Chapter 50
Applications of Independent Component Analysis in Cognitive Radio Sensor Networks

Zahooruddin
*COMSATS Institute of Information Technology
47040, Pakistan*

Muhammad Iqbal
*COMSATS Institute of Information Technology
47040, Pakistan*

Ayaz Ahmad
*COMSATS Institute of Information Technology
47040, Pakistan*

Farooq Alam
*COMSATS Institute of Information Technology
47040, Pakistan*

Sadiq Ahmad
COMSATS Institute of Information Technology 47040, Pakistan

ABSTRACT

Independent component analysis is extensively used for blind source separation of different signals in various engineering disciplines. It has its applications in several areas of communication, multiple input multiple output, orthogonal frequency division multiplexing, wireless sensor networks, and cognitive radio networks. In this chapter, the authors discuss the general theory of independent component analysis, wireless sensor networks, cognitive radio networks, and cognitive radio sensor networks. The main focus of the chapter is the application of independent component analysis in cognitive radio networks, wireless sensor networks, and cognitive radio sensor networks. The issues and challenges of these emerging technologies are discussed while applying independent component analysis. Cognitive radio sensor network is a promising technology to efficiently resolve the issues of spectrum usage in sensor networks. The authors are the first to discuss the applications of independent component analysis in cognitive radio sensor networks. At the end of this chapter, they discuss some future research problems regarding the applications of independent component analysis in cognitive radio sensor networks.

1. INTRODUCTION

Blind source separation is a signal processing technique used for un-mixing of the recorded mixed data from any physical process (Hyvarinen, Karhunen, & Oja, 2001). Independent component analysis (zadeh, & Shirazi, 2009) is a technique used for blind source separation and features extraction from the recoded multidimensional statistical data (Hyvarinen, & Oja, 2000). The advantages of independent component analysis algorithms include its simple mathematical models, less computational complexity and applicability in real scenario, because the observed data from any physical process is always the combination of underplaying physical processes (Doebelin, 2004). Examples are, electrocardiogram (ECG) signals sensed through different electrodes, speech signals recorded through microphones, communication signals received through different antennas. The collected signals in ECG, speech processing, or communication systems will be mixtures of different signals. The objective in such a system is to get the underlying original signals from the mixed data, without having information about the channel characteristics and the sources.

Independent component analysis has a lot of applications in communication (Zarzoso, & Nandi, 2004), speech processing (Gillet, & Richard, 2008; Zahooruddin & Alam, 2010), biomedical signal processing (Castells, Igual, Rieta, Sanchez, & Millet, 2003; Langley, Rieta, Stridh, Millet, Sornmo & Murray, 2003), vibration analysis (Li, Yan, Tian, Yuan, Peng & Li, 2012) and machinery fault diagnoses (Pöyhönen, Jover & Hyötyniemi, 2003). These applications are summarized in Figure 1.The applications in wireless communication include wireless sensor networks, cognitive radio networks, code division multiple access, multiple input multiple output systems, and orthogonal frequency division multiplexing, which are shown in Figure 2. It is mainly used for the suppression of inter symbol interference; inter channel interference, and co-channel interference, automatic modulation classification, spectrum sensing, and blind channel estimation. In this chapter the applications of independent component analysis are studied in wireless networks like wireless sensor networks, cognitive radio networks, and cognitive radio sensor networks. To the best of our knowledge independent component analysis is yet not used in cognitive radio sensor networks.

Wireless sensor networks are used for monitoring of physical environment or to detect different events in the sensing field. A large number of sensor nodes are deployed_in the field to sense any physical phenomena or to track an object and transmit the sensed or observed data through wireless channels. A sensor node consists of sensor, communication system, storage and processing system. These nodes have very small size and efficient processing and communication units

Figure 1. Applications of independent component analysis in different engineering disciplines
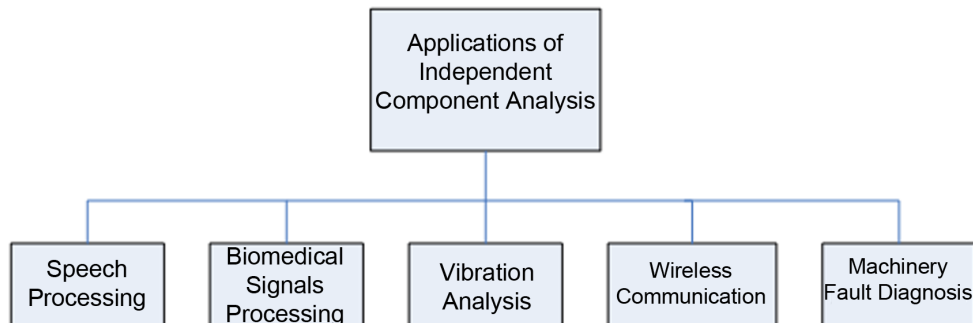
Related Content

Co-Operative Load Balancing in Vehicular Ad Hoc Networks (VANETs)
G. G. Md. Nawaz Aliand Edward Chan (2011). *International Journal of Wireless Networks and Broadband Technologies (pp. 1-21).*
www.irma-international.org/article/operative-load-balancing-vehicular-hoc/64624

Efficient Channel Utilization and Prioritization Scheme for Emergency Calls in Cellular Network
K. N. Rama Mohan Babu, K.N. Balasubramanya Murthy, G.V. Pavithraand K.R Mamatha (2014). *International Journal of Wireless Networks and Broadband Technologies (pp. 56-69).*
www.irma-international.org/article/efficient-channel-utilization-and-prioritization-scheme-for-emergency-calls-in-cellular-network/121659

Heterogeneous Dynamic Priority Scheduling in Time Critical Applications: Mobile Wireless Sensor Networks
Arvind Viswanathan, Garimella Rama Murthyand Naveen Chilamkurti (2012). *International Journal of Wireless Networks and Broadband Technologies (pp. 47-54).*
www.irma-international.org/article/heterogeneous-dynamic-priority-scheduling-in-time-critical-applications/85005

Agent-Based Resource Management for Mobile Cloud
Zhili Sun, Yichao Yang, Yanbo Zhouand Haitham Cruickshank (2016). *Mobile Computing and Wireless Networks: Concepts, Methodologies, Tools, and Applications (pp. 200-216).*
www.irma-international.org/chapter/agent-based-resource-management-for-mobile-cloud/138183

Recursive Spatial Multiplexing with Adaptive Interference Whitening
Usama Y. Mohamad, Ibrahim A. Shah, Thomas Hunzikerand Dirk H. Dahlhaus (2017). *International Journal of Wireless Networks and Broadband Technologies (pp. 43-59).*
www.irma-international.org/article/recursive-spatial-multiplexing-with-adaptive-interference-whitening/201850