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Performance Evaluation of on Demand Energy Efficient Routing Protocol for WSN

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Abstract

In this paper, reactivity and artificial bee colony based protocol for wireless sensor networks has been proposed. From the survey it is found that GSTEB indicates quite significant results within the available wireless sensor network protocols. The tree based routing need shortest path between the origin and the sink, however the shortest path problem is NP-Hard in nature. Therefore, the artificial bee colony is required to raise the GSTEB protocol further to find the shortest route. The use of reactivity has been ignored in the case of GSTEB routing protocol, clustering is required to decrease the redundant data. GSTEB has been applied only on small networks the aftereffect of the dense network has been ignored in GSTEB protocol. Therefore, the proposed technique has been designed and implemented in the MATLAB tool. From various metrics, evaluation of improvement of the proposed technique over GSTEB has been found.

Keywords: *GSTEB; reactivity; artificial bee colony; clustering*

1. Introduction

Routing is a procedure of path determination between the source and the destination upon data transmission request. In WSNs the network layer is utilized for the implementation of routing of the information. It is known that in multi-hop networks source node cannot reach base station directly. So, intermediate nodes have to relay their packets. Implementation of the routing tables provides the solution. Routing tables contain the detailed lists of sensor node options for the given destination. Routing table is the procedure of routing algorithm along with the help of routing protocol for their maintenance and construction. WSN Routing Protocols can be classified into many different ways, based on their way of establishing the path for routing, based on the structure of the network, based on the operation of the protocol, based on the communication initiator, and based on protocol selection of next-hop on the route of sent message. The way of establishing the routing paths is considered [1].

2. Routing Protocols Based on Path Establishment

The routing paths can be made in any of the following ways, namely, proactive, reactive and hybrid. The foremost proactive protocol computes all the routes before they are actually required and store the computed routes in the routing table of every sensor node. Reactive protocols compute routes when they are actually needed. Hybrid protocols use the combination of these two ideas.

Proactive Protocols: Proactive routing protocol is supposed to maintain accurate and consistent routing tables of all the sensor network nodes by using the periodic dissemination of the routing information. Here, all the routes are computed in advance. Many of proactive routing protocols could be used in hierarchal and flat structured network. The benefit of flat proactive routing is their ability to compute

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the optimal path which also requires overhead for the computational work and is not accepted in most of the environments. Hierarchal proactive routing provides a better solution when the routing demands are for huge ad hoc network.

Reactive Protocols: - The global data of all sensor nodes is not maintained rather the establishment of route between the source node and the destination node is according to its on demand dynamic search. To find out the route from the source node to the destination node a route finding query is used along with the reverse path to reply the queries. Therefore, in the case of reactive routing, the selection of the route is on demand using route querying even before the route is established. The strategies differ in following ways: by reestablishing and recomposing the path in case of any failure and by minimizing the communication overhead which is owing to flooding on the networks.

Hybrid Protocols: - It is used for the application on huge networks. It constitutes of proactive as well as reactive routing strategies. Here, clustering technique is used to make the network scalable and stable. The sensor network is partitioned into many subgroups (clusters) which are maintained dynamically according to nodes status i.e. whether a node is added to the cluster or leave a cluster. It uses proactive technique only when routing is required inside the clusters and the reactive technique is used when routing is required across the subgroups (clusters). Hybrid routing strategy exhibits network overhead which is required in maintaining the clusters [1].

3. Artificial Bee Colony Algorithm

The Artificial Bee Colony algorithm was introduced by Karaboga in 2005 for optimizing numerical problems, which consist of three groups:

1. Employed bees,
2. Onlooker bees and
3. Scouts

The bee carrying out search randomly is known as a scout. The bee going to the food source visited by it before and sharing its information with others bees is known as employed bee and the bee waiting on the dance area is known as onlooker bee. The onlooker bee and scout also called unemployed bee. ABC algorithm called the collective intelligence searching model consists of three essential components: Employed bees, Unemployed bees and Food sources. The employed and unemployed bees search for the rich food sources around their hive. Analogously, in the view of optimization context, the number of food sources in ABC represents the population of possible solutions. The position of a good food source indicates the position of a better solution to the given optimization problem. The quality of nectar of a food source represents the fitness cost of the associated solution (value of the benchmark function) [2].

