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DEPARTMENT OF ENGINEERING MATHEMATICS AND INTERNETWORKING

TITLE OF THESIS: PATH PLANNING MODELS FOR MOBILE ANCHOR-ASSISTED LOCALIZATION IN WIRELESS SENSOR NETWORKS

TIME/DATE: 10:00 am, Tuesday, February 13, 2018

PLACE: Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:
Dr. Thomas Kunz, Department of Systems and Computer Engineering, Carleton University (External Examiner)
Dr. Frank Comeau, Department of Engineering, St. Francis Xavier University (Reader)
Dr. Srinivas Sampalli, Faculty of Computer Science, Dalhousie University (Reader)
Dr. Nauman Aslam, Department of Computer and Information Sciences, Northumbria University (Supervisor)
Dr. William Phillips, Department of Engineering Mathematics and Internetworking, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE: Dr. Guy Kember, Department of Engineering Mathematics and Internetworking, Dalhousie University

CHAIR: Dr. Roger McLeod, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

As event detection is one of the main purposes of using wireless sensor networks (WSNs), the location of nodes is essential to determine the location of an event when it occurs. Many localization models have been proposed in the literature, one of which is to deploy a set of static location-aware nodes, called anchors, to exchange information with the other nodes to determine their location. Another promising proposal involves replacing these sets of static anchors with only one mobile anchor (MA). While this method seems to produce favorable results, it also brings new challenges. The primary challenge is to find an optimal path for the mobile anchor to follow while taking into account the need to provide highly accurate data and more localizable nodes in less time and with less energy. This thesis proposes techniques for mobility-assisted localization in WSNs. In this research work, four main contributions are achieved in the design of such models.

Firstly, we introduce a new static path planning model for mobile anchor-assisted localization in WSNs. Our proposed model guarantees that all nodes can receive the localization information and thus estimate their location with higher localization accuracy in comparison to similar static models. Moreover, this model overcomes the problem of collinearity and considers the metrics of precision and energy consumption as well as accuracy, localization ratio and the path length of the mobile anchor.

Secondly, although some path planning models in two-dimensional (2D) regions have been proposed in recent years, many WSNs’ practical applications are applied in three-dimensional (3D) regions. We also introduced a three-dimensional path planning model for mobile anchor-assisted localization in WSNs. Our proposed model offers higher performance regarding localization accuracy with a lower error rate in comparison to other proposed models.

Thirdly, we propose a novel distributed range-free movement mechanism for mobility-assisted localization in WSNs when the mobile anchor’s movement is limited. The designed movement is formed in a real-time pattern using a fuzzy-logic approach based on the information received from the network and the nodes’ deployment. The novelty of this model lies in employing multiple individual inputs in a fuzzy-logic approach for path planning that are important to minimizing the localization error and maximizing the localization ratio. Our proposed model offers superior results in several metrics including both localization accuracy and localization ratio in comparison to other similar works.

Finally, we design two novel dynamic movement techniques that offer obstacle avoidance path planning for mobility-assisted localization in WSNs. The movement planning is designed in real-time using two swarm intelligence-based algorithms: the Grey Wolf Optimizer (GWO) and Whale Optimization Algorithm (WOA). The novelty of our proposed models is the use of optimization algorithms to direct the path formation of the MA, which helps to maximize the localization ratio and minimize the localization error. Both of our proposed models provide better outcomes in comparison to other existing works in several metrics including both localization ratio and localization error rate.