AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computers and Systems Engineering Department

Localization and Positioning Techniques in WSNs

by
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Bachelor of Science in Electrical Engineering
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A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Electrical Engineering
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Abstract

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Localization and Positioning Techniques in WSNs

Masters of Science dissertation

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This dissertation presents the problem of counting and tracking multiple targets, whose motions are independent. The counting problem is investigated by estimating the number of targets. Estimation is done by using the dynamic counting techniques, which exploit the temporal and spatial dependencies of the targets. Meanwhile, the target tracking problem is approached by estimating the targets trajectories, through the implementation of an enhanced probability hypothesis density-based filter. The proposed target tracking approach enhances the probability hypothesis density-based filter, to include the dynamic counting techniques. This enhancement introduces the implementation and simulation of the enhanced dynamic counting probability hypothesis density (DC-PHD) approach. This paper investigates the implementation of four of the existing target tracking and counting algorithms:

1) ClusterTrack filter, which is based on particle filtering techniques. It explores multiple targets tracking in a one-dimensional environment.
2) A distributed energy efficient (DEE) algorithm that tracks a single target in a two-dimensional environment.
3) Multicolor particle filter (MCPF) technique, which tracks multiple targets in a two-dimensional environment.
4) Probability hypothesis density filter, upon which this work is based. It shows the originally proposed multiple target tracking and counting in a two-dimensional environment.

The dissertation shows the simulations of the DC-PHD, by exploring different environmental settings. The accuracy of the proposed algorithm is derived mathematically, where the disc sensing model is used. Simulations compare the performance of the proposed algorithm with the previously mentioned target tracking approaches. These comparisons show the efficiency of the proposed target counting and tracking technique, by using the disc sensing model of the sensor nodes.

Keywords: Dynamic counting, Multi-target counting and tracking, Particle filter, Probability hypothesis density-based filter (PHD), Wireless Binary Sensor Networks (WBSNs).

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The work included in this thesis was carried out by the author at Computers and Systems Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Nourhan Tarek Ahmed AbdEl Naiem

Signature

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Date: 18 / 01 / 2020

SUMMARY

This dissertation presents the implementation of some of the target tracking and counting techniques, while emphasizing the performance of the proposed algorithm. The dissertation is organized as follows:

Chapter One: It begins with an introduction about this dissertation and the contribution presented in this work.

Chapter Two: In this chapter, a survey of some of the most common localization techniques, as well as, a representation of the overall classification of the localization techniques.

Chapter Three: This chapter investigates the implementation of four of the commonly known target tracking and counting techniques, which are used as a measurement of the performance of the proposed algorithm.

Chapter Four: This chapter presents a detailed demonstration of the proposed algorithm.

Chapter Five: In this chapter, the simulation of the enhanced DC-PHD algorithm is presented, where different scenarios are introduced. As well as a comparison between simulations of the proposed algorithm and the tracking algorithms that were introduced in chapter three.

Chapter Six: Finally, the dissertation ends by extracting conclusions and stating future work that might be done based on this work.

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Chapter 1: Introduction

1.1. Research motivation

A wireless sensor network (WSN) is composed of a large number of sensor nodes that can be placed inside the area under study. Recent advancements in technology have made it possible to build low cost sensor nodes that could be densely deployed in the region of interest either randomly or in a structured predefined manner. Although this flexibility in node deployment is considered as an advantage for the applications that are interested in studying crisis regions, it means that the network is required to be able to self-organize and determine the topology of its sensor nodes.

Location discovery of the sensor nodes has been one of the main keys in establishing a WSN. In many applications, the position information of the sensor nodes must be provided along with the sensed data, otherwise this data would be meaningless. When considering the monitoring of the volcano's activity application, it was observed that some of the sensing nodes report that the volcano is in a stable state, while others report the high activity of the volcano. This situation clearly shows the need to identify the location of these sensor nodes, so that the obtained data would become more sensible and meaningful.

Localization is known as the process of discovering the location of the sensor nodes, while positioning is the actual placement of the sensors within the environment. The basic idea in finding the location knowledge could be obtained by providing the sensor nodes with a GPS. These sensor nodes are commonly known as anchor nodes.

The simplest type of WSNs is the wireless binary sensor networks (WBSN), in which the deployed sensor nodes are binary. Binary sensors could detect the presence