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RESEARCH ARTICLE

Path Planning Algorithm for Mobile Anchor-Based Localization in Mobile Networks

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Abstract: Mobile technology has helped to simplify networking by enabling multiple computer users to simultaneously share resources in a home or business without additional or intrusive wiring. A Mobile Network consists of hundreds or thousands of nodes and a small number of data collection devices. Localization of these mobile nodes is an essential issue in mobile networks because many applications require the mobile to know their locations with a high degree of precision. Various localization methods based on mobile anchor nodes have been proposed for assisting the mobile nodes to determine their locations. However, none of these methods attempt to optimize the trajectory of the mobile anchor node. Accordingly, proposed path planning scheme, ensures that the trajectory of the mobile anchor node minimizes the localization error and guarantees that all of the mobile node can determine their locations.

Keywords Mobile Network, Localization, Mobile Anchor, Path Planning

I. INTRODUCTION

With the increasing use of small portable computers, wireless networks, and satellites, a trend to support computing on the move has emerged—this trend is known as mobile computing or nomadic computing. Also referred to as anytime/anywhere computing, mobile computing has several interesting and important applications for business (such as instant claim processing and e-commerce), telecommunications and personal communications, national defense (tracking troop movements), emergency and disaster management, real-time control systems, remote operation of appliances, and in accessing the Internet. Since a user may not maintain a fixed position in such environments, the mobile and wireless networking support allowing mobile users to communicate with other users (fixed or mobile) becomes crucial. A possible scenario may involve several different networks that can support or can be modified to support mobile users. When dealing with different wireless networks, a universal mobile device should be able to select the network (LAN, the Internet, PCS, or satellite) that best meets user requirements.

A Mobile Network consists of hundreds or thousands of nodes and a small number of data collection devices. The nodes have the form of low-cost, low-power, small-size devices. The nodes gather the information of interest locally and then forward this information over a wireless medium to a remote data collection device (sink), where it is fused and analyzed in order to determine the global status of the network area.

In Mobile Networks, sensed data with location information is valuable. Several schemes, broadly classified into two categories, have been proposed for dealing with the localization. First, the range-based schemes need either node-to-node distances or angles for estimating locations. The range based schemes typically have higher location accuracy but require additional hardware to measure distances or angles. Second, the range-free schemes do not need the distance or angle information for localization. Although these schemes cannot accomplish as high accuracy as the range-based ones, they provide an economic approach. However, the accuracy of current algorithms is mostly environmentally sensitive which leads to low reliability and low success rate about the location results.

II. RELATED WORK

There are two types of Mobile Anchor Path Planning first is Static Path Planning and the second is Dynamic Path Planning.

A. Static Path Planning

Koutsonikolas et al. proposed three path planning schemes for the mobile anchor node in the localization scheme presented by Sichitiu and Ramadurai, namely SCAN, DOUBLE SCAN and HILBERT. In SCAN, the mobile anchor node travels along a single dimension (e.g. the x-axis or y-axis direction), and the distance between two neighboring segments of the node trajectory defines the resolution of the trajectory.
In DOUBLE SCAN, the collinearity problem is resolved by driving the anchor in both the x- and the y-directions. However, whilst this strategy improves the localization performance of the sensor nodes, the path length is doubled compared to that of SCAN, and thus the energy overhead increases accordingly.

In HILBERT, the mobile anchor node is driven along a curved trajectory such that the sensor nodes can construct non-collinear beacon points and the total path length is reduced. To reduce the collinearity without significantly increasing the path length, HILBERT is proposed, which makes the mobile beacon to take more turns.

Huang and Zaruba presented two further path planning schemes designated as CIRCLES and S-CURVES, respectively, for avoiding the collinearity problem inherent in the scan method.
In CIRCLES, the mobile anchor follows a sequence of concentric circular trajectories centered at the center point of the deployment area, since straight lines invariably introduce collinearity, we would like to reduce the amount of straight lines on the beacon path. Thus, we design CIRCLES which consists of a sequence of concentric circles centered within the deployment area.
While in S-CURVES, the anchor follows an S-shaped curve rather than a simple straight line as in the SCAN method. S-CURVES is based on SCAN, which progressively scans the deployment area from left to right. However, at each scan, S-CURVES takes an ‘S’ curve instead of going in a straight line.

