Anchor Node Placement for Localization in Wireless Sensor Networks

by

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A Dissertation submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
Master of Applied Science

Ottawa-Carleton Institute for
Electrical and Computer Engineering

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Carleton University
Ottawa, Ontario, Canada
June 2010

The undersigned recommend to

the Faculty of Graduate Studies and Research

acceptance of the Dissertation

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Dr. Thomas Kunz, Supervisor

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2010

Abstract

Applications of wireless sensor network (WSN) often expect knowledge of the precise location of the nodes. One class of localization protocols patches together relative-coordinate, local maps into a global-coordinate map. These protocols require nodes that know their absolute coordinates, called anchor nodes. While many factors influence the calculated position errors, in this class of protocols, the placement of these anchor nodes has a significant impact. Through simulation, using the Curviliner Component Analysis (CCA-MAP) protocol, we show the impact of anchor node placement and a set of rules to ensure the best possible outcome.

Dedicated to my wife and children who supported me through the long process of this research.

Acknowledgments

I would like to thank Professor Thomas Kunz for his guidance and encouragement that made this research possible. Further, I would like to thank Li Li whom, along with Professor Kunz, performed the initial CCA research and wrote the basis for the Matlab simulations used in this thesis. Finally, my colleagues Shafagh Alikhani and Ben Gardiner who provided a tireless ear to listen to ideas throughout the process.

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Chapter 1

Introduction

Scientists, engineers, and researchers use wireless sensor networks (WSN) for a wide array of applications. Many of these applications rely on knowledge on the precise position of each node. While some may only require relative coordinates within the network, most biological, geophysical, and other scientific applications require coordinates on a global coordinate system. Perhaps the obvious solution is for each node in the network to be equipped with GPS or other location positioning service. However, constraints on cost, power consumption, as well as visibility of satellites forbids this.

Many protocols have been propopsed [TODO refs] to calculate relative positions amongst the nodes of a network. They vary in the required network functionality in terms of radio ranging or range-free. However, in all cases, in order to convert from relative to global coordinates, some of the nodes do require a local source of global coordinates by using GPS or some other source. This can be achieved by operators recording the global coordinates during network deployment or by the device having GPS embedded in a subset of the nodes. We call these enhanced nodes anchors. Here, we explore the effect of anchor node placement within the network on the overall localization errors, on a network-wide basis. This provides network planners with a set of general rules to minimize the number of anchor nodes required while avoiding poor node localization, allowing scientists to assume a maximum position error during their own research.

1.1 Motivation

During previous work designing localization protocols[TODO ref Li Li, etc], authors often choose anchors at random within the network. Frequently, their simulations are run multiple times with different anchors in order to statistically exclude anchor node placement from their results. Figure [TODO] demonstrates this using a CCA simulation. This phenomenon led to this quest to determine the best anchor node placement.

//TODO Include result plot showing varying

1.2 M

any localization protocols and algorithms provide a set of relative coordinates that are then transformed into global coordinates. For the purpose of this research, we chose CCA [TODO] as the algorithm to provide simualtions results. A Matlab©simulation of this algorithm already existed [TODO], and was modified to provide the necessary output statistics presented here. CCA is described in more detail in [TODO reference Background - CCA].

Chapter 2

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2.1.1 Sub-Section Heading

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Sub-Sub-Section Heading

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Sorry no details available [1, 2].

List of References

[1] W. Smith and H. Johnson, "A title of an article," *Journal of Applied Stuff*, vol. 17, pp. 735–744, 1978.

[2] J. Doe and W. Smith, "A conference paper," in *IEEE Conference on Nothing*, pp. 375–380, 1988.

Appendix A

Derivation of Some Nasty Equation

Here is the derivation.