A NEW METHOD TO OPTIMIZE THE LOCALIZATION OF SENSOR NODE USING DERIVATIVE HARMONY SEARCH ALGORITHM-BASED K-MEANS CLUSTERING PROTOCOL FOR EXTENDED COVERAGE AREA AND ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORK

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This project and research work is dedicated to my beloved parents

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ABSTRACT

In this project, the optimization in Wireless Sensor Network (WSN) is using MATLAB software. The optimization is focused on the fundamental problems in WSN which are coverage area and energy efficiency. WSN consists of a large number of sensor nodes used to gather information from an unattended location and transmit it to particular users. The coverage problems deal with how well the sensor node to monitor a certain area. The sensor nodes should be able to monitor the whole area of the network. Energy is used when sensor nodes send data to the base station. Each sensor node is powered by limited energy source then, optimization is needed to solve this problem to prolong the lifetime of the WSN. The problem occurs in WSN can be solved using Derivative Harmony Search Algorithm (DHSA) and implement together with K-means clustering algorithm. By using this method the data transferred have low energy consumption and the covered area is optimal. The performance of DHSA will be compared with other algorithms which such as Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) in terms of coverage area and energy efficiency. From the simulation, it shows that by using a Derivative Harmony Search algorithm-based K-means clustering algorithm, it has a better solution compared to PSO and GA in terms of energy efficiency which is the energy consumption for communication is low.

ABSTRAK

Di dalam projek ini, pengoptimuman dalam rangkaian pengesan tanpa wayar adalah menggunakan perisian MATLAB. Pengoptimuman memfokuskan kepada masalah asas yang berlaku di dalam rangkaian pengesan tanpa wayar iaitu kawasan liputan dan kecekapan tenaga. Rangkaian pengesan tanpa wayar mengandungi nod pengesan yang banyak yang digunakan untuk mengumpul maklumat daripada kawasan tanpa pengawasan dan menghantar kepada pengguna. Masalah kawasan liputan berurusan dengan bagaimana nod pengesan mengawasi sesuatu kawasan. Nod pengesan perlu mengawasi keseluruhan kawasan rangkaian. Tenaga akan digunakan apabila nod pengesan menghantar data kepada stesen pangkalan. Setiap nod pengesan menggunakan kuasa yang terhad jadi, pengoptimuman diperlukan menyelesaikan masalah yang berlaku bagi memanjangkan hayat rangkaian pengesan tanpa wayar. Masalah yang berlaku di dalam rangkaian pengesan tanpa wayar boleh diselesaikan menggunakan algoritma carian keharmonian terbitan dan dilaksanakan bersama Algoritma K-kaedah kelompok. Dengan menggunakan cara ini, data yang dihantar mempunyai penggunaan tenaga yang rendah dan kawasan liputan yang optimum. Prestasi algoritma carian keharmonian terbitan akan dibandingkan dengan algoritma yang lain seperti pengoptimuman kawanan zarah dan algoritma genetik. Simulasi menunjukkan dengan menggunakan algoritma carian keharmonian terbitan dan algoritma K-kaedah kelompok, mempunyai penyelesaian yang lebih baik daripada pengoptimuman kawanan zarah dan algoritma genetik dalam terma kecekapan tenaga di mana tenaga yang digunakan untuk komunikasi adalah rendah.

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LIST OF ABBREVIATION

WSN	-	Wireless Sensor Network
DHSA	-	Derivative Harmony Search Algorithm
IHS		Improved Harmony Search
HS		Harmony Search
PSO	-	Particle Swarm Optimization
GA	-	Genetic Algorithm
HMS	-	Harmony Memory Search
HM	-	Harmony Memory
PAR	-	Pitch Adjusting Rate
Bw	-	Bandwidth
HMCR	-	Harmony Memory Considering Rate
NI	-	Number of Iteration

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CHAPTER 1

INTRODUCTION

This project focuses on the Derivative Harmony Search Algorithm (DHSA) based K-means clustering protocol used to optimize the localization of sensor node in terms of energy efficiency as well as coverage area of the sensor nodes.

1.1 Project Introduction

Wireless sensor network (WSN) defined as a network consists of a large number of sensor nodes and used to collect information from a neglected location and send it to specific user [1]. It is used in various applications include, but not limited to, monitor the habitat, track the object, control the nuclear reactor, detect the fire and monitor the traffic. One of the major problems in WSNs is coverage problem. The coverage problems deal with the ability of the network to monitor a particular area. Besides that, a challenge in WSN is to preserve limited energy resources to extend the lifespan of WSN. A proposed method to solve energy efficiency and coverage problem is using DHSA which is established from Improved Harmony Search (IHS) algorithm. IHS is the improvement of basic Harmony Search (HS) algorithm which can effectively conform the parameters of HS. IHS algorithm searches for optimum solution by using stochastic derivative.

The stochastic derivative is the summation of three terms based on a basic HS algorithm. The three terms are probability of random selection, probability of memory consideration and probability of pitch adjustment. Optimal localization of sensor nodes in a WSN can be found by using this algorithm which can save more energy and optimize the coverage area. The k-means clustering protocol is implemented together with the proposed algorithm to save energy consumption because this approach can avoid long distance communication by choosing the cluster head among the nodes.

