin, & Balasingham, 2014).

Various authors have also presented significant insight in the form of edited books and chapters on wireless communications, cognitive radios, and e-health systems. Some of the works are as follows. Hossain and Diamond (2008) studied the impact of fourth generation wireless access networks on e-health. They carefully analyzed the 4G wireless technology and various e-health applications and then presented a 4G heterogeneous wireless access network based architecture for implementing an intelligent software-defined radio based e-health system. Their work also analyses the task of bandwidth allocation and admission control for e-health services in a heterogeneous wireless environment. Phunchongharn, Hossain, and Camorlinga (2010) talked about the various clinical challenges in a healthcare environment and then suggested the use of wireless technologies for overcoming these challenges. Further, they