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A Survey on Neighborhood Dependant Topology Control in Wireless Sensor Networks

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ABSTRACT

Wireless sensor networks are the ultimate technology for communication that allows network nodes to communicate without the need for a fixed infrastructure and wires. They use electromagnetic waves, as the information transmission.The development of network technologies has prompted sensor folks to consider alternatives that reduce costs and complexity and to improve reliability. This paper addresses the issues associated with the steady connectivity which reduces the overall power consumption and a comparison study is made on these issues. A hierarchical cooperative technique is also proposed to increase the Packet delivery ratio and to reduce the overall energy consumption of the network. Keywords: Wireless Sensor Networks, Reliability, Connectivity, Power Consumption

1. INTRODUCTION

A wireless sensor network (WSN) has important applications such as remote environmental monitoring and target tracking. Wireless sensor networks are fast growing and existing research technology. They use sensors that are smaller, cheaper, and intelligent. These sensors are equipped with wireless interfaces with which they can communicate with one another to form a network. The design of a WSN depends significantly on the application, and it must consider factors such as the environment, the application's design objectives, and cost, hardware, and system constraints. The potential of wireless sensor networks deals with the scalability of network protocols to design power conserving topology and simple and effective protocols for different operations.

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Topology control is a technique used mainly in wireless sensor networks in order to reduce the initial topology of network to save energy and extend the lifetime of the network. The main goal is to reduce the number of active nodes and active links, preserving the saved resources for future maintenance.There are two ways of implementing the topology control, power control and power management.

In order to be easily implementable in a realistic scenario, a topology control protocol should be fully distributed, asynchronous and localized. The challenges of wireless sensor network for the topology control are fault tolerance, scalability, energy consumption. The issues that we have taken implements these scenarios.

The rest of the paper is organized in the following manner: Section 2 we describe the related works on neighborhood dependent topology control algorithms. In section 3 we make a comparison chart on the related parameters. In section 4 we describe about the overview of the proposed methodology. And in section 5 conclusion on the current state of these issue and future work are given.

2. RELATED WORK

In [1] R. Wattenhofer, L. Li, P. Bahl, and Y. M. Wang, proposed a simple distributed algorithm where each node makes local decisions about its transmission power and these local decisions collectively guarantee global connectivity. There are two phases in this algorithm. In the first phase, each node broadcast a neighbor discovery message with arbitrary power *p*. The value p ranges from $0 \le p \le P$. Each receiving node acknowledge this broadcast message. On receiving the acknowledgement it records all acknowledgements and the direction they came. They determine the direction by IEEE antenna . It continues the neighbor discovery process by increasing its transmission radius untill there is atleast one neighbor in every cone of á degree where $\alpha = 2\Pi/3$ or till it hits the maximum transmission power P. If a node (A) with maximum power P has a cone $C = [\rho, \rho + \alpha]$ without a node, then the node (A) will decreases its transmission power back to the minimum power. Such that there is no cone without a neighbor. In second phase, if a node (A) has two neighbor node (*W*, *V*).Such that the power needed to send from *U* to *W* is higher than to send from *U* to *V*. So we can remove *W* from the set .Thus there is less neighbors which keep best route .This algorithm mainly guarantee good minimum power route.

In [3] D.M. Blough, M. Leoncini, G. Resta, P. Santi, proposed an approach to topology control based on the principle of maintaining the number of neighbors of every node equal to or slightly below a specific value k. When the actual number of neighbors is below the threshold, the transmission range is increased untill the number of neighbors are in proper range .They implement k-neighbor protocol approach for distance estimation. Here the nodes are stationary each have maximum transmission power P .The approach enforces symmetry on the resulting communication graph, thereby easing the operation of higher layer protocols. To evaluate the performance of this approach, they estimated the value of k that guarantees connectivity of the communication graph with high probability. Distance estimation technique is based on 1. Radio signals strength indicator and 2. Time of arrival, comparing the time of arrival of different kinds of signals. This issue gives higher performance than other algorithm by evaluating the energy cost i.e. energy efficiency.