The algorithm requires setting of various parameters:

1. "**n**"- no. of scout bees
2. "**m** out of **n** sites visited" – no. of selected sites
3. **"e** out of **m** selected sites" - best sites
4. **"nep" –** no. of bees recruited for **best** sites
5. **"nsp" –** no. of bees recruited for (**m-e**) selected sites.
6. Initial size of the patches **ngh** that includes the site and its neighborhood and the stopping criterion.
7. Number of algorithm step repetitions **imax.**

The flowchart of the Algorithm of the Basic Bees is shown

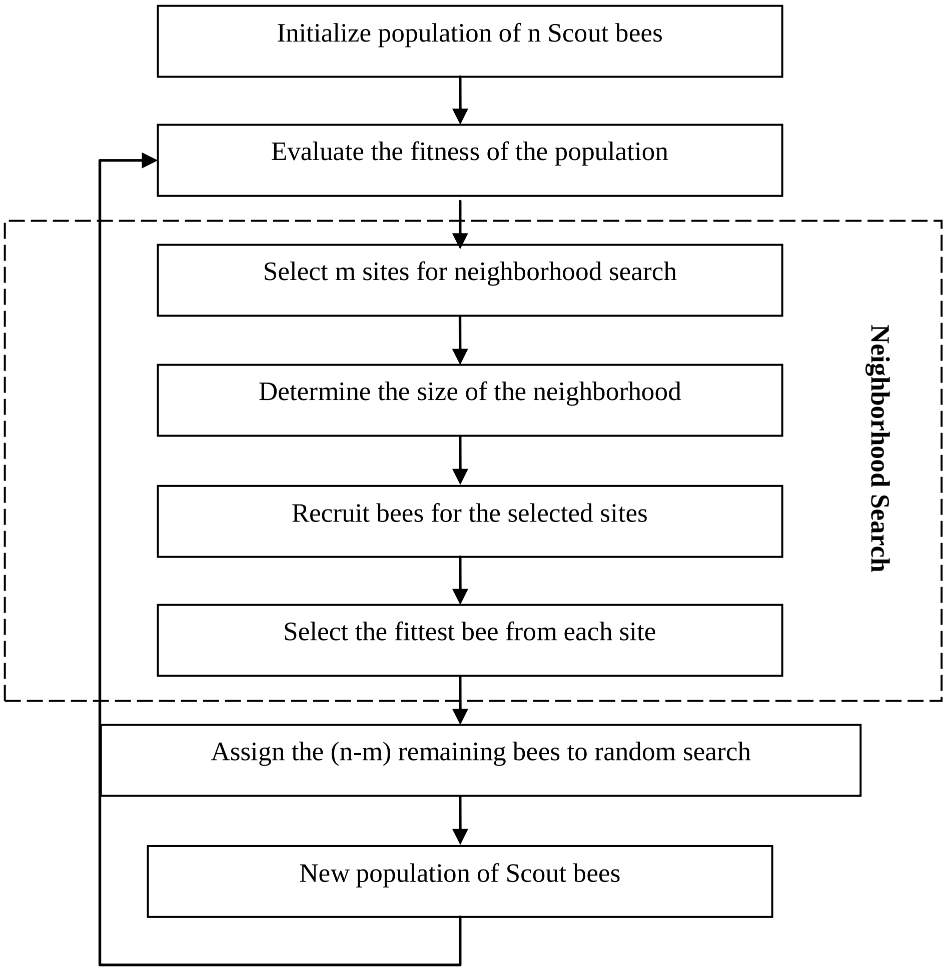

Figure 1. Flowchart of Basic Bee Algorithm

4. Literature Survey

Initially, artificial bee colony (ABC) algorithm which is an optimization algorithm and is based on a particular intelligent behavior of honeybee swarms was introduced. Comparison among the performance of various algorithms, ABC algorithm, particle swarm optimization, differential evolution and evolutionary algorithm was done for multi-dimensional numeric problems. The simulation result shows that the performance of artificial bee colony algorithm was comparable to those of the above mentioned algorithms and could be efficiently employed in solving engineering problems with high dimensionality [2]. A new energy adaptive protocol was introduced to cut back overall power consumption and maximize the network lifetime in a heterogeneous WSN. Within our protocol, New Clustering Algorithm with Cluster Members bounds for the energy dissipation avoidance in WSN determines a confidence value for any sensor node that wants to be a group head with parameters such as remaining energy of the sensor nodes and distance between the sensor nodes and distance between the CHs in each round. Simulation results showed that new algorithm performs better as LEACH and LEACH-E and cut back energy consumption and progresses WSN performance and lifetime [3]. A new enhancement in LEACH named I-LEACH was analyzed and proposed. An improvement was done by considering basically three factors; residual energy in nodes, distance from base station and number of neighboring nodes. A node was considered as head node if it had optimum value for the discussed three factors *i.e.*, had more residual energy as compare to average energy of network, more neighbors than average neighbors for a node calculated in network and node had less distance from base station in comparison to node's average distance from BS in a network. Reduction in energy consumption and prolongation in network life time was observed [4]. An energy efficient clustering protocol was introduced to boost lifetime of wireless sensor networks. The goal of EECPL was to distribute energy load among all the sensors to reduce the energy consumption and increase network duration of WSNs. EECPL organizes nodes into subgroups and ring topology is used to forward the data packets so that all sensor nodes receive the data from a prior neighbor and transmit the data to