Chapter 11
A Novel Approach in the Detection of Chipless RFID

Prasanna Kalansuriya
Monash University, Australia

Nemai Chandra Karmakar
Monash University, Australia

Emanuele Viterbo
Monash University, Australia

ABSTRACT

This chapter presents a different perspective on the chipless RFID system where the chipless RFID detection problem is viewed in terms of a digital communication point of view. A novel mathematical model is presented, and a novel approach to detection is formulated based on the model. The chipless RFID tag frequency signatures are visualized as points in a signal space. Although data bits are stored in the tags using unconventional techniques, the proposed model enables the detection of these data bits through conventional robust detection methods. Through simulations it is shown that the proposed detection method has better performance compared to contemporary detection approaches.

INTRODUCTION

Radio frequency identification (RFID) is widely used in many aspects of modern society where applications range from farming and food industry to finance and banking (Weinstein, 2005). The key feature that makes RFID such an attractive technology in many applications is the ability of quick, automatic and wireless extraction of information. This saves huge amounts of time and labor required for the monotonous procedures involving information retrieval, data entry and inventory management in many applications.

Despite the superior technological capacity, RFID technology has not yet fully penetrated into applications involving large scale item tagging such as library management systems, retail industry, logistics etc. (IDTechEx, 2006; S. Preradovic & Karmakar, 2010). This is due to the fact that the printable and integrated circuit technology enabling the advance features of the RFID tag has not proven to be cost effective when competing with existing technologies such as the one and two dimensional optical barcodes.

However, recent advances in RFID technology have promised a significant reduction in the cost

DOI: 10.4018/978-1-4666-1616-5.ch011

Copyright © 2012, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

of RFID tags. These tags, commonly referred to as chipless RFID tags in literature (S. Preradovic & Karmakar, 2010), possess no integrated circuitry (chip) and are essentially passive reflectors or absorbers of electromagnetic radiation. Due to the absence of any electronic circuitry or any intelligent signal processing a chipless RFID is essentially the radio frequency counterpart of the ordinary optical barcode. This enables mass scale production of these tags at a very low cost comparable with optical barcodes but with some of the attractive features and benefits of the conventional RFID technology.

The conventional chipped RFID tag uses standard methods to wirelessly transfer the information it holds to an RFID reader. These methods vary in complexity from communication protocols such as WLAN, Zigbee and Bluetooth used for active RFID tags to simple back-scatter modulation techniques using amplitude shift keying (ASK), frequency shift keying (FSK) and phase shift keying (PSK) in passive and semi-passive RFID tags (Bolic, Simplot-Ryl, & Stojmenovic, 2010). The functionality of the chip and the wireless transfer of information are both powered by energy extracted from an interrogation signal sent by the RFID reader or by energy contained in an energy storage such as a battery. In the case of a chipless RFID tag, since it has no chip to facilitate active means of wireless transmission of digital data, it relies on passive approaches to convey the information it holds. As oppose to actively digitally re-modulating the interrogation signal sent by the RFID reader a chipless RFID tag passively transforms the interrogation signal characteristics to carry data back to the reader. This transformation occurs when the interrogation signal hits the tag and it is characterized by the passive microwave properties of the chipless RFID tag. Sharp and abruptly changing features in the amplitude (S. Preradovic, Balbin, Karmakar, & Swiegers, 2008; S. Preradovic & N. C. Karmakar, 2009), phase (Balbin & Karmakar, 2009) or time of arrival (Chamarti & Varahramyan, 2006; Hu, Law, & Dou, 2008; Shao, et al., 2010) of the modified interrogation signal are used in order to represent data bits. A portion of the modified interrogation signal is reflected back towards the RFID reader where it is used to detect the information carried by the chipless tag. The detection performed by the RFID reader is essentially comparable to a miniature RADAR system attempting to distinguish different data carrying RADAR signatures produced by chipless RFID tags. Transferring data using analog and passive means has shifted the intelligence required at the tag into the reader and lowered the cost per tag. However, it has significantly increased the processing requirements at the RFID reader.

Detection of the data stored in the chipless RFID is performed by analyzing the received modified interrogation signal. The signal processing involved is quite challenging since the received signal is very weak and is also affected by unwanted interference and noise such as, mutual coupling between antennas at the receiver, clutter in the environment, mulitpath etc. Different techniques are reported in research literature for the detection of information contained in the received signals from chipless RFID tags. In (Koswatta & Karmakar, 2010; S. Preradovic & N.C. Karmakar, 2009) chipless RFID reader designs are presented which utilize threshold based detection through the use of calibration tags. Here, the effect of clutter and antenna coupling is also removed by using the calibration tags. However, since this approach is based on hard thresholds derived through calibration it does not posses the flexibility and adaptability required in the detection process to address errors due to a dynamic environment. The authors of (Blischak & Manteghi, 2009; Manteghi, 2010) characterize the backscattered radiation from a chipless tag using a set of poles and residues. The data is stored using the pole locations which are changed by altering the structure of the chipless RFID tag. Detection is performed by extracting the poles and residues from the backscattered signal using the Matrix Pencil Algorithm. This method

14 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/novel-approach-detection-chipless-rfid/65983

Related Content

Effect of Nodes Mobility on Density-Based Probabilistic Routing Algorithm in Ad-hoc Networks
Hean-Loong Ongand Essam Natsheh (2012). *International Journal of Wireless Networks and Broadband Technologies (pp. 29-48).*
www.irma-international.org/article/effect-nodes-mobility-density-based/75526

The Next Generation CDMA Technology for Futuristic Wireless Communications: Why Complementary Codes?
Hsiao-Hwa Chen (2012). *Wireless Technologies: Concepts, Methodologies, Tools and Applications (pp. 2014-2041).*
www.irma-international.org/chapter/next-generation-cdma-technology-futuristic/58881

Safety of Mobile Wireless Sensor Networks Based on Clustering Algorithm
Amine Dahane, Nasr-Eddine Berrachedand Abdelhamid Loukil (2016). *International Journal of Wireless Networks and Broadband Technologies (pp. 73-102).*
www.irma-international.org/article/safety-of-mobile-wireless-sensor-networks-based-on-clustering-algorithm/170430

Customer Relationship Management as an Imperative for Academic Libraries: A Conceptual Model-121 E-Agent Framework
Amanda Xuand Sharon Q. Yang (2016). *Mobile Computing and Wireless Networks: Concepts, Methodologies, Tools, and Applications (pp. 395-428).*
www.irma-international.org/chapter/customer-relationship-management-as-an-imperative-for-academic-libraries/138192

Connecting One Belt One Road Countries via Wireless Sensor Network
Kwok Tai Chui, Wadee Alhalabi, Ryan Wen Liuand Patricia Ordóñez de Pablos (2021). *Research Anthology on Developing and Optimizing 5G Networks and the Impact on Society (pp. 1070-1085).*
www.irma-international.org/chapter/connecting-one-belt-one-road-countries-via-wireless-sensor-network/270229