Improving localization in Wireless Sensor Networks

A research proposal

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1. INTRODUCTION

Localization plays an important role in wireless sensor networks. The main goal of a sensor network is sensing data, typically from a lot of different (unknown) positions. To actually put the sensed data to use, the location where it was sensed must be known. This is where localization comes in.

Localization schemes use sensors to measure connectivity or distance between nodes. Typically, a small number of nodes (called "anchors") know their own position in advance. From this information, the position of every node can be calculated (or estimated).

There are a number of ways to obtain this information. Some examples include infrared sensors, acoustic timing difference estimation, visual position estimation, though most current applications use signal strength estimation on the implicit wireless communication channel present on every node to obtain localization information ([BHE00]). In my research I will focus on these types of networks, that use a small number of anchors and use their RF communication devices for range based information. Focus will also be on range-based localization schemes, since range-free localization has more trouble identifying which anchor nodes have useful information for a given normal node (also see research problem #2).

Current localization techniques are heavily influenced by obstructions in the environment [EE04]. Obstructions like walls, mirrors or glass decrease signal strength significantly, but generally by a constant value. If we visualize this in a situation with a number of anchors to one side of an obstacle and an anchor and a normal node to the other side of the obstacle, we get the situation in figure 1.

In this situation, the normal node (green) to the right will incorrectly estimate ranges to the anchor nodes (blue) to the left of the obstacle. Due to the obstruction, it will seem as if the anchor nodes are more to the left than they actually are (depicted by the red nodes). If the green node would determine its own position based on the (incorrect) ranges obtained from the anchor nodes, it would estimate its position too far to the right (how much depending on the algorithm used).

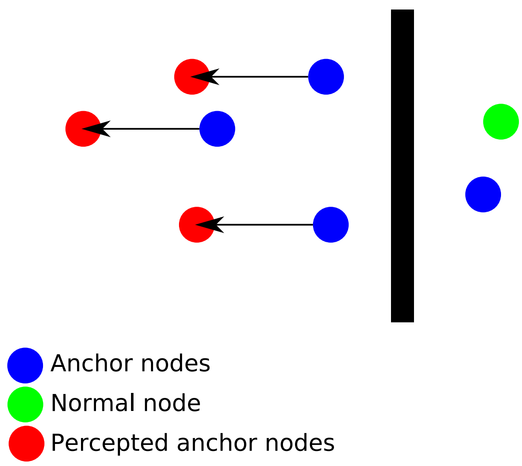

Figure 1: Example of signal obstruction

The proposed solution to this problem, is taking advantage of the one anchor node to the right. For the purpose of improving the localization, this node will pretend it is a normal node. Later on, it can use its known position for improving the calculated data. The node will estimate the distance to the other anchor nodes or even perform the same localization algorithm as the normal node. Since the node knows its actual location, it can detect that the range finding to the other anchor nodes is not accurate.

It should be possible to use this information to improve the localization of nearby nodes. As a simple example, assume that both nodes to the right perform a localization algorithm. The calculated positions are shown in red in figure 1. The anchor node is able to calculate the error in localization. If the normal node (green) compensates for this error, it will calculate the correct position.

Exactly how and when to employ these corrections is the subject of this research.

2. RESEARCH QUESTIONS

In this research, the following questions will be answered.

1. In what ways can one deduce information from the difference between anchors known position and their

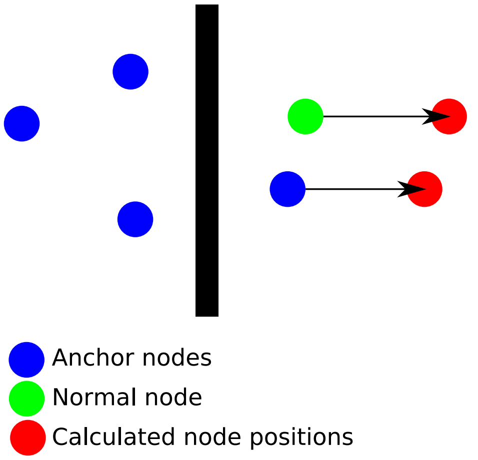

Figure 2: Example of position correction

measured position? Examples to think of are directly checking range finding methods or performing a full localization algorithm to determine the error.

2. In what ways can this information be used? Trivially, all nodes nearby an anchor node use that node's offset data. Obviously it is non-trivial to determine which nodes are exactly nearby an anchor node. Also, using offset data from multiple nodes might improve the accuracy of this data.

3. For the most promising method (or methods) above, how much better is this method than conventional localization schemes? For different situations, anchor densities, node and obstacle distributions, the effect of these improvements will be measured.

3. PLANNING & METHODOLOGY

In the first half of this research, the first two questions will be answered. A number of different methods will be expanded on. These methods will be quickly implemented in a simulator, which offers some insight in the performance of these methods. Since a lot of methods are only marginally different, this should not take too much time. Also, this offers some hands on experience using the simulator.

At the end of this phase, one or two well defined methods to improve localization are delivered. In particular, these are the methods that give the best performance in the initial testing.

The simulator used is Matlab, with simulink extensions. A number of extra add-ons, specifically for localization problems, have been written at Twente University, which allow one to focus on the algorithms without focusing too much on implementation details.

In the second half of this research, the selected methods are further tested. Now, more thorough tests are performed, using multiple situations with differing numbers of obstacles and other sources of disturbance.

The result of this research will thus be a well defined method for improving localization, along with factual data on how well it performs in different (types of) situations.

4. REFERENCES

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