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Performance Improvement in a Wireless Sensor Network by Reduction Chain Complexity using Honey Bee Optimization

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Abstract: ***In Wireless Sensor Network, due to the limited power of nodes, efficient routing plays important role in order to save the energy of wireless sensor nodes and to enhance the network lifetime of the WSN. In this paper, a new protocol, O-PEGASIS (Optimized PEGASIS) has been presented to reduce the chain complexity in PEGASIS. A new methodology has been designed to overcome the problem of PEGASIS by using the Artificial Bee Colony (ABC) optimization technique. The Optimization algorithms are search approaches which are carried out to search an optimal solution to a problem, in order to fulfill objectives. The results of O-PEGASIS (Optimized PEGASIS) have been compared with PEGASIS and by reducing the chain complexity, the performance of wireless sensor network is improved. Thus, the proposed protocol is more efficient as compared to PEGASIS i.e. chain based protocols.***

Keywords: Honey bee optimization, WSN, network lifetime, chain based routing, PEGASIS.

1. Introduction

In the previous years, there is huge increase in the researches related to Sensor networks due to its applicability in various application areas such as, agriculture, medical Field, safety, health and industrial automation. The Wireless sensor network is practiced and applied in various different applications ranging from military to medical and from industry to home. A sensor network (WSN) consists of autonomous sensors which are spatially distributed to monitor environmental and physical conditions and to cooperatively pass over their data through the network to the base station in wireless sensor network.

There are several routing protocols which have been introduced in Wireless Sensor Networks (WSN) which are different from each other on the basis of various applications and network architecture (structure). There are lots of challenges and issues in designing the network for wireless sensor nodes: hardware energy efficiency, infrastructure-less network (distributed routing, distributed synchronization, adapting to changes in connectivity, real time communication and security) major constraint energy, Random deployment (autonomous setup and maintenance).

These wireless sensor nodes have a ability to sense, measure and collect information from the environment (surroundings) and pass along the sensed data to the end user. Besides collecting the sensed data and controlling actuators, a sensor node may need to perform some other computation on the measured and sense data. The Wireless Sensor Network consists of several number of sensor nodes which are limited in energy sources and one of the main challenge in wireless sensor network (WSN) is to increase the lifetime of sensor network. Basically this term lifetime of network means , the time for the 1st node or a certain % of network nodes to run out of power. The lifetime of the network strongly depends on the lifetime of single sensor node and in this paper we are mainly working on how to increase the lifetime of the network.

2. Literature Study

Stephanie Lindsey and Cauligi S. Raghavendra (2002), the wireless Sensor nodes consist of restricted battery power and wireless communications is done systematically to gather useful information from the field and capturing the sensed and measured information in an energy efficient manner is critical to operate the sensor network for a very long time. In collecting a data, problem is defined in a round of communications where each and every sensor node has a data to be passed over to the base station. If the transmission of data takes directly to the base station by each sensor node then it will consume the power quickly. The LEACH protocol give an elegant solution where all clusters before transmitting the data to the base station , fuse the data and by randomizing approach the cluster heads are appointed, to pass over the data to the base station. LEACH protocol achieves an improvement over direct transmissions and in this paper, we use a protocol name: PEGASIS (Power-Efficient Gathering in Sensor Information Systems), a chain-based routing protocol that is an improvement over the LEACH protocol. In PEGASIS, each and every sensor node communicates only with a close neighbor and takes turns while transmitting the sensed data to the base Station, thus reduce a large amount of energy spent per round and the simulation results show that LEACH is far behind than PEGASIS in performance.

Dervis Karaboga · Bahriye Basturk (2007), A Swarm intelligence is a research branch of science that models the population of swarms or interacting agents which are able to self-organize. An ant colony, an immune system or a flock of birds is a typical example of a swarm intelligence system. The swarming of the bees around their hive is another example of swarm intelligence system. Artificial Bee Colony (ABC) Algorithm is an optimization methodology based on the intelligent behavior of honey bees. In this paper, Honey Bee's algorithm is used for optimizing multivariable functions and the results produced by ABC algorithm, Particle Swarm Algorithm (PSO) and a flock of

birds Genetic Algorithm (GA) have been compared and the results outline that ABC algorithm outperforms the other swarm intelligence algorithms.

