ANALYSIS OF THE PERFORMANCE OF TREE CLUSTER BASED DATA GATHERING ALGORITHM IN WSN

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Abstract— Wireless sensor networks are presently an emergent area for Research and Development because sensor network constitute a platform for many applications associated to monitoring the surroundings, healthcare, military surveillance and many more. Wireless sensor networks have a major cause of concern from the energy point of view. Data collection in wireless sensor nodes has been a major concern when are looking to save energy in a real time scenario especially in reactive network. With limited energy of all the nodes, an efficient data gathering algorithm plays a major role. In order to improve the energy efficiency, Tree-cluster based data gathering algorithm is used for data gathering purpose. This Algorithm consists of three stages, tree construction, Rendezvous Points(RPs) and Sub-Rendezvous Points(SRPs) selection, and data collection. However, this protocol uses the only two hop neighbours for weight calculations. In this paper an improved TCBDGA algorithm is proposed. The proposed algorithm uses more than two hops neighbours for tree construction to gather data. The time stability, Energy and Throughput have been used as the parameter to show improved results.

Keywords— Data Gathering Algorithm; TCBDGA; Selection Weight Calculation; I-TCBDGA

I. INTRODUCTION

In recent times an efficient design of a Wireless Sensor Network has become a leading area of research. A Sensor is a tool that detects some type of input from both the physical or environmental conditions, such as pressure, heat, light, etc and responds. The output of the sensor is mostly an electrical signal that is transmitted to a controller for furthermore processing.

A Wireless sensor network can be defined as a network of tools that can pass the information collected from a monitored field through wireless links. Simulation results show that PEGASIS is efficient than LEACH. For most of the applications, in addition to minimizing energy, it is also important to consider the delay incurred in gathering sensed data [1]. The data is forwarded through multiple nodes, and with a gateway, the data is attached with other networks like wireless Ethernet.

In proposed tree-cluster based data gathering algorithm, which is named TCBDGA for short, a mobile sink initiates the data collection tour periodically from the BS, stops at each rendezvous point, gathers data from the nodes in its one-hop radius directly, and finally, return back to the BS for one round. The whole algorithm comprises of three stages, tree construction, RPs and SRPs selection, and data collection. In tree construction stage, every node is weighted by its residual energy, its distance to the BS, the number of its two-hop neighbors and the average residual energy of its one-hop neighbors. By linking with its one-hop neighbors and comparing their weight, every node considers the neighbor with the maximum weight as its parent node. Thus, the data-gathering tree can finally be constructed. Data gathering and Aggregation Protocol), which are near optimal minimum spanning tree based routing techniques, where one of them is the power-aware version of the other [2]. In RPs and SRPs selection stage, every root node of the trees is considered as a Rendezvous Point. And each tree is decomposed into a set of sub-trees depending on its depth and its traffic load. Then Sub-Rendezvous Points (SRPs) can be found in the sub-trees for further load balancing. In the data collection phase, the positions of RPs and SRPs are considered as the stop points of the mobile sink. Each sensor node will transmit its data to the corresponding one-hop neighbors of its associated RP or SRP, the latter will reserve and upload them to the mobile sink when it arrives. In data collection stage, when the mobile sink visits each RP/SRP every round, the latter decides whether or not to send a tree-reconstructing request according to the remaining energy ratio of its one-hop neighbors. If the condition is met, the corresponding RP/SRP sends the request to the mobile sink after it reaches. Finally, the sink decides whether to perform tree reconstruction according to the proportion of the number of requests to the number of RPs and SRPs.

II. RELATED WORK

Lindsey et.al in [1] this paper, they present an improved scheme, called PEGASIS (power-efficient gathering in sensor information systems), that is a near-optimal chain-based protocol that minimizes energy. In PEGASIS, each node communicates only with a nearby neighbor and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Simulation results display that PEGASIS performs better than LEACH. For many applications, in addition to minimizing energy, it is also vital to consider the delay incurred in gathering sensed data.

