Routing in Sensor Networks

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Introduction

Sensor networks are often used today, but they are limited by the nodes battery and therefore the routing needs to be optimized.

Background

This assignment is made by using TinyOS and simulations. There exist 3 different topologies; comb, holes and grid. Each node has a battery and it's distance to the sink and other nodes can be calculated. The nodes sends messages that contains a content, which is the value 1, and some other information about the node that sends the message. Messages are sent to the sink, and passed between the nodes in the topology. In each round nodes will change its router based on given properties. The sinks collects the messages content it receives.

Implementation

Part 1

A new more optimized basic routing algorithm has been developed. The idea behind the algorithm is to use the current information about the nodes and the assigned router(if any) distance to the sink node via it's designated router. This is also the solution suggested in the chapter "Georouting", in the book "Ad hoc and sensor networks" by Dorothea Wagner and Roger Wattenhofer, from 2009. The node will check if it is closer to the sink node via the message sender instead of the current node it is using as router. If the node isn't using any other node as router, the distance from the node itself will be compared with the distance to the sink via the message sender. Additionally the battery will be compared as well if the distances are exactly the same in case of the node using a router. In the case where no node is assigned, the message sender will be the new router if it's battery is the same or better than the current node's, and if the distance to the sink node via the message sender is the same or less.

Part 2

Cluster head are used in order to increase the performance. This is done by some randomly selected nodes announce themselves as clusterhead in each round. This is a suggested solution in the chapter "Data gathering", in the book "Ad hoc and sensor networks" by Dorothea Wagner and Roger Wattenhofer, from 2009. The clusterhead that has the best battery and that is closest to the sink will be selected as in part 1. If two nodes that announces themselves as cluster head has the same battery level and distance to the the sink, then the one with the lowest id will be chosen. If the node has no neighbor that is a clusterhead it will perform the same algorithm as in part 1. The cluster heads will also perform the part 1 algorithm. The cluster heads aggregates the incoming content. Each time the cluster head

gets an content message from another node it will increase the content with 1, and when the clusterhead send the content (after 1 round) it send all the content and set the content to 0.

Result

Part1

With battery mode ON the new version of the Basic algorithm; optimized basic performs better than the basic algorithm. Without battery the basic and optimized basic algorithm perform almost the same, although the basic is better in comb topology. The algorithms implemented several checks regarding the battery in the optimized basic algorithm makes the algorithm less efficient when battery are not used.

Table 1.

Topology	Sink nodes	Battery mode	Algorithm	Nr. Messages collected by sink
GRID		ON	BASIC	152
GRID		OFF	BASIC	780
GRID		ON	OPTIMIZED BASIC	195
GRID		OFF	OPTIMIZED BASIC	780
HOLES		ON	BASIC	117
HOLES		OFF	BASIC	540
HOLES		ON	OPTIMIZED BASIC	138
HOLES		OFF	OPTIMIZED BASIC	486
COMB		ON	BASIC	105
COMB		OFF	BASIC	540
COMB		ON	OPTIMIZED BASIC	143
COMB		OFF	OPTIMIZED BASIC	540

Part 2

The result for the cluster head, battery mode both on ON and OFF it is clear that the solution for part 2 has some problems as it should be better than the result for part 1.

Table 2.

Topology	Sink nodes	Battery mode	Algorithm	Nr. Messages collected by sink
GRID		ON	OPTIMIZED BASIC	195
GRID		OFF	OPTIMIZED BASIC	780
GRID		ON	CLUSTERHEAD	175
GRID		OFF	CLUSTERHEAD	530
HOLES		ON	OPTIMIZED BASIC	138
HOLES		OFF	OPTIMIZED BASIC	486
HOLES		ON	CLUSTERHEAD	120
HOLES		OFF	CLUSTERHEAD	382
COMB		ON	OPTIMIZED BASIC	143
COMB		OFF	OPTIMIZED BASIC	540
COMB		ON	CLUSTERHEAD	130
COMB		OFF	CLUSTERHEAD	400

Discussion

Part 1

Several other version, that weren't as successful were also implemented. Some of them was almost the same as the one implemented but with more unnecessary checks, which makes the algorithm slower and also required more battery. Version were only the battery or only the distance were checked were really inefficient as well. Additionally, a version where only the current node's distance to the sink compared to the sendings node's distance to the sink didn't work that well, as the distance to the sending node needs to be counted in as well.

Part 2

The first version of the cluster head algorithm, were implemented in a static way where the cluster head was set in the beginning of the execution. As the battery runs out, no clusterhead exists and no messages are sent. This was a very bad implementation. Then some other non-static implementations were made. The problem with those was the routing algorithm, that were too complicated to be efficient. The final solution uses the exactly same routing algorithm as in part 1, but with additional check when it should run. This solution also has several problems as a clusterhead solution should perform better than the optimized basic algorithm in part 1. The problem probably lies within the conditions of when the routing algorithm should run.

Conclusion

It is important to consider both the battery and distance when doing routing in sensor network. After a while it is a good practise to see if there exist a node that would work better as the role of a router. Also, avoid to unnecessary calculations as the computing is expensive when having nodes with battery. The use of a cluster head is to be recommended, although this implementation doesn't completely work.