School of Computer Science
MS Thesis
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TOPOLOGY LEARNING IN WIRELESS SENSOR NETWORKS: ALGORITHMS AND APPLICATIONS

ABSTRACT

An ad hoc wireless sensor network (WSN) constitutes of a set of sensor nodes and dynamic network topology among them. Message transmission is the only way to information dissemination, topology discovery and the functionality of a WSN. However, message transmission is a very challenging problem for WSN due to its high energy cost and sensors' limited power. Reducing the number of transmissions is crucial for the long time sustainability of a WSN. In order to solve that problem, we propose five distributed algorithms to minimize the size of messages and number of message transmissions during topology discovery in a WSN. We start by deriving a tree based logical structure of nodes where some nodes have higher degree of connectivity than others.

We then perform the topology discovery operation on the tree structure by transmitting messages using a distributed algorithm. The payload capacity of a message is fixed in protocols of WSNs. If we put too much information in a packet, then it needs to be split into multiple messages. Therefore, in our algorithms, we concentrate on keeping the message size fixed and small. Our five routines are designed based on three traversal mechanisms (top-down, bottom-up, and random walk) and two information convergecasting (gathering of information for sending towards a central node) approaches (all or nothing, and partial). The result of the distributed algorithms is a set of nodes that contain the connectivity information of the entire network.

We present a set of performance study using WSN of varying sizes, ranging from 20 to 150 nodes. Our performance study suggested a significant decrease in the number of message transmissions where the tree is used as an underlying structure for topology discovery. We also analyze and compare the situations when topology is known by a single node in the network and multiple nodes in the network. We show that the network performance increases when the topology is known to multiple nodes rather than a single node.

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