Chapter 7

Conclusion and Future Work

This chapter concludes the thesis and proposes the future work, which can be researched and built up based on the ideas proposed. This thesis addresses the topology control issues in Wireless Sensor Network. The novel methods to achieve quality measures such as network lifetime, connectivity, coverage and reliability together with implementation and simulation results are presented in this thesis. In addition to this affecting parameter such as residual energy, message overhead,energy overhead has been discussed at the time of increasing lifetime. Throughout the thesis, either the proof of concept or simulation and the implementation results are presented to validate the findings.

The type of topology control used in a wireless network determines, among other things, the neighbors of each node in the network as well as transmitting power of each node. The number of neighbors of each node will have a direct impact on the routing protocol. In that, it determines the amount of redundancy there is in the network, whether or not the network is connected, the size of routing tables and the amount of time it will take for the routing protocol to generate routing tables. Therefore, it is ideal to have a networking-layer-friendly topology control mechanism that produces a connected network and results in smaller routing tables. The choice of transmitting power, on the other hand, determines the quality of the signal received at the receiver. It also determines the range of transmission and the magnitude of interference created for other receivers. As a result of this, power control:

- Affects the physical layer, since it determines the quality of the received signal.
- Affects the network layer and routing, since it affects the transmitting range.
- Affects the transport layer, since interference causes congestion.
- Affects medium access control, since contention is dependent on transmitting range.

It is evident therefore that the choice of power level, determined by the topology control mechanism, has far-reaching effects across the different layers of the wireless network protocol stack. The performance of the whole system is therefore affected by the choice of topology control.

7.1 Summary of Achievements

Motivated by extending the lifetime of a sensor network a topology control algorithms proposed in this thesis. The researchers have proposed different approaches with some assumptions and constraints to solve lifetime extension problem. The proposed research work investigated and developed some approaches in line with earlier research that are summarized in following paragraphs. Extensive experimentation on simulator has been done as a part of research work to develop energy efficient topology control algorithm for Wireless Sensor Network. The performance measure of different topology control algorithms was computed for different categories of networks of varying sizes. Breadth and extent of algorithms are investigated in this research.

LEBTC algorithm is designed for the above-described network model. The algorithm works in two phases with all the mathematical calculations. The first phase provides all the calculations related to neighbouring RSSI metric table and energy is calculated. In the second phase, the algorithm performs a redundant edge removal process without affecting the connectivity. This phase is designed to reduce the node degrees, which helps in reducing interference. link efficiency based topology control Algorithm has maximized the lifetime of the network. The energy efficiency of wireless sensor network and the lifetime maximization problem is handled by overall link efficiency and a fair selection of node for transmission.

The proposed approach presents a new topology control scheme based on fairness, admissibility and effectiveness of nodes using RSSI. It deals with the dynamics like eliminating unnecessary links in the dense network, increasing the lifetime of sensor networks while maintaining connectivity of the network and ensures that the network is associated with an efficient energy link. We have discussed the characteristics of RSSI as a link efficiency metric and design a new link quality estimation metric based on it. We studied and implemented existing topology control protocol such as RNG, GG, KNeigh and FETC etc. The proposed contribution improved on FET, GG, RNG by minimizing imbalance. Rigorous experimentation has been done to check the performance of the proposed algorithm. We have considered different node sets such as 100, 200, 300 etc. different iteration, such as 2 times, 5 times , 10 times and analyzed the performance. After experimentation, it is concluded that proposed LEBTC is approximately 14% better than its competitor Algorithms.

POLY is a semi-distributed graph theoretic topology control convention for WSN. It finds the quantity of polygon present in the network by displaying network as associated chart. To accomplish energy effectiveness, the convention frames a CDS like polyphonic network, which thus give reliability on account of arbitrary connection disappointment. It adjusts to topological changes in the remaining energy of nodes. Connectivity ought to be kept up in the construction stage.

IPOLY considers EH as a backup node, the lifetime of wireless sensor network field can boost the time allotment of sensor fields with clustering and base station arrangement. Existing CDS-based conventions have impressively brought down system reliability on the grounds that every edge (join) in these topologies serves as an extension edge and therefore does not provide any redundancy in the network. The enhanced algorithm has fewer message overhead. It has less energy consumption compared to other available CDS based methods. The developed algorithm performs well in static as well as the dynamic environment. IPOLY algorithm is more reliable than its competitors, and it reduces message complexity compare to other CDS based algorithms. The developed algorithm performs well in static as well as the dynamic environment. Proposed solution provides eliability more than 100%. It reduces message complexity approximately by 27%. The First EhPOLY algorithm is compared with A3, EECDS, CDS Rule K. And it has been found that Performance of EhPOLY is better than its competitor algorithms by 19%. In this contribution, we have considered static and dynamic maintenance techniques for EhPOLY. Best performance of IPOLY is observed in dynamic maintenance technique. For residual energy, energy overhead EHPOLY performs better than its competitors by 17%.