a next neighbor. After receiving aggregated information from prior neighbors, CHs transmit the aggregated data to the Sink. EECPL reaches significant energy savings, balances the energy consumption among the sensor nodes and reduces communication overhead [5]. The protocol Heterogeneous Hybrid Energy Efficient Distributed Protocol was introduced for WSN to prolong the lifetime of the network. According to simulation result H-HEED achieves longer lifetime along with more effective data packets when compared with the HEED protocol. The performance evaluation of the proposed protocol H-HEED was done in comparison to HEED protocol using Matlab. It was seen that there is significant improvement in network lifetime in case of H-HEED protocol in comparison with HEED protocol [6]. Researchers have proposed many energy aware protocols such as HEED, PEGASIS, LEACH, PEDAP and TBC. General Self-Organized Tree-Based Energy-Balance (GSTEB) routing protocol was proposed that builds a routing tree by using a process where, for every round, base station assigns a root node and broadcast this selection to all the sensor nodes. Subsequently, every node selects its parent node by considering only itself and its neighbor's information/data, thus made GSTEB a dynamic protocol. Simulation results showed that GSTEB performs better than other protocols to balance energy consumption, which prolongs the lifetime of WSN [7]. An efficient algorithm was introduced for increasing the network lifetime and to secure the data throughout. It is a moving strategy called as Energy Aware Sink Relocation for the mobile sinks in WSN. Today's system reduces the energy usage of the network and also reduces the security while transferring the data across the node. In this algorithm, the BS assigns the root node and broadcasts the data to the sensor nodes. But, it's a challenge such as for example, for every single transaction if the same base station was employed then its nodal energy was reduced to a greater extent leading to nodal failure at each round of transaction. This reduced the lifetime of a network to a better extent. For routing purpose the MCP (Maximum Capacity Path) algorithm was introduced. And also re- locatable sink method was introduced for relocating sinks and increasing network lifetime [8].

The theoretical approach was given to survey on Hierarchical routing protocol for WSN & also discussed about their performance. Basically, the important feature of routing protocol is to reduce the energy consumption of the sensor node and prolong the lifetime of the network. The network structured routing protocol in WSN is classified into three categories: Flat, Hierarchical and Location based [9].

5. Experimental Setup

To implement the proposed algorithm, design and implementation has been done. Table 1.1 shows all the variables and the constants required to simulate this work. These parameters are of standard value which is used as benchmark for WSNs.

