COOPERATIVE BEAMSTEERING IN WIRELESS SENSOR NETWORK BASED ON BACKTRACKING SEARCH ALGORITHM

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DEDICATION

This thesis is dedicated to my beloved family, who are always praying for my success as well as motivate and encourage me throughout this project,. It is also dedicated to my supervisor, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

The progressive development of Wireless Sensor Network (WSNs) contributes to many applications such as in the intelligent transport system (ITS), safety monitoring, military and in natural disasters prevention. In parallel to WSNs, the idea of internet of things (IoT) is developed where IoT can be defined as an interconnection between identifiable devices within the internet connection in sensing and monitoring processes. With recent growth in both size and power efficient computing, the concept of the ubiquitous WSN has aggressively emerged as an acknowledged research topic. As the capabilities of individual nodes in WSNs increase, so does the opportunity to perform more complicated tasks, such as cooperative beamsteering (CB). This CB manages to improve the range of communications and save precious battery power during the transmission. Therefore, this research proposes a meta-heuristic algorithm to organize node location in array arrangement. It is expected to effectively improve radiation beampattern fluctuations, exhibits lower complexity and less energy. From the simulation that has been done, it's observed that the proposed algorithm helps to reduce the side lobe level, thus better radiation beampattern is achieved.

ABSTRAK

Rangkaian sensor tanpa wayar berkembang dengan progressif dan menyumbang kepada banyak aplikasi seperti sistem pengangkutan pintar, pemantau keselamatan, ketenteraan dan pencegah bencana alam. Selari dengan rangkaian sensor tanpa wayar, idea bagi internet of things (IoT) dikembangkan di mana IoT dapat didefinisikan sebagai interkoneksi antara peranti yang boleh dikenalpasti dalam sambungan internet dalam proses penginderaan dan pemantauan. Pekembangan terkini bagi kebesaran dan kecekapan tenaga pengkomputeran menyebabkan konsep rangkaian sensor tanpa wayar telah menjadi topik penyelidikan yang dikenali ramai. Keupayaan nod individu dalam rangkaian sensor tanpa wayar meningkat dan ianya dapat memberikan peluang kepada nod untuk melakukan tugas yang lebih rumit, seperti beamsteering koperasi (CB). CB ini dapat meningkatkan rangkaian komunikasi dan menjimatkan kuasa bateri semasa penghantaran. Oleh itu, kajian ini mencadangkan algoritma meta-heuristik untuk mengatur lokasi nod dalam pelbagai susunan. Ianya dijangka berkesan dalam memperbaiki secara effektif turun naik radiasi. Daripada simulasi yang telah dilakukan, algoritma yang dicadangkan dapat membantu mengurangkan tahap lobus sampingan, maka radiasi beampattern lebih baik dapat dicapai.

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LIST OF ABBREVIATIONS

ADC	-	Analog to Digital Converter
AF	-	Array Factor
BS	-	Base Station
BSA	-	Backtracking Search Algorithm
CB	-	Collaborative Beamforming
CEO	-	Cross-Entropy Optimization
CPU	-	Central Processing Unit
CSCSO	-	Cuckoo Search Chicken Swarm Optimization
EA	-	Evolutionary Algorithm
FNBW	-	First Null Beam Width
HPBW	-	Half Power Beam Width
LFA		Linear Feed Array
NSGA		Non-dominated Sorting Genetic Algorithm
SLL		Side Lobe Level
SEONS		Side-lobe and Energy Optimization Array Node Selection
VNAA		Virtual Node Antenna Array
WSN		Wireless Sensor Network

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CHAPTER 1

INTRODUCTION

1.1 Background Review

Wireless sensor network (WSN) is formed by numerous autonomous sensor nodes [1]. These sensor nodes are interconnected and spreading in an specified area that has been targeted to create a network. Environmental monitoring, civil structure monitoring and smart grids system are some applications that are used commonly [2]. The sensors nodes are also possible to collaborate so that they can sense, collect, processing information and transmit between them or to the base station. Furthermore, the power needed for these sensor nodes to function normally is supplied from batteries.

For many cases, WSN is implemented in a tough environment where it is difficult to reach for human. This can impact the efficiency of battery replacement. In addition, the power consumption of WSN application is huge for all operations including monitoring, collecting data as well as transmission. This has become one of the most concern aspects, as the unwanted high battery power consumption is to be optimized in order to maintain the communication capabilities [3].

This project proposes improve method to ameliorate the radiation beampattern performance so that the power consumption in WSN can be optimized. A number of studies show that collaborative beamforming (CB) helps to reduce power consumption and fulfill the maximum power gain for the antenna array. Moreover, CB is able to extend the secure communication link between a sensor network and base station (BS). CB works with an efficient metaheuristic algorithm in order to share the consummation of energy between several nodes in order to receive better signal strength [4].

For this project, the sensor nodes are spread arbitrarily within a virtual antenna array. These sensor nodes are fabricated in a way that they unite together to form a collaborative antenna array. The collaborative nodes are also designed to form a linear array formation. The position of the chosen collaborative nodes is resolved by assessing the optimum parameters related to the antenna array. Thus, a metaheuristic algorithm named Backtracking Search Optimization Algorithm (BSA) is developed to figure out the problem of selecting the optimum position of linear array nodes. BSA is a metaheuristic that capable in taking care of numerical improvement issues. BSA is less dependent on the parameters initial value and easy to implement, as it is an uncomplicated structured algorithm. Furthermore, BSA has an effective boundary control and magnificent convergence characteristic, which provide efficient search [5].

Ergo, the proposed algorithm has several notable merits, namely improved radiation beampattern fluctuations, exhibits lower complexity and less energy. For that reason, this algorithm can produce the maximum power gain for the antenna array by finding the optimum collaborative nodes to form a linear array. The power utilization in the WSN can be decreased fundamentally in such way.

1.2 Problem Statement

It has been stated that the degradation of beamforming gain performance is caused by the significant position error of nodes [6]. One drawback of collaborative beamforming of sensor nodes is that the random placement of sensor nodes would affect the sidelobe patterns. Sidelobe generally is radiation in unwanted directions and has less intensity than the main lobe. Consequently, an algorithm is needed to find the best location of sensor nodes in case of any random nodes deployment. An optimum gain, simple and reliable sensor nodes are preferable. Therefore, a proficient algorithm that can decide the ideal location of sensor nodes as well as expend less vitality for computation and communication is structured.

1.3 Objectives

This work is aiming to ameliorate performance of the radiation beampattern, which is employing collaborative beamforming as well as developing an algorithm that is depend on the Backtracking Search Optimization Algorithm methodology. Therefore, the objectives of the proposed work here can be broken down in the following steps:

1. To develop an algorithm based on Backtracking Search Optimization Algorithm (BSA) that can decide the ideal location of sensor nodes, for any irregular nodes deployment.

2. To accomplish the greatest power gain for the collaborative sensor node array.

3. To minimize side lobe level (SLL) for the collaborative sensor node array.

1.4 Scope of Project

The scope of this project is mostly about modelling of sensor nodes in wireless sensor network environment. Then, Backtracking Search Optimization Algorithm is developed to create a linear array nodes formation in WSN. Furthermore, the examination of the execution of BSA in terms of SLL minimization and null placement needs to be done as well as comparing the developed model with current models.

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