Cellular Automata , a self-reproduction system is s decentralized computing model. Using local information, it provides an excellent platform for performing complex calculations. Topology control algorithms is based on the selection of a deterministic or randomized way of a suitable subset of sensor nodes that must remain active. It provides 40% more coverage. Self-reproduction for simulating and evaluating topology control algorithms in sensor network uses MATLAB programming environments and compared results. Each algorithm is supported the choice of an appropriate set of sensing element nodes that have to stay active. One each of them deterministically selects the set of positive nodes, a weak random supply so as to pick that node ought to stay active. This contribution presents the performance of Cellular and Cyclic Cellular Automata (Self-reproduction).

In view of the perception that the utilization of weighted margolus or weighted block neighborhoods in the comment settle on better choices on whether to stay active reacting Self-reproduction results in enhanced execution of calculation TCA-1, we exhibit simulation results for the execution of TCA-1 as far as active sensors and global energy, connectivity and coverage acquired through simulations utilizing Self-reproduction with the accompanying neighboring schemes: Moore, von Neumann, Weighted Margolus, Weighted Block and Slider; the situation when no topology control calculation is utilized is additionally described. It is plotted that the utilization of self-reproduction with a moore, weighted margolus or Slider neighborhood raises the best execution of ImpTCA-1 calculation. Keeping in mind the end goal to acquire effective simulations of topology control calculations in WSNs, Self-reproduction neighborhoods ought to catch the way that when nodes have expanded learning of their encompassing surroundings or idle.

A weighted margolus neighborhood in comparison with algorithm ImpTCA-2 through a Self-reproduction System with a Moore neighborhood as far as active nodes, global energy, coverage, and connectivity; the situation when no topology control calculation is utilized is additionally defined. It is observed that the randomization utilized by ImpTCA-2 prompts (somewhat) enhanced results (thinks about to the deterministic ImpTCA-1 to the extensive network lifetime, coverage and connectivity are concerned. The cyclic Self-reproduction based technique covers the common region sensing problem and ensures the minimum number of active node in the network. If any active node fails for transmission, the standby node will be selected by cyclic Self-reproduction . This protocol of " going to sleep and waking up after the fixed amount of time" make it ideal for controlling topology and extending lifetime of the network.

ImpCCA is the best performer amongst all other competitors referred in contributions related to cellular automata. Even the employment of weak randomization looks to boost the performance of easy topology control algorithms; the role of a lot of excellent varieties of randomization deserves investigation. moore, weighted margolus or slider neighboring schemes ought to be more popular in corresponding self-reproduction system used for simulation. Self-reproduction System based algorithm provides better connectivity and coverage for large scale network. Improved Self-reproduction system is better in connectivity, coverage, reliability and network lifetime.

Comparative performance analysis of algorithms has been done with the research work and it is found that ImpCCA is the best performer algorithm in the category of cluster based algorithms. We compared this algorithm with well Known LEACH suggested in the literature. Considering coverage as a performance metric, ImpCCA is approximately 40% better than the LEACH. For active nodes and connectivity ImpCCA is performing well. By considering approximately 65 different scenarios ImpCCA is 20% better than the ImpTCA1, ImpTCA2, Weighted Blocks, Weighted Morgules, Von Neuman and Moor.

7.2 Future Work

There are still many aspects of topology control for sensor networks that were not considered in this thesis due to the fact that some of them were out of scope or due to limitations of time and resources. There are plenty of rooms that can be explored and added on top of proposed algorithms. Beyond the issues that have been evaluated in the focus of this thesis, there are still numerous aspects for further research. Here, I would like to add some of these possibilities and open issues that came across my mind while working on this thesis. At the end of this thesis, we point out some thoughts, and open problems for future research.

Topology control algorithms were not designed to deal with mobility. Mobile agents should use the clustering approach to sharing the load with cluster head nodes. Future topology control should explore various mobility patterns to create a stable topology. Network lifetime should be defined to meet the requirement of the application. However, target application of the algorithm is rarely discussed. Various definitions of network lifetime are used in topology control. However, it is not sufficient and accurate. It should be defined in the targeted application. A variety of radio models had been used by the topology control algorithm to compute topology of networks. The power adjustment approach doesn't consider energy consumption in the receiver and considers total energy consumption in transmitters only. The realistic energy model should be reviewed by topology control to get a better result.

Sensor networks are embedding wireless sensor devices with different capabilities and functionalities that require new algorithms and communication protocols. For example, cluster-based architectures may utilize more powerful devices to aggregate data and transmit information on behalf of resource constraint nodes. In the future, we have to work on "How to find exact CA rules which will model a particular application."