Tan et.al in [2] this paper, they presents two new algorithms under name PEDAP (Power Efficient Data gathering and Aggregation Protocol), that are near optimal minimum spanning tree based routing stratergies, where one of them is the power-aware version of the other. Their simulation results present that our algorithms perform well both in systems where base station is far away from and where it is in the centre of the field. PEDAP accomplish between 4x to 20x improvement in network lifetime contrasted with LEACH, and about three times improvement compared with PEGASIS.

Akkaya et.al in [3] this paper surveys latest routing protocols for sensor networks and shows a classification for the various approaches pursued. The three main classifications explored in this paper are data-centric, hierarchical and location-based. Each routing protocol is described and discussed under the suitable classification. Moreover, protocols using contemporary methodologies such as network flow and quality of service modeling are discussed as well.

Chuan Zhu [4] Wireless sensor networks (WSNs) have been widely applied in various industrial applications, which involve collecting a massive amount of heterogeneous sensory data. However, most of the data-gathering strategies for WSNs cannot avoid the hotspot problem in local or whole deployment area. Hotspot problem affects the network connectivity and decreases the network lifetime. Hence, we propose a tree-cluster-based data-gathering algorithm (TCBDGA) for WSNs with a mobile sink. A novel weight-based tree-construction method is introduced. The root nodes of the constructed trees are defined as rendezvous points (RPs). Additionally, some special nodes called sub rendezvous points (SRPs) are selected according to their traffic load and hops to root nodes. RPs and SRPs are viewed as stop points of the mobile sink for data collection, and can be reselected after a certain period. The simulation and comparison with other algorithms show that our TCBDGA can significantly balance the load of the whole network, reduce the energy consumption, alleviate the hotspot problem, and prolong the network lifetime

Ye et.al in [5] this paper, they propose a novel clustering scheme EECS for wireless sensor networks, that better suits the periodical data gathering applications. Their approach elects cluster heads with more remaining energy through local radio communication while achieving well cluster head distribution; further more it launches a novel method to balance the load among the cluster heads. Simulation results depicts that EECS outperforms LEACH significantly with prolonging the network lifetime over 35%.

Zhang et.al in [6] Based on generation rules of traditional scale-free networks, this paper added several restrictions to the improved model. The simulation result depicts that improvements made in this paper have made the entire network have a better resilience to the random failure and the energy costs are more balanced and reasonable. This improved model which is based on the complex network theory demonstrates more applicable to the research of wireless sensor network.

Wenguo et.al in [7] Energy consumption is one of the most vital issues to the wireless sensor network, which determines the network lifetime. The non-uniform property of energy consumption is deliberated in this paper. Theoretical analysis indicates that the average energy consumption of the sensor is heavy non uniform, that decreases with the hop number to the sink node (or the sensor connected to the high level in a heterogeneous sensor network). In a wireless sensor network, the energy utilization rate is extremely low whereas the coefficient of energy waste is extremely high, which are monotone decreasing and increasing with the hop number to the sink node (or the sensor connected to the high level in a heterogeneous sensor network) respectively.

III. PROPOSED METHODOLOGY

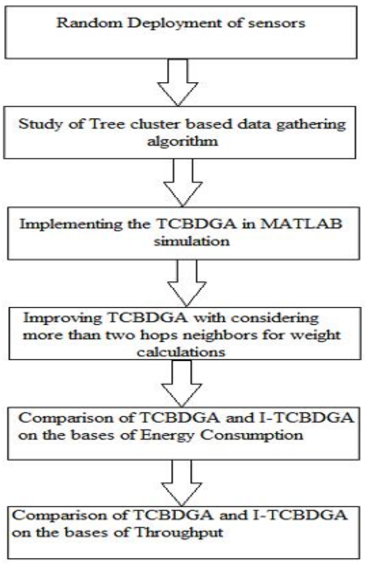

Figure1: Flow Chart of the work process

M. Zhao and Y. Yang,``Bounded Relay Hop Mobile Data Gathering in Wireless Sensor Networks" [9] have proved that in order to pursue a trade off between the energy saving and data gathering latency, which achieves a balance between the relay hop count for local data aggregation and the moving tour length of the mobile sink, the relay hop count d should be constrained to a small level (2 or 3) to limit the energy consumption at sensors. Therefore, Chuan Zhu [8] only considered the number of two-hop neighbours of a node to calculate the selection weight of each node.

