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Dynamic Improved Path Planning for Mobile Beacon in Wireless Sensor Network

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Abstract

The main intention of wireless sensor network is to provide the information about the spatiotemporal characteristics of the observed physical world. In many wireless sensor network applications, namely forest fire detection, animal tracking etc., it is important to locate the sensor with accuracy. Locating the sensors after they have deployed is termed as localization. Most of the localization algorithm relies on the availability of reasonably accurate location information. This is valid only in few networks which has location sensing devices, such as GPS receivers are available at all nodes. In real time, equipping GPS with all sensor nodes are rare due to its cost, power. To overcome these limitations various path have been proposed to derive approximated locations of all nodes using the mobile beacon. In existing systems, Localization techniques that are proposed for sensor nodes are calculated by receiving the mobile beacon signal with their coordinates by incorporating the various path planning scheme like SCAN, DOUBLE SCAN, HILBERT and Z curve for trajectory of mobile beacon. Those path planning strategies resulting in existence of collinear problem and localization error of nodes. In this paper, a novel Tree - Climbing path planning mechanism is proposed. The proposed path ensures to overcome collinear problem by travelling in a tree based path. The performance of a novel tree climbing is analysed using the NS2 simulator.

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Keywords: *Localization, Mobile Beacon, Path Planning, Sensor Nodes, Wireless Sensor Networks*

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1. Introduction

In most of the wireless sensor networks (WSN) comprises of many low cost sensor nodes that has been widely used in a various application like environmental monitoring, forest fire detection, battle field surveillance, and health monitoring. For example, the nodes that are deployed in the sensor network has to monitor fires and should locate the fire with some accuracy to enable the fire-fighter to act in response. Thus sensor information in many application is associated with the location where the information with locations are sensed. The data transmission of the sensor network is more efficient, if the location of the sensor nodes are more accurate. The trajectory of mobile beacon is an important research issue that are designed to minimize the energy cost in the localization and maximize the location accuracy for sensor networks. The main objective is to design a path to guide the mobile beacon to travel in a trajectory which can be used to localize other sensor nodes. The problem of finding a best trajectory for a mobile beacon was discussed with important observation that a node is localized if beacon trajectory is close to that node, and if a beacon travels in a straight line it is difficult to determine in which side of the line the node lies, so it result in localization error. Localization is one of the major issue in WSN to determine the physical location of unknown nodes in the field. So, it is necessary to place sensors equipped with Global Positioning System (GPS). However for a larger network, placing sensors with Global Positioning System (GPS) is cost effective. Many of the proposed methods used various techniques to locate the nodes in which only a limited sensor nodes equipped with GPS allow to move throughout the sensor network area with their knowing coordinates. This kind of node is called as mobile beacon. These nodes transmit their position information to help other nodes to localize themselves. In this paper, we consider a novel Tree Climbing path of a mobile beacon to ensure the shortest path. The proposed trajectory can achieve a good trade-off between range and path length. The performance of the proposed trajectory estimates by a series of simulation using ns-2 simulator.

2. Literature Survey

Many research has been done on localization for wireless sensor networks over last period. To estimate their position, the nodes with unknown coordinates are helped by one or more nodes with known coordinates. The static sensor with one mobile beacon is used to localize the set of static sensors. The different types of predefined static paths such as SCAN, DOUBLE SCAN, HILBERT, CIRCLE, S-Curve Z-Curve, in relation to localization are proposed. The main goal of developing a trajectory for a Mobile Beacon (MB) is to find shortest path to reach target node. Some mobile beacon path has been proposed in [1, 2, 3]. A brief study is done on the existing mobile beacon trajectories for localization in wide sensor networks. The three well known trajectories are proposed in [1] for the mobile beacon assisted localization are Scan, Double Scan and Hilbert space filling curve. All these trajectories attains exact location estimation compare to Random Way Point (RWP). These trajectories covers the complete network field. The location accuracy is calculated based on the distance between two successive beacon positions. In SCAN, the mobile beacon travels along x-axis and y-axis and covers all nodes in the deployed area. The distance between the two parallel y-axis of the mobile trajectory defines the resolution [1]. However, it suffers from collinear problem i.e. beacon messages transmit the signal when it travel along a straight line. The second proposed trajectory is DOUBLE SCAN, mobile anchor node traverse in both direction i.e. along x-axis and y-axis with double the distance for the same resolution in the sensing field. Existence of collinear problem still persist in DOUBLE SCAN. In HILBERT curve, the mobile beacon takes many turns traverse along the trajectory in such a way that the sensor nodes can receive three non-collinear beacon message without increasing path length. The main disadvantage is that this trajectory will never move on the border of the sensing field, and its location is not accurate. Further, two static path planning were proposed in [3] by Huang and Zaruba are CIRCLES and S-CURVES. This static path planning are introduced to reduce the straight lines trajectory for a mobile beacon to localize in WSN. In CIRCLES, the mobile anchor moves in a sequence of concentric circles. Since the deployed area is a square, it uncovers the four corners. The four corners of the square are covered by increasing the path length of the circle, which in