

Simulation Time and Energy Test for Topology Construction Protocol in Wireless Sensor Networks

Satyam Gupta, Gunjan Gupta

Department of Electronics and Communication Engineering, Invertis University, Bareilly, India
e-mail: satyam9598@gmail.com

Abstract

Coverage area and energy consumption are very big challenges in the field of Wireless Sensor Networks (WSNs) as it affects the number of sensors, connectivity and network. Since the sensors are operating on battery of limited power, it is a challenging aim to design an energy efficient Topology Control protocol, which can minimize the energy and thereby extend the lifetime of the network. Through this paper an attempt has been made in terms of simulation time and spent energy in construction of topology in the sensor network by comparing Just Tree and K-neigh Tree protocols. The result shows that K-neigh Tree protocol consumes less energy than Just Tree protocol.

Keywords: just tree, K-neigh tree, energy consumption, topology construction, wireless sensor networks (WSNs)

1. Introduction

Past several years have witnessed a great success of Wireless Sensor Networks (WSNs). As an emerging and promising technology, WSNs have been widely used in a variety of long term and critical applications including event detection, target tracking, monitoring and localization and so on. A sensor network usually consists of n number of sensor nodes which are self organized into multi-hop fashion. By working together, sensor nodes coordinate to finish a common task [1, 7]. Since sensor nodes are very small in size, due to their tiny size, sensor node cannot be equipped with big batteries. Therefore, energy conservation is very crucial in the context of sensor networks. So to conserve energy in sensor networks, one of the approaches proposed so far is Topology Control. The basic idea behind Topology Control is to restrict the network topology, i.e. energy need for transmission depends on the distance between transmitter and receiver. There is wide range of operations that Topology Control can perform to conserve energy for sensor nodes, it includes reducing the transmission range of the nodes and turning off the nodes which are not in use.

The simulation is performed on ATARRAYA software [2] for the design and evaluation of Topology Control algorithms in Wireless Sensor Networks. In Atarraya Software, there are number of Topology Control protocols [2, 6] present which include protocols like A3, A3 Coverage, Simple Tree, Just Tree, K-neigh Tree, EECDS, CDS Rule K. In this work we had compared Just Tree and K-neigh Tree protocols.

Just Tree: The Just tree algorithm [6] assumes one sink node responsible for message/information broadcast. The sink nodes are capable of sending or receiving messages from other neighboring sensor nodes. The message or number of events are propagated within the network using the same concept of parent node and child node, the parent node initiates the message and transfer this message to other sensing nodes acting as child node. The concept of Just Tree ensures that as the deployment area will increases or if the deployment area is constant the number of nodes if increased will denote the increase in the size of the tree in order to efficiently cover a flexible or constant deployment area.

K-neigh Tree: The sink node transmits a HELLO message to all its neighbors at highest power, which contains its ID number and its tree level. The node that accepts the HELLO message stores the ID of transmitted node and tree level, calculates the distance with the transmitting node and sets its state to reside. After accepting the HELLO message for the first time, a node transmits a HELLO message of its own to its own neighbors and sets a timer in order to listen for its neighbor's messages. The K-neigh Tree protocol assumes that the nodes have no knowledge of their locations, and that they can change their transmission power

in a regular manner. Using a discrete number of power levels will be studied in a future work [4] [6]. The computational complexity of the protocol depends directly on the selected sorting algorithm, while the message complexity is of 2 messages per node, which could be reduced to 1 message if the UPDATE message is not sent.

2. Simulation Results

The algorithms mentioned above are evaluated on simulator ATARAYA which was specifically designed for Wireless Sensor Networks. The Simulator allows us to select the different network parameters, such as simulation time, number of message transferred (events), Queue size and Energy Consumed.

3. Analysis

The result of simulation produced in Table 1 and 2 shows that all the algorithms have their individual and independent role for construction of topology. The protocols were evaluated on a specifically designed simulator for WSN topology. The simulator Atarraya allows the scalability of the underlying network with the ease of selecting different network parameters, such as deployment area, number of nodes and communication range.

Table 1. Performance of Just Tree Algorithm

Nodes	Simulation Time (sec)	Consumed Energy (mJ)
100	13.420	22.917
150	9.337	45.768
200	8.092	72.714
250	7.725	101.597
300	7.087	155.007
350	7.113	191.539
400	6.020	237.844
450	6.408	289.575
500	5.446	367.961

Table 2. Performance of K-neigh Tree Algorithm

Nodes	Simulation Time (sec)	Consumed Energy (mJ)
100	4.485	22.553
150	4.110	43.836
200	4.250	72.670
250	4.218	101.665
300	4.094	146.147
350	3.894	185.190
400	3.886	240.264
450	3.989	296.363
500	3.926	361.614

As clearly shows in tables that each parameter of every protocol increases/decreases with increase in number of nodes. But when we talk about the comparative study of the two protocols then we find that simulating results produced by K-neigh Tree protocol had given the best results among the other Topology Control protocol as it takes less simulation time and less amount of energy spent in Topology Control in comparison with Just Tree protocol.