Jennifer Yick, Biswanath Mukherjee and Dipak Ghosal (2008), the wireless sensor network (WSN) has various important applications such as target tracking and remote environmental monitoring and all this has been enabled by the availability, particularly in previous years, of sensors that are, cheaper, smaller and intelligent. These sensors contain a wireless interfaces through which they can communicate with one another to form a wireless network. The design of a wireless sensor network (WSN) depends significantly on the application, and it is built by considering the factors such as the environment, cost, hardware, the application's design objectives and system constraints. Following a top-down approach or methodology, we present an overview of various new applications and then review the literature on various aspects of Wireless Sensor Networks and we classify the problems into three different categories: (1) communication protocol stack, (2) network services, provisioning, and deployment and (3) internal platform and underlying operating system and this paper we review the major development in these 3 categories and showcase new challenges.

Dervis Karaboga · Bahriye Akay (2009) Swarm intelligence is an emerging area in the field of optimization and providing a optimal solution to an problem and the researchers have developed various optimization algorithms by modeling the behaviors of different swarms (animals and insects such as bees, birds, ants and fishes). In 1990s, Ant Colony Optimization algorithms have been introduced based on ant swarm and Particle Swarm Optimization and they have been concerned with solving the optimization problems in various areas. However, the intelligent behaviors of bees have inspired the researchers especially during the last decade to develop new algorithms. This papers work presents a survey of the algorithms described based on the intelligence in bee swarms and their applications in various areas.

Kamalam Balasubramani (2013), The Artificial Bee Colony (ABC) algorithm is a population-based evolutionary approach proposed by Karaboga in the year 2005. The Artificial Bee Colony (ABC) algorithm is easy and very flexible compared to other swarm algorithms. This methodology because of its good convergence properties has become very popular and is widely used. The intelligent foraging behavior of honey bees has been reproduced in ABC algorithm. Numerous ABC algorithms were developed for solving optimization, unconstrained and constrained problems based on foraging behavior of honey bees. This paper work attempts to provide a comprehensive survey of research on ABC algorithm and a system of comparisons is used to designate the very importance of ABC algorithm, its enhancement and applications.

Richa Mehta and O.S. Khanna(2013), In Wireless Sensor Network, due to the power limitation of power of nodes, efficient routing plays very important role in order to save the energy of wireless sensor nodes and to enhance (increase) the lifetime of the WSN. In this paper, a new protocol is shown i.e. O-PEGASIS (Optimized PEGASIS) that has been presented to cut down the complexity of chain in PEGASIS. A new approach or method has been used to overcome the problem of PEGASIS by using the Honey Bee's optimization technique and the results of O-PEGASIS (Optimized PEGASIS) have been compared with two other chain routing protocols that are EAPHRN and PEGASIS and a simulation result shows that the lifetime of O-PEGASIS is far much better as compared to EAPHRN and PEGASIS.

3. Problem Description

PEGASIS is the chain Based hierarchical routing protocol in which all the wireless sensor nodes are structured or placed in form of a chain using the algorithm called greedy algorithm. This chain based routing approach distributes the energy load equally among the wireless sensor nodes in the wireless sensor network and the main key idea behind the PEGASIS is to form a chain among the wireless sensor nodes so that each and every node will transmit to and receive from a close or a nearby neighbor. The aggregated data passes from node to node and then directly get fused to the designated or labeled leader and finally forwarded to the base station. And For constructing the chain, we assume that each sensor node have global knowledge of the wireless sensor network. Nodes take turns (rounds for communication) in transmitting data to the Base Station so that the average energy exhausted by each node per round can be minimized. PEGASIS considers all the wireless sensor nodes in order to balance the network but still there are various flaws in this chain based routing approach. Some of flaws are like unacceptable data delay time due to a single long chain and wastage of the network energy due to redundant transmission path. So to minimize the wastage of energy and to overcome other flaws found in PEGASIS, a new approach is designed i.e. O-PEGASIS (Optimized PEGASIS)

4. Proposed Work

A. Why We Use O- PEGASIS (Optimized PEGASIS):

A new protocol i.e. O-PEGASIS (Optimized PEGASIS) has been introduced to reduce the complexity of chain in PEGASIS. A new approach has been used to overcome the problem of PEGASIS by using the Artificial Bee Colony optimization technique.