Therefore, while implementation of TCBDGA in this work during weight calculation of each node only two hop neighbours are taken into account. However, the weight calculation can be improved by taking more than two hop neighbours into consideration which in turn can improve the efficiency of network. Thus, the selection weight calculation is improved in this work which in turn leads to improvement in energy consumption and throughput.

IV. EXPERIMENTAL SETUP

The experimental work is done in MATLAB as it is a great tool for testing and developing various systems. Chuan Zhu [8] proposed a tree-cluster-based data-gathering algorithm (TCBDGA) for WSNs, in which tree clustering is introduced. The root nodes of the constructed trees are defined as rendezvous points (RPs). Additionally, some special nodes called sub rendezvous points (SRPs) are selected according to their traffic load and hops to root nodes

In this system, GUI was developed and using that GUI based tool, the sensor deployment is done randomly on which TCBDGA is executed. Firstly, out of all the sensors, RPs and SRPs are selected .Then the weight of each sensor node is calculated for TCBDGA. The weight calculation is improved by considering more than two hop neighbors while calculations and thus calculation of Energy consumption and Throughput for both the algorithms-TCBDGA and I-TCBDGA.

The snapshots of work done are given as:

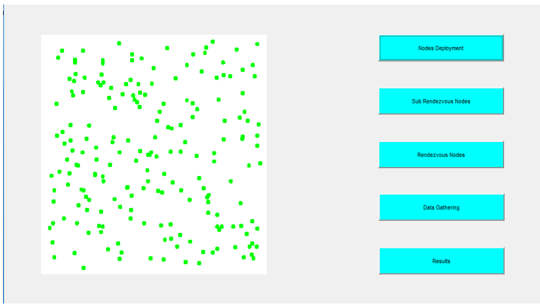

Figure 2: Snapshot showing the deployment of nodes

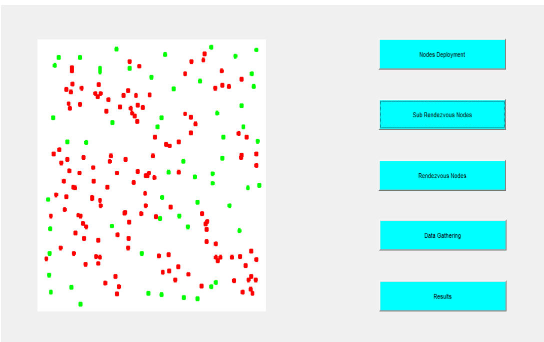

Figure 3: Snapshot showing the Sub-Rendezvous nodes

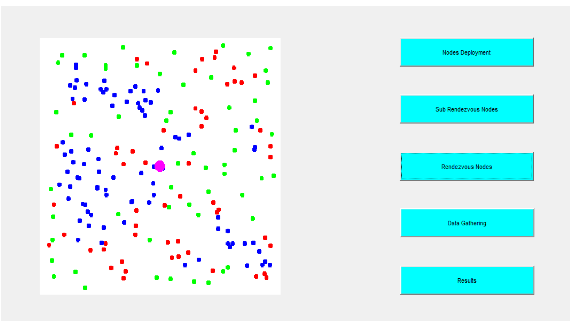

Figure 4: Snapshot showing the Rendezvous nodes and BS

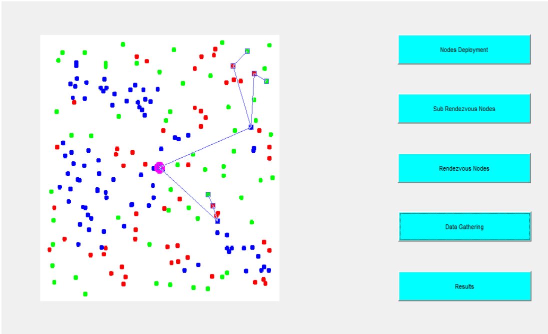

Figure 5: Snapshot showing the Data Gathering process using TCBDGCA

RESULTS AND CONCLUSION

In TCBDGA, while weight calculation of each node only two hop neighbours are taken into account. The weight calculation in I-TCBDGA is improved by taking more than two hop neighbours into consideration which in turn improves the efficiency of the network. The parameters of both the algorithms-TCBDGA and I-TCBDGA are calculated and compared with the help of curves and tables. The parameters compared and calculated are Energy consumption of each node after data transfer round, Throughput of data and time after which re-selection of nodes is required.