In [5], S. Lin, J. Zhang, et al., presents a lightweight algorithm of Adaptive Transmission Power Control for wireless sensor networks. In ATPC, each node builds a model for each of its neighbors, describing the correlation between transmission power and link quality. Each node has ATPC module which transmits the beacon messages to the neighbor node. In the neighbor node, they use RSSI to calculate the transmission range and the link quality form the received messages. Here the transmission range is adjusted according to the threshold link quality. When the threshold value is attained a notification is given as acknowledge. Thus the neighbors are discovered and connected for the data transmission. With this model, they employ a feedback-based transmission power control algorithm to dynamically maintain individual link quality over time.

In [6] Paolo Costa, Matteo Cesana, et al., has proposed a cooperative, lightweight and fully local distributed approach to adaptively tune the transmission power of sensors in order to match connectivity constraints. In this two phases are used. They have used neighbor discovery in which they transmits the signal to its neighbors and the k neighbors, and they increase the range till it finds the k neighbors. In second phase they use Topology Control

Update. It checks whether the number of neighbors are within the critical value . If the number of neighbors are higher than the critical value it decreases the range. The cooperative approach is done to connect the node which have the minimum number of neighbors, such that it makes the network fully connected. They use neighbor discovery method and topology control update when there is any node failure. Thus it consumes minimum energy by creating an efficient topology by finding its neighbors.

3. COMPARISON TABLE

Table 1
Comparison of different Topology Control Algorithms

Parameters	*DTC-PEO*	*K-NEIGH-STC*	*CO-TC*	*ATPC*
Node	Mobile nodes	Stationary nodes	Mobile nodes	Stationary nodes
Protocol	AODV	Mobile grid, LINT	K-Neigh protocol	TDMA
Topology	Small node degree	Value k	Value k	Transmission Power and link Quality
Advancement	TCMPRN TCM-TPA	CBTC	NNNC, K-NSTC	EESS
Transmission Range	Local info	Threshold value	Threshold value	According to neighbor discovery
Neighbor Discovery	Broadcast message	Transmission range	Beacons	Beacons
No of Neighbor	Depends on max transmission range	Preferred value k	Value k	Depends on transmission power level
Connectivity	Maximum nodes	Fully	Fully	Fully
Improves	Average node degree, node lifetime	Energy efficiency	Energy efficiency	Link quality, RSS
Hop	Null	Multi hop	Multi hop	3 hop