B. Dynamic Path Planning

In the topology-based path planning, each sensor node gathers its neighborhood information based on message exchange and then provides the information to the mobile anchor node. Based on the topology information, the path planning of the anchor node can be translated into graph traversing problems. Li et al. proposed breadth first and backtracking greedy algorithms for graph traversing. Wang et al. chose the shortest path traversing as the trajectory of the anchor node. The mobile anchor node performs a depth-first traversal algorithm based on RSS-based distance information. Kim et al. presented an adaptive path planning for the mobile anchor node.

III. ANALYSIS OF PROBLEM

Most localization mechanisms use fixed anchors. However, if all of the nodes within the network have the ability to determine their locations, a large number of fixed anchors are required. Thus, several methods have been proposed for reducing the anchor deployment cost by utilizing GPS-enabled mobile anchors, which navigate the network field and issue periodic beacon messages advertising their current coordinates. However, the problem of

deriving the optimal trajectories of the mobile anchors in the network field has attracted relatively little attention. Although several anchor movement strategies have been proposed for Mobile network, they are all based on some specific localization algorithms, and thus their compatibility with other localization methods is not guaranteed.
The existing path planning methods can be classified into static and dynamic methods. The static methods design the trajectory before localization, and the anchor must follow the give path during localization. The simplest path is random paths such as RWP (Random Waypoint) and Gauss-Markov path, whose drawback is that they cannot cover the entire ROI to localize all unknown nodes. To overcome this drawback, three paths are used called as Scan, Double-Scan, and Hilbert.

Scan and Double-Scan are composed of a series of straight lines, and Hilbert is Hilbert spacing-filling curve. The drawback of SCAN is that straight lines introduce collinearity, and there are many locations where the beacon broadcasts heard are collinear. To reduce the collinearity without significantly increasing the path length, HILBERT is proposed, which makes the mobile beacon to take more turns.

Circles and S-Curves proposed in aim to avoid the collinearity of virtual anchors, which require the anchor moves along curves instead of straight lines, but they cannot covers entire ROI. CIRCLES can only guarantee that the four corners of the sensing field are covered by expanding the diameter of the concentric circles. As a result, the path length is extended, and the energy consumption is increased. In S-CURVES, the trajectory of the mobile anchor cannot guarantee that each sensor node can construct two valid chords.

IV. Proposed Path Planning Scheme

This path planning method for the mobile anchors used in the localization scheme uses a single mobile anchor to enable the nodes to construct two chords of a communication circle of which they form the center point, and the intersection of the perpendicular bisectors of these two chords is then calculated in order to pinpoint the node position. The mobile anchor moves randomly through the network field (i.e., in accordance with the Random Waypoint model), and thus it is possible that some of the nodes cannot be localized. Therefore, the path planning scheme designed to both minimize the localization error of the individual nodes and to maximize the number of nodes which can determine their locations.

In the localization scheme, a single mobile anchor node moves randomly through the network field broadcasting periodic beacon messages containing its current coordinates. The locations of the individual nodes are determined by exploiting the fact that the perpendicular bisector of a chord of a circle passes through the center of the circle. It is assumed that the communication range over which a mobile node can detect broadcasts from the mobile anchor node is bounded by a circle and the mobile node is located at the center of this circle. As the anchor node moves through the network field, it broadcasts its coordinates periodically, and each mobile node chooses appropriate locations of the anchor node (called beacon points) to form chords of its communication circle. Once three beacon points (i.e. two chords) have been constructed, the mobile node determines it location by calculating the intersection point of the two perpendicular bisectors of the chords. This method provides a computationally straightforward means of determining the node locations.

V. CONCLUSION

In this we use the path planning scheme that uses mobile anchor. It minimizes the localization error of the individual mobile nodes and maximizes the number of sensor nodes which can determine their locations. Proposed scheme removes the drawback of five existing path planning schemes, namely DOUBLESCAN, CIRCLES, S-CURVES, HILBERT, and the original random movement strategy. It has been shown that all nodes can determine their locations.

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