B. Artificial Bee Colony Optimization

a. Foraging behavior of Bees

A Artificial Bee Colony (ABC) moves themselves in different directions over long distances in order to exploit large number of food sources. The foraging process or behavior begins in a colony with searching for the most promising flower patches by sending the scout bees. The scout bee moves randomly from one patch to another in search of food. When the scout bees return to the hive, they found a patch that is measured on the basis of certain quality threshold and then they deposit their nectar and go to the dance floor to perform a dance called waggle dance. The waggle dance is kind of activity done for colony's

communication and through this waggle dance, all the information of flower patch that is required is conveyed to other bees and the information contained in it is such that distance of flower patch from hive, the direction in which the patch is found and its quality fitness. This information is very beneficial for sending the honey bees without using any maps to the flower patches. The waggle dance enables the colony to determine the fitness of various flower patches on the basis of the food quality and the amount of energy required to harvest it. After waggle dance, the scout bee goes back with other bees of the colony which are influenced by waggle dance towards the flower patch (these are the follower bees that were waiting inside the hive).

b. Artificial Bees Colony Algorithm

Artificial Bees Colony algorithm performs both local plus global search by utilizing it exploration and exploitation methodologies, respectively. The main purpose of Honey Bee's algorithm is to find out an optimized solution by using the bee's natural foraging behavior for searching food. The Artificial Bees Colony algorithm begins by placing a scout bees randomly in the search space and then the fitness by the scout bees are calculated of the various sites that are visited and the bees that have the highest fitness are appointed as "selected bees" and the sites visited by them are selected for neighborhood search. Now, selected fittest bees from each flower patch are selected and the remaining bees in the colony are randomly allotted in search space and then their fitness is measured. These steps of algorithm are performed again and again until a stopping criterion is met. The Honey Bee's algorithm carried out a kind of neighborhood plus random search and it can be used for both functional and combinational optimization.

5. Results

The efficiency of the proposed protocol i.e. O-PEGASIS has been evaluated in MATLAB 2007 tool and it has been outline in simulation results that the proposed protocol (O-PEGASIS) has solved the chain complexity of PEGASIS up to a great extend. In the proposed protocol i.e. O-PEGASIS, chain complexity is reduced by using Honey Bee's optimization approach and is more efficient in saving the energy.

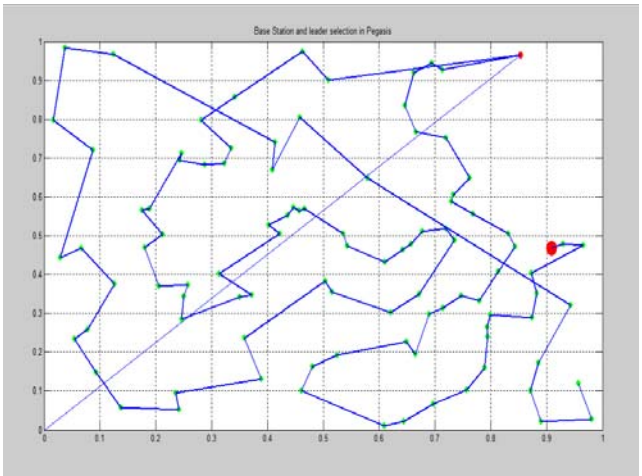

Figure 5.1: chain complexity in PEGASIS

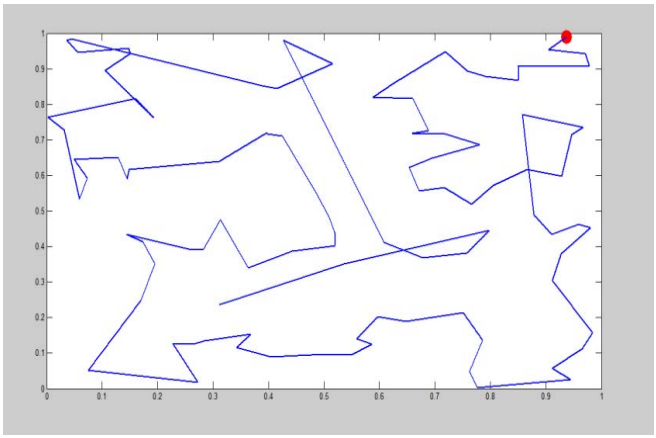

Figure 5.2: chain complexity reduced in O-PEGASIS

In simulation, number of rounds of communication (Network Lifetime) against the dead nodes lost by the network of O-PEGASIS has been computed which is much better than PEGASIS. In below given table we are showing the results of PEGASIS as compared to O-PEGASIS, in which the network lifetime (no of rounds) increases with the decrease of Alive nodes or with the increase of dead nodes and this very thing in shown through below given graps for PEGASIS and O-PEGASIS respectively.