Table 1: Table showing the Energy consumed by nodes per packet transfer of data

Energy Consumed by nodes per packet transfer		
NODE	I-TCBDGA	TCBDGA
1.	6.62	7.37
2.	8.97	11.57
3.	5.67	6.21
4.	2.01	3.37
5.	4.79	5.55
6.	2.27	4.15
7.	1.89	3.04
8.	10.97	13.42
9.	9.83	12.24
10.	6.38	7.6
11.	5.03	5.75
12.	5.81	6.37
13.	5.81	6.67
14.	3.88	4.29
15.	5.01	5.4

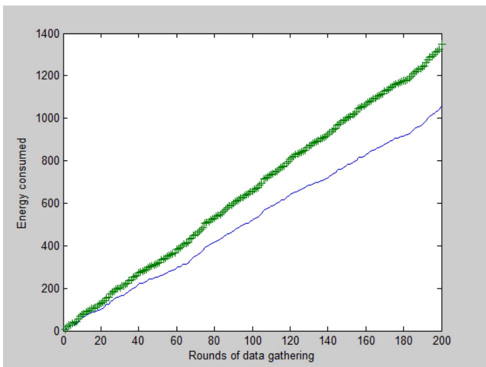

Figure 6: Snapshot showing the Energy Consumed by nodes (Green curve shows TCBDGCA and Blue curve shows I-TCBDGCA)

Table 4.2: Table showing the Throughput of data transfer

Throughput of nodes for data transfer		
NODES	TCBDGA	I-TCBDGA
1.	1.17	1.28
2.	0.67	1.28
3.	0.54	0.93
4.	0.04	0.06
5.	0.03	0.51
6.	0.32	0.36
7.	0.08	0.10
8.	0.71	0.79
9.	0.26	0.29
10.	1.14	1.98
11.	0.65	0.72
12.	0.62	1.19
13.	0.09	0.12
14.	1.88	2.84
15.	0.16	0.19

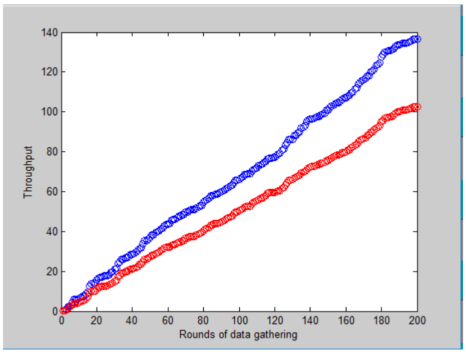

Figure 7: Snapshot showing the comparison of throughput (blue curve is of TCBDGCA and red curve is of I-TCBDGCA)

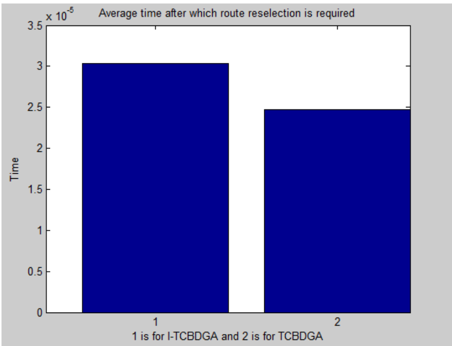

Figure 8: Snapshot showing the comparison of time, after which reselection of route is required

The outcomes show that the I-TCBDGA which considers more than two hop neighbors in weight calculation of nodes performs better than TCBDGA which only considers two hop neighbors in weight calculation of each node. The energy consumed by nodes while transferring of data is more in case of TCBDGA. The throughput of I-TCBDGA and TCBDGA was compared and is more in I-TCBDGA. Thus, the network lifetime with I-TCBDGA increases as the energy of nodes is conserved. The re-selection of nodes for tree construction is also required after more time in I-TCBDGA.

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