Computer Science

Vikram Kulkarni

Coexisting problems for wireless sensor networks working in 2.4 GHz frequency band

GRIN

Bibliographic information published by the German National Library:

The German National Library lists this publication in the National Bibliography; detailed bibliographic data are available on the Internet at http://dnb.dnb.de .

Imprint:

ISBN: 9783346075338

This book at GRIN:

https://www.grin.com/document/509404

Vikram Kulkarni

Coexisting problems for wireless sensor networks working in 2.4 GHz frequency band

GRIN Verlag

A Book on

AVOIDING INTERFERENCE FOR WIRELESS SENSOR NETWORKS WORKING IN 2.4GHz FREQUENCY BAND FOR SMART GRID APPLICATIONS

by

Dr. VIKRAM. K

Assistant Professor

Department of Information Technology

Mukesh Patel School of Technology Management Engineering

NMIMS University

Mumbai - India

ABSTRACT

With the introduction of Information and Data-Communication Technology (ICT) to the present electrical power systems, the traditional electrical-grid system is becoming more intelligent and adaptive. The ICT successfully establishes bi-directional communication between Utility companies and the consumer for improving the generation and utilization of power. Wireless Sensor Network (WSN) is efficiently utilized by wide-ranging Smart Grid (SG) applications. Despite many advantages, WSN faces a challenge of avoiding interference experiencing from other coexisting wireless technologies working in the 2.4GHz unlicensed frequency band. Providing support for WSN in terms of avoiding interference is a very challenging issue due to the dynamic wireless communication environment and extremely limited resources. In the present thesis, the problem of interference experienced by WSN in 2.4GHz has been investigated. The challenges, limitations and requirements for avoiding the interference for WSN working in the vicinity of other technologies like WiFi and Bluetooth have been identified. As a result of the literature survey carried out, it was identified that proper channel selection and channel prioritization for WSNs working in the coexisting environment had not been adequately developed till then. Hence, there was a requirement for addressing these issues. The contribution of this thesis consists of five novel schemes for improving the performance of WSNs working under the influence of WiFi.

Firstly, a Cross Layer Multi Channel Medium Access Control (CMCMAC) Algorithm is proposed. This algorithm estimates the initial channel parameters like Received Signal Strength Indicator (RSSI) and Channel Occupancy Rate (COR). Then,these parameters are applied to the Hidden Markov Model (HMM). Then, based on the estimation, the channel with less interference is identified and is selected for data communication. The CMCMAC performance was compared to the existing protocol, FDRX. CMCMAC outperforms 11% in terms of Packet Delivery Ratio (PDR) and 21% better in terms of Energy Consumed (EC) for different scenarios, based on the varying number of nodes and different data traffic scenarios.

Secondly, Forward Error Correction for CMCMAC (CMCMAC-FEC) is proposed with an aim of better data recovery of partially collided packets at the destination side. This algorithm further enhanced the performance of CMCMAC. Thus, with varying

number of nodes and constant WiFi data rate, CMCMAC-FEC outperformed by 7% in terms of PDR as compared to CMCMAC. CMCMAC-FEC performed 9% better in terms of PDR when number of nodes are constant and WiFi data rates are changing.

Thirdly, Particle Swarm Optimization Based Load Aware Channel Estimation and Channel Scheduling (PSOLACES) Algorithm is proposed. Development of PSOLACES recommends the channel shifting with a minimum frequency shift of 7MHz for the improved performance of WSN working under the influence of WiFi.

Fourthly, Collaborative Framework for Avoiding the Interference (CFAI) is proposed. CFAI Algorithm assures better channel utilization. The average number of packets generated by ZigBee network based on CFAI gets reduced in number. Also, CFAI assures better throughput compared to the existing works like CFMSS, PSOLACES, K.Hong et al.,and RDBS.

Finally, Interference Aware Adaptive Transmission Power Control (IAATPC) is proposed for WSN. IAATPC analyzes the power level needed by a node in the network to ensure reliable data delivery. The data transmission is performed under different network conditions by adaptively controlling the transmission power; and in turn, ensuring network efficiency. From the results, it can be inferred that the average residual energy of a node based on IAATPC is 9.6% higher than AMTPC.

The proposed schemes in this thesis are based on simulation results obtained. All the presented schemes avoid interference by proper channel selection under diverse operational conditions by considering different Quality of Service (QoS) parameters; and assure better PDR, EC, reduced Frame Error Rate (FER) and proper channel utilization. The performance of WSN has been improved by strictly following the latency requirements of SG applications.

Keywords: *Home Area Networks*, *Interference Avoidance*, *Smart Grid Communications*, *The 2.4GHz Frequency Band*, *Wireless Sensor Networks*.

ACKNOWLEDGEMENT

With immense pleasure and deep sense of gratitude, I dedicate this book to **Lord Dharmapuri Lakshmi Narashimha Swamy**.

I could able to complete this book only with the blessings of **Mahaperiya Sri Sri Sri Chandrashekarendra Saraswathi Swami**

I wish to extend my profound sense of gratitude to my parents **Mr. Madhusudhan Rao and Mrs. Vijaya** for all the sacrifices they made during my research and also providing me with moral support and encouragement whenever required.

Last but not the least, I would like to thank my wife **Mrs. Ravali** and my daughter **Maithreyi** for their constant encouragement and moral support along with patience and understanding.

Dr. VIKRAM. K

TABLE OF CONTENTS

LIST OF FIGURES

Every figure was created by the author.