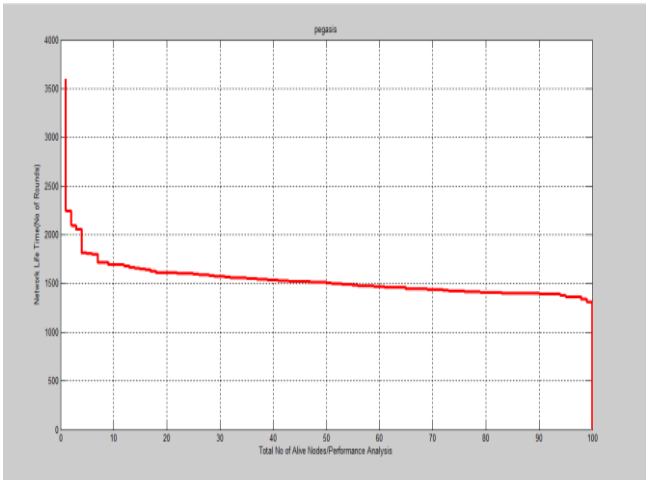

Figure 5.3: PEGASIS

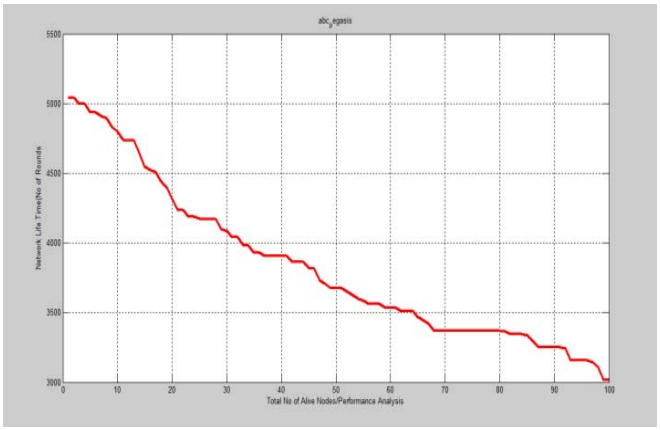

Figure 5.4: O-PEGASIS

Now, values of Network Lifetime (rounds of communication) are shown corresponding to the number of nodes in the Wireless Sensor Network for PEGASIS and O-PEGASIS respectively.

Table 5.5: Showing the values of network lifetime of PEGASIS and O-PEGASIS with respect to equal no of nodes

Network lifetime / No of nodes	PEGASIS	O-PEGASIS
10	2700	4600
20	2650	4400
30	2600	4200
40	2500	3950
50	2400	3700
60	2300	3550
70	2250	3500
80	2200	3300

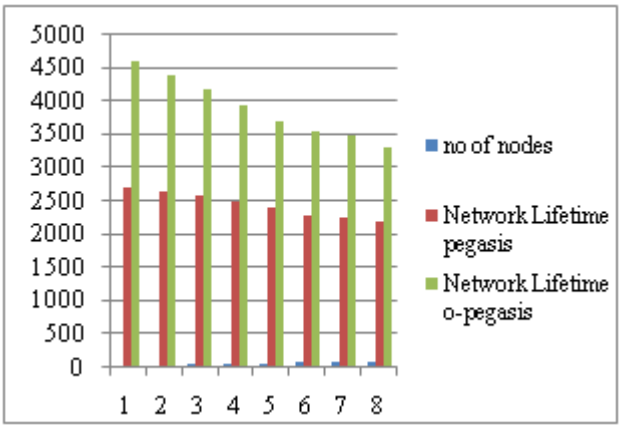

Figure 5.6: Shows a combined result of PEGASIS and O-PEGASIS, which shows that O-PEGASIS perform much better than PEGASIS

This bar graph result is built on the basis of the values from the above given table no 5.5. In below graph plotted x-axis (No of Nodes) and y-axis (Network Lifetime)

6. Conclusion

A new hierarchical routing protocol has been proposed for Wireless Sensor Networks (WSN) that attempt to enhance the network lifetime as well as throughput of Wireless sensor network. There were lots of limitations in PEGASIS (like wastage of the network energy due to redundant transmission path and unacceptable data delay time due to a single long chain). The efficiency of the proposed protocol i.e. O-PEGASIS has been evaluated in MATLAB tool and the proposed protocol gives better results as compared to PEGASIS. In future, we can work by optimizing the energy parameter along with the distance parameter or by changing the function for further reducing the chain complexity.

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Author Profile

Parul Mittal received the B.Tech degree in Computer Engineering from Malout Institute of Management & Information Technology, Malout in 2011.. During 2012-2014, I stayed in networking lab, to do a research on Swarm Intelligence. The technique, I used is Honey Bee algorithm to improve the performance of Wireless Sensor Network by reducing the chain complexity.