Table 1.1. Experimental Setup

Parameter	Value
Area(x,y)	100,100
Base station(x,y)	50,150
Nodes(n)	1000
Probability(p)	0.1
Initial Energy(Eo)	0.01
Transmiter_energy	50nJ/bit
Receiver_energy	50nJ/bit
Free space(amplifier)	10nj/bit/m2
Multipath(amplifier)	0.0013pJ/bit/m4
Maximum lifetime	150
Message size	4000 bits
Effective Data aggregation	5nJ/bit/signal

6. Methodology

The design and flow of implementation is described as follows along with each single step.

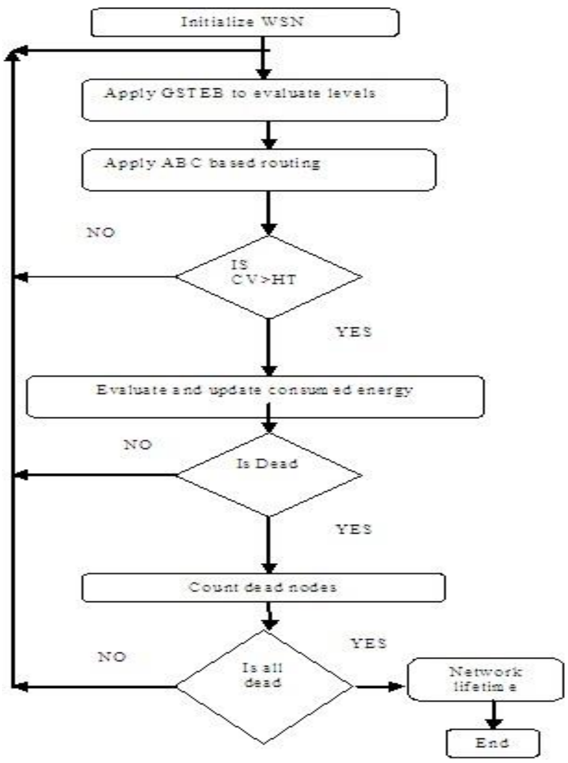

Figure 2. Proposed Methodology

Step 1: Initialize network
Step 2: Deploy the network randomly in predefined sensor field.
Step 3: Apply GSTEB to evaluate the levels.
Step 4: Check if Current value (CV) > Hard threshold (HT)
Step 5: Apply artificial bee colony optimization on clusters to find the best route among the nodes to sink.
Step 6: Evaluate and update energy consumption.
Step 7: Check whether all the sensor nodes become dead, if yes then show the network life time and Return else continue to step 3.

7. Performance Evaluation

a) Dead Nodes Representation

Figures below show total number of dead nodes on the basis of change in the position of Sink. Y-axis is representing dead nodes. X-axis is representing total number of rounds.

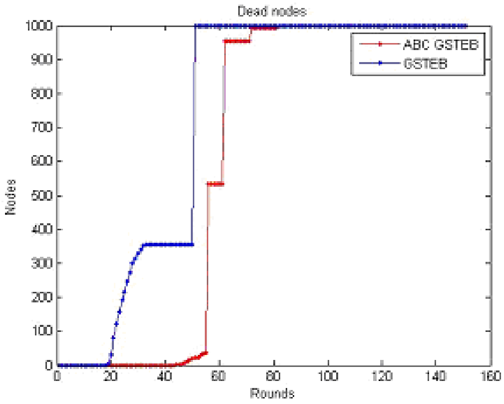

Figure 3. Comparison of Dead Nodes at Sink(X, Y) = (50, 150)

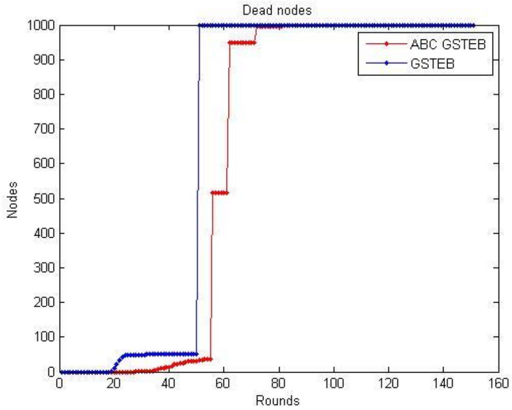

Figure 4. Comparison of Dead Nodes at Sink(X, Y) = (150, 150)

