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Efficient Range based Algorithm for Localization in Pilgrim Tracking Scenario

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ABSTRACT: Wireless Sensor Networks has its own importance in different contexts of life such as tracking, monitoring etc. Network Localization is an essential requirement for different wireless sensor network realistic applications. Pilgrim Tracking is one of the realistic application. Tracking large number of people is very difficult process during the season time. The wireless sensor network can be used in such a situation. Localization refers to the self organizing of the sensor nodes with their known positions. This paper presents an efficient modified triangulation algorithm for localization technique which can be used to find the position of the pilgrim having a sensor node in hand. It is fast and simple for implementation in wireless sensor networks for pilgrim tracking. Received Signal Strength Indicator is measured using triangulation method and the mappings of these signals are done to get the estimated position of the unknown node. Positioning is an important factor to find or track the sensor node. Received Signal Strength Indicator from different sensor nodes are compared for estimating the position of the node.

KEYWORDS: Wireless Sensor Networks (WSN), tracking, localization, received signal strength indicator, triangulation

I. Introduction

Localization has its own importance in wireless sensor network scenario. The important function of a sensor network is to collect and forward data to destination. It is very important to know the location of the data from where it is collected. This kind of information can be obtained using localization technique in wireless sensor networks.. Localization of sensor nodes is an interesting research area and many works have been done so far is highly desirable to design low-cost, scalable and efficient localization mechanisms for WSNs. It is a way to determine the location of the sensor nodes Localization is estimated through communication between localized node and unlocalized node for determining their geometrical placement or position. Location of the sensor node is determined by means of distance and angle between nodes. There are many concepts used in localization such as lateration, angulation, trilateration and triangulation. Localization schemes are classified as anchor based or anchor free, centralized or distributed, GPS based or GPS free, fine grained or coarse grained, stationary or mobile sensor nodes and range based or range

The two fundamental principles used in traditional localization techniques are triangulation and trilateration. The triangulation method employs antenna arrays and tries to estimate the direction of signal from a to-be-located radio source. At least two such estimates are required from two antenna arrays located at two different locations. The location of the signal source can be estimated at the intersection of lines of directions from the two antenna arrays. AoA also called as direction of arrival (DoA), is a localization approach belonging to the triangulation methods. A receiver (e.g., a base station) uses the angle