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Cooperative Localization in Wireless Adhoc and Sensor Networks using Hybrid Distance and Bearing (Angle of arrival) Measurements

M.Tech. Scholar Aamir Khan[1], Prof. Manoj Singh Tomar[2]
Department of Electronics & Communication Engineering
School of Research & Technology
People's University, Bhopal (M.P.), India

Abstract- In this research we have made an attempt to address localization in static as well as mobile sensor networks. For static network we have proposed two distributed range based localization techniques called (i)Localization using a single anchor node (LUSA), (ii) Distributed binary node localization estimation (DBNLE). Both the techniques are proposed for grid environment. In LUSA, we have identified three types of node: anchor, special and unknown node. For every anchor node there exists two special node and they are placed perpendicular to the anchor node. Localization in LUSA is achieved by a single anchor node and two special nodes. Localization occurs in two steps. First special nodes are localized and then the unknown nodes. We have compared LUSA with a closely related localization technique called Multi-duolateration (MDL). It is observed that the localization error and localization time is lesser in LUSA. In DBNLE a node is localized with only two location aware nodes instead of three nodes in most localization techniques. This not only reduces the localization time but also the dependency.

Keywords- GPS, WSN, LUSA, DBNLE, MDL

I. INTRODUCTION

Data gathered by a sensor node is usually reported to the sink for necessary action. For initiating a prompt action the sink must be a ware of the location information of the reporting node. For example, assume that fire has occurred in some part of the forest and a nearby sensor report this information to the sink. For quick response, the reporting sensor should include its location along with other information. Tagging of location stamp along with the sensed information is possible only when the reporting node is localized. This signifies the importance of localizing a node prior to its data collection process. Sensor nodes are low cost devices. Use of GPS to obtain location information will increase their cost. An alternative to the use of GPS is to obtain location information through localization algorithms. Use of localization algorithms mandates the deployment of a few location aware node. The remaining nodes are localized with the extra hardware cost.Reduce the localization error, and localization time.

II.DISTRIBUTED BINARY ESTIMATION APPROACH

Most of the existing localization techniques use three or more anchor nodes for localizing a single unknown node except for those schemes where directional antenna is used. In the scheme using directional antenna [39] algorithmic complexity, size and cost of node is more. In this chapter, we propose a range based localization algorithm for sensor networks in a grid environment. The proposed technique localizes an unknown node using two anchor/location- aware nodes.

III. Distributed Binary Node

1.Localization

In this section, we proposed a node localization technique called Distributed Binary Node

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Localization Estimation (DBNLE). The proposed localization technique is distributed in nature. We call it binary, because each unknown node other than the edge nodes (placed with respect to anchor node) use two location aware nodes in the localization process. The following assumptions are made in DBNLE:

- Nodes are deployed in a grid.
- Distance between the grid points are set as per the RSSI requirement.
- Nodes are classified into three types:

1. Anchor node- Nodes whose position is known either through GPS or manually built-in. In DBNLE there is one anchor node.

2. Un- known node- Node which use localization technique to determine its position.

3. Settled node- These are the nodes that have obtained their location information through a localization technique. They serve as an anchor node for the remaining unknown nodes. Deployment of nodes in a grid is shown in Figure 1.

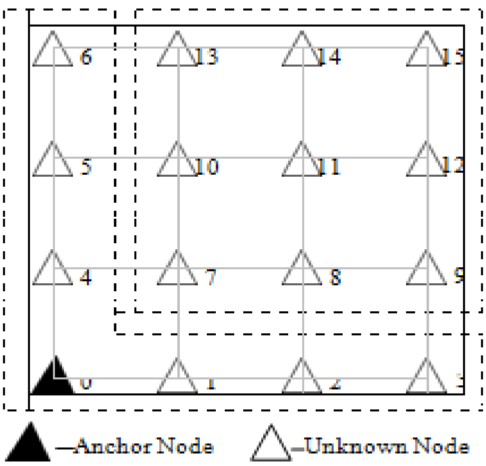

Fig. 1 Deployment of nodes in a grid, showing the Placement of anchor and unknown nodes.

DBNLE operate in three phases:

- First phase: Edge nodes with respect to anchor node get localized and become settled nodes,
- Second phase: Settled nodes broadcast their position, and
- Third phase: Unknown node gets localized after obtaining position and range measurements from any two settled nodes. Phase Two and Three continues until all nodes get localized.

2. Localization of Edge nodes

Lines 13 – 16 in Algorithm 1 explain localization of edge nodes. We consider Figure 4.1 to illustrate localization of edge nodes. In Figure 4.1, node 0 is the anchor node, and nodes 1, 2, 3, 4, 5, and 6 are the edge nodes. Let (x_0, y_0) be the location of anchor node 0. On receiving location information from the node 0, node 1, and node 4 gets localized. Node 1 compute its co-ordinate asfollows:

$x_1=x_0+$distancebetweennode0and1, $y_1=y_0$.