4. OVERVIEW OF PROPOSED METHODOLOGY

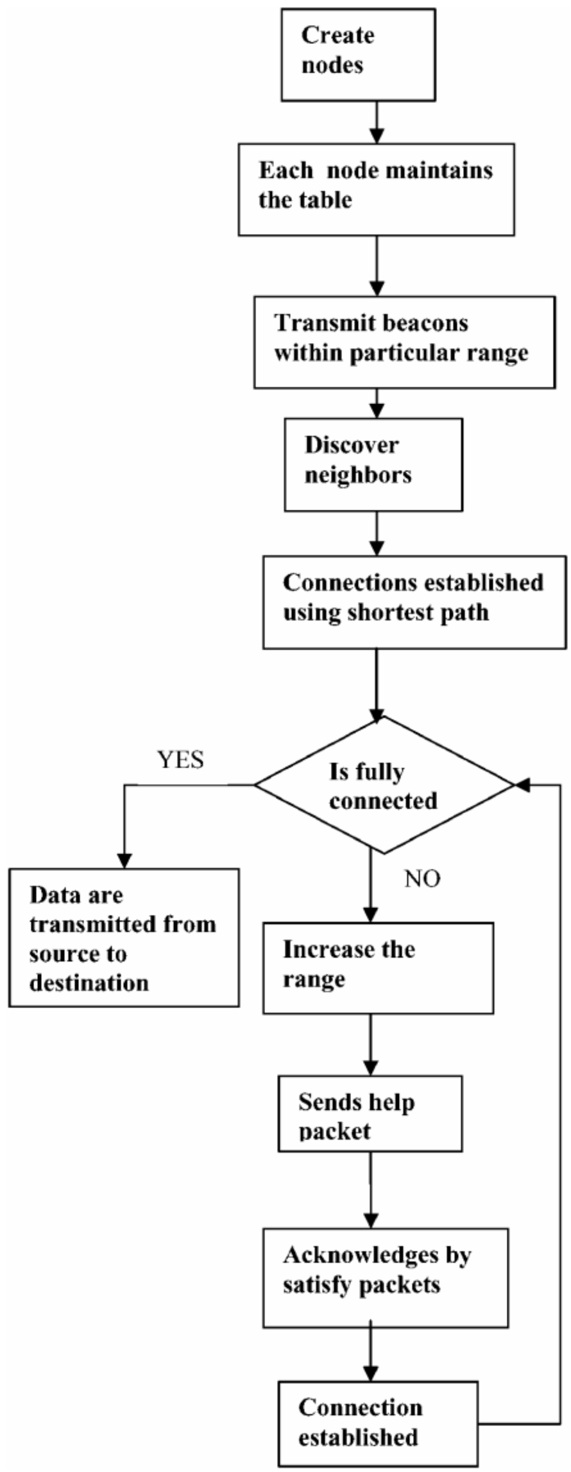
On comparing the above existing issues on various ways, there are some disadvantages. In ATPC [5], each node does not have a critical number of neighbors so it has to maintain all the neighbor details for getting those details more energy is spent. In distributed topology control for power efficient operation in multihop wireless networks [1], there is no guarantee for fully connected network, so it is not such an efficient topology for the data transmission and they don't have k-neighbor concept. In k-neigh protocol for symmetric topology control in wireless network [3], there is strictly bounded time for maintaining connectivity so there is less possibility for the data to reach the destination.

In [6]cooperative approach for topology control in wireless sensor network, node having minimum number of neighbors increases it transmission range to maximum and sends the help packet for the connectivity so this leads to more energy consumption. When it find more number of neighbors above threshold value it reduces the transmission range. By doing this once again the number of neighbors may become less than *K*. Thus an oscillatory behavior is established.

From the above, we can propose a Hierarchical Cooperative Technique (HCT) to overcome these problems by improving some of the steps which increases the life time of the network. In this approach the nodes are created, each node maintains a table with the details of distance, transmission range and its neighbor list by transmitting the beacon messages to its *K* neighbors within a particular range γ. This table is helpful for getting a fully connected network. If there is any node which is not having critical number of neighbors, it increases it transmission range by γinc and sends the help packets to it *k* neighbor. The nodes which receives the help packet extend its neighbor list to $k + 1$ also its transmission range so as to reach the node. When the number of node is above the threshold value it sends back satisfy packet to the nodes above the critical value so as to reduce the transmission range.

In order to avoid this oscillatory behavior, a hierarchy on the satisfy packet issuing nodes based on the traffic is set. Nodes with less traffic is at the top level which is given a higher priority and connectivity should be maintained to those nodes. Other node with lesser priority is removed from the neighbor table. Thus a critical number of neighbors required for the connectivity is maintained and power consumption is also reduced avoiding the oscillatory behavior.

4.1. Flow Chart



5. CONCLUSION

In this paper we have evaluated the different topology control algorithms and a comparison is made. A new Hierarchical Cooperative Technique is also proposed to increase the energy efficiency and connectivity .This may lead to a very effective topology control for wireless sensor networks. Here a cooperation approach is done by the node which is below desired range sends the help packet. On getting the connectivity it sends back satisfy packet along with the hierarchical data so that oscillation problem can be avoided. By implementing this proposed work, we can get a high energy efficiency and a high Packet Delivery Ratio by maintaining the connectivity property of the network.

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