1.2 Problem Statement

Coverage area and energy efficiency are the two major issues occur in the scattering of wireless sensor node [11]. The coverage area is defined as how well a sensor network will monitor a defined area [12]. The sensor nodes should be able to

monitor the whole area of the network. In order for the sensor node transfer data to the base station, energy is used. Usually, a limited energy source such as a battery is powered to each sensor node that limit the lifetime of WSNs. Since the nodes located in areas that are difficult to reach, it is inconceivable to recharge or replace the battery. The sensor nodes used energy for computation, sensing and communication. If the distance between nodes and base station is large, more energy is used. Hence, energy consumption needs to be considered for a longer lifetime of sensor nodes in the network.

The proposed algorithm used to solve coverage and energy efficiency problems is DHSA which is based on IHS algorithm. By using the developed algorithm, the data transferred has low energy consumption and the covered area is optimal [11]. Clustering protocol named K-means clustering protocol is implemented together with the proposed algorithm in order to solve energy efficiency problem.

1.3 Objectives

1. To develop the DHSA in WSN.
2. To implement the developed algorithm with K-means clustering protocol.
3. To compare the performance of DHSA with other algorithms such as Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) in terms of coverage area and energy efficiency.

1.4 Scope of Work

The scope of work in this project is divided into three sections which are deployed, analysis and optimization.

1.4.1 Deployment

The deployment part involves the understanding of all the theories on WSN, DHSA and k-means clustering protocol. Besides that, it is also includes the understanding on how doing the simulation of the algorithm and clustering protocol.

1.4.2 Optimization

There are two major issues in WSN that need to be optimized which are coverage area and energy efficiency. Both of the issues are optimized using appropriate simulation.

1.4.3 Analysis

The analysis is mainly on the optimization of the coverage area and energy efficiency. The parameter setting is needed for the initialization. These parameters are:

1. The size of the coverage area used are 100x100m, 300x300m and 500x500m. The purpose of using three samples of areas is to find out how well the sensor nodes can monitor in different size of areas.
2. There will be no limitation on the number of sensor nodes.
3. The radius of the sensor nodes is 5m and communication radius of sensor nodes is 10m.
4. The battery level of the sensor nodes is fixed at 3 J.

The simulation result is compared with other algorithms such as PSO and GA in order to know which algorithm is better in terms of coverage area and energy efficiency.

1.5 Significance of Project

The significant of this project to the WSN is by using the optimization method proposed in this project, the lifetime of the sensor nodes can be prolonged. This will make the operation of WSN cost effective due to the long lifetime of the sensor nodes.

1.6 Thesis Organization

This thesis is organized into five chapters. The first chapter is the introduction of the project, which include the project title, problem statement, objectives and scope of work. The second chapter is the literature review which contains theory related to this project. Methodology is a third chapter where the flow of the project is shown. Besides that, all the work involved in completing this project also explained in this chapter. The fourth chapter is a result and discussion which includes all the results of the project. Visual representation is shown by plotting graphs, tables, diagrams and charts. The fifth chapter is the conclusion and recommendation which will conclude the accomplishment of the project based on the objectives stated. The recommendation is about the further development of the project.

CHAPTER II

LITERATURE REVIEW

This chapter can be divided into three parts. The first part is about the software used for the simulation. The second part is about the theoretical study of the project such as the understanding of WSN, DHSA and K-means clustering protocol. The third part is the study of the recent works of the proposed algorithm and k-means clustering protocol. The study of the recent works helps in the progress of this project. It is because the previous research can be used and modified depending on the project title. Besides that, the previous research gives the guidelines so that this project is on the right track to get the successful result.

2.1 Recent Work

Bhattacharyya *et al.* [1] has discussed the architecture of WSN. Transferring information by prolonging the lifespan of the network and by utilizing energy efficient routing protocols are the main design goal of WSN. Apply a different architectures and designs in sensor network depending on the applications used. The architectural issues and challenges for wireless sensor networks stated in this paper are the distribution of node, the dynamicity of network, energy efficiency, transmission of data, data fusion and scalability. Several routing protocols that been discussed in this paper are Threshold sensitive Energy Efficient sensor Network (TEEN), Low Energy Adaptive Clustering Hierarchy (LEACH), Adaptive Threshold TEEN (APTEEN), Power Efficient Gathering sensor Information System (PEGASIS) and more clustering protocols.

An overview of improvements in optimization problems using a harmony search algorithm is presented by Moh"d Alia *et al.* [4]. The step of choosing the best data from some sets of available alternatives under certain constraint if there are any is the definition of optimal. The optimization problem can be solved by maximizing and minimizing the cost function or objective function of the problem. The harmony search algorithm is one of the most lately built up optimization algorithm and the most effective algorithm in the field of combinatorial optimization. The interest in this algorithm conveys the researchers to develop and improve its operation in line with the necessity of problems that are solved.

Hoang *et al.* [7] proposed the recent developed harmony search algorithm for optimizing the energy using up by the network and minimizing the intra-cluster distance. This paper presented a centralized cluster-based protocol where the base station determines and group a sensor nodes into clusters according their location and residual energy. The evaluation of the algorithm is fulfilled by simulating a sensor node network with MATLAB. The simulation results show that by using the harmony search algorithm based K-means clustering protocol the energy