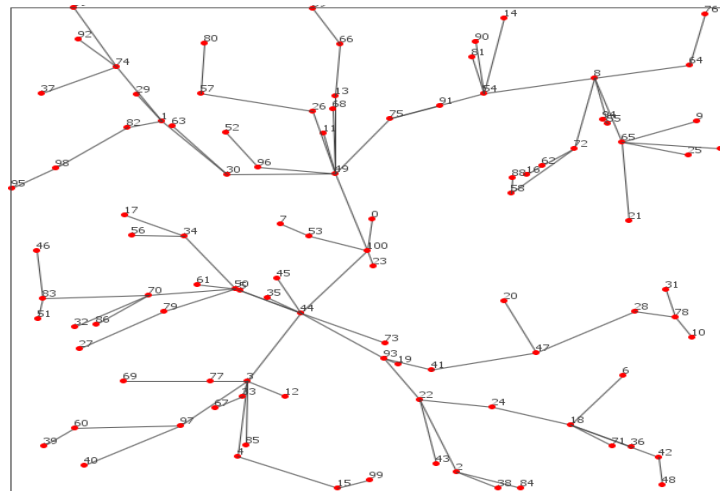


Figure 1. Deployment of 100 nodes

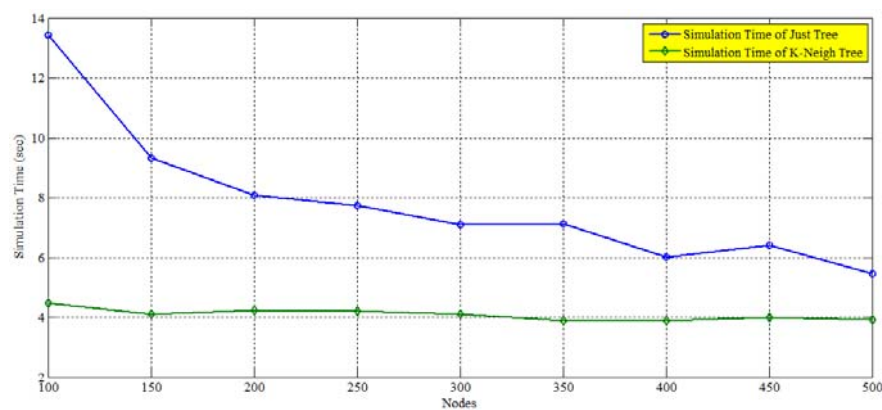


Figure 2. Nodes v/s Simulation time of Just Tree and K-neigh Tree

In Figure 2, as we clearly observe that simulation time taken by K-neigh Tree protocol is almost constant while simulation time of Just Tree goes on decreasing and taking more time to control topology than K-Neigh Tree protocol.

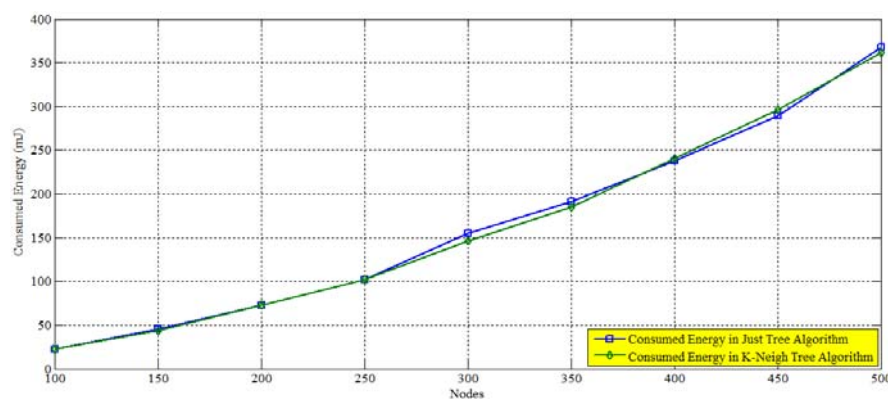


Figure 3. Nodes v/s Consumed Energy in construction of Just Tree and K-neigh Tree

In Figure 3, we are talking about Consumed Energy in both topology control algorithms and we observe that K-neigh Tree algorithm has consumed less energy although there is a minute difference between the energy consumed in K-neigh Tree and Just Tree algorithm, i.e. of 6.347mJ.

4. Conclusion

The above given graphs clearly shows that how differently these Topology Control algorithms work. That Topology would be beneficial for us that took less time and spent less amount of energy so that our sensors may work for long lasting.

Through the comparative study of the two algorithms, i.e. Just Tree and K-neigh Tree, we found that the simulation time for Just Tree algorithm remains almost constant for 500 nodes and spent energy level also is more than that of K-neigh Tree algorithm. So on the basis of above obtained graphs for 500 nodes, we can conclude that K-neigh Tree algorithm is better than Just Tree algorithm as it takes less time and utilizes less amount of energy spent in Topology Construction. Further in future lot of work would be carried out in other topologies as mentioned above.

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