Node 4 compute its position as:

$x_4 = x_0$,

$y_4 = y_0 +$ *distance between node* 0 *and* 4.

3.Localization of Unknown nodes

In the proposed scheme an unknown node requires location information from two settled nodes for localization. An unknown node should not be equidistant from the two settled nodes considered for localization. Figure 2 shows the selection of settled nodes for localization. Figure 2(a) shows the wrong selection and Figure 4.2(b) shows the correct selection of settled nodes by an unknown node. On receiving the location information from two settled nodes, an unknown node compute the following: (i) Its distance from two settled nodes,(ii) distance between two settled nodes, (iii) the angle at which the position information of settled node was transmitted.

For localization we consider only the angular information of settled node whose location information was received first. An unknown node selects two settled node for localization, which are not equidistant from it and computes the distance between them. To illustrate the localization of unknown nodes, we consider nodes 7 and 10 of Figure 4.1. Location information broadcast by node 0 is received by node 7 as shown in Figure 4.3(a). Let b1 be the distance between node 7 and node 0, and θ1 be the angle at which node 0 have transmitted beacon to node 7. Location information broadcast by node 1 is received by node 7, and let a1 be the distance between node 7 and node 1. Let c be the computed Euclidean distance between node 0 and 1 at node 7.

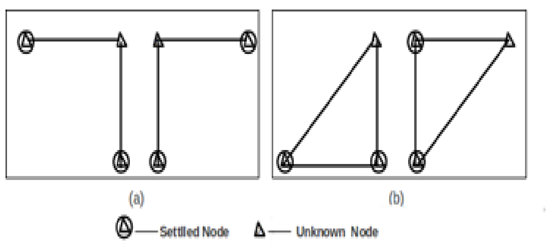

Fig. 2 Selection of settled nodes for localization.

III.SIMULATION RESULTS

We have simulated DBNLE, using Castalia simulator [46] that runs on the top of the Om- net++ and compared with a closely related scheme called

Multiduolateration (MDL). Metrics considered for comparison are: (i) Accuracy in location estimation, and (ii) Time required for localization. Localization of MDL is shown in Figure 3. It works in two phases: (i) First phase: In this phase edge nodes are localized using internal division as

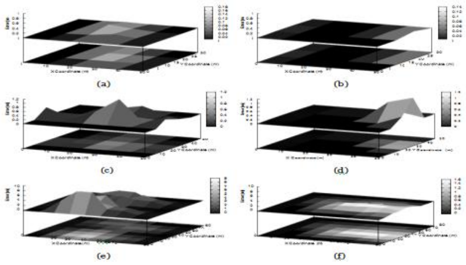

Figure 3: Geographical distribution of error for a grid size of 6 × 4, 6 × 6, and 9 × 9 is shown in a, c, and e respectively for MDL and b, d, and f respectively for DBNLE.

4. Localization Time

Localization time refers to the time required for the localization of the whole network. Localization time of both MDL and DBNLE for different grid size is shown in Figure 4.It is observed that MDL takes more time for localization than DBNLE. This increase in localization time is attributed to the shortest path algorithm used by each surface node for the selection of its reference edge nodes.

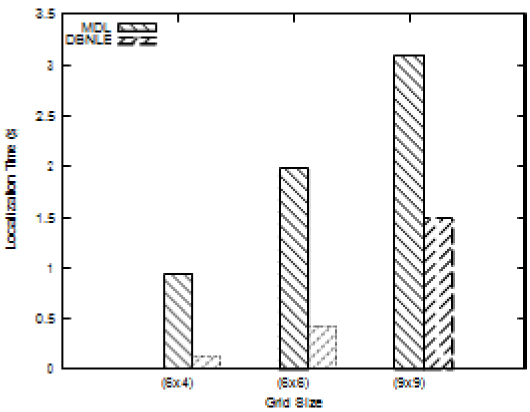

Figure 4: Localization time of MDL vs. DBNLE in different grid sizes.

IV.CONCLUSION

Most existing localization algorithms for static WSNs were designed to work with at least three anchor nodes except in those cases where directional antenna is used. Usage of antenna not only increases the cost, but also the size of node as well as complexity of the algorithm. As the number of anchor nodes required in a network increases, overall cost of the network also increases. In addition, energy drainage of the network increases, but the localization time of the whole network decreases. Further, anchor nodes installed with GPS do not work well everywhere. Therefore, at present we are in the need of a novel technology that will solve the following problems: (i) reduce the number of required anchor nodes, (ii) localize sensor nodes in areas where GPS do not work well, (iii) minimize the localization error.In this research we have proposed localization technique for static as well as mobile WSNs.

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