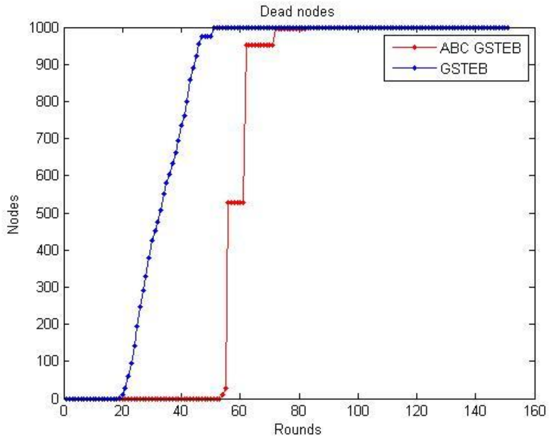

Figure 5. Comparison of Dead Nodes at Sink(X, Y) = (75, 75)

b) Remaining Energy

Figures below show remaining energy on the basis of change in the position of Sink. X-axis is representing number of rounds. Y-axis is representing the energy in joules.

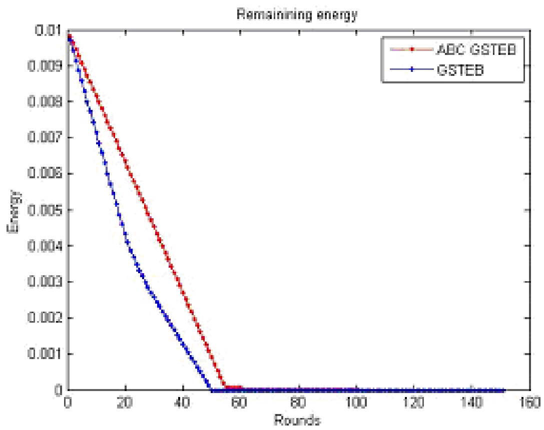

Figure 6. Comparison of Remaining Energy At Sink(X, Y) = (50, 150)

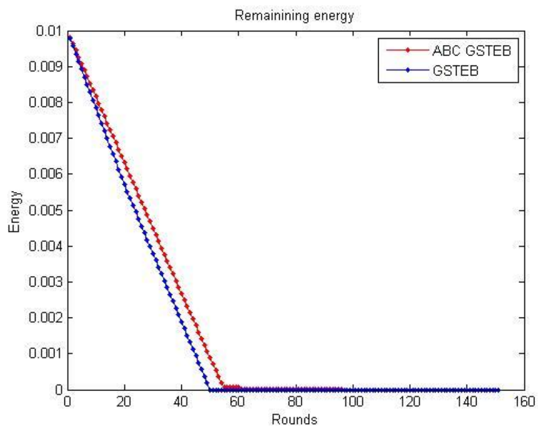

Figure 7. Comparison of Remaining Energy at Sink(X, Y) = (150, 150)

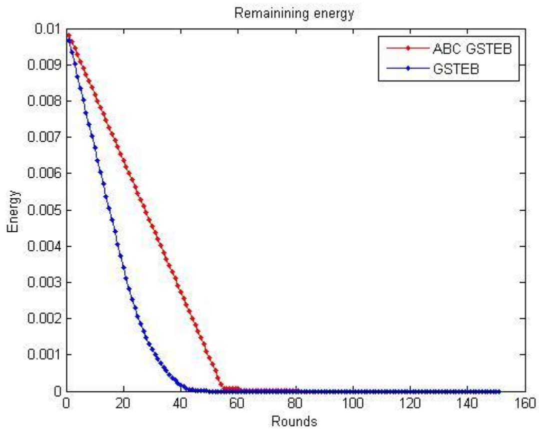

Figure 8. Comparison of Remaining Energy at Sink(X, Y) = (75, 75)

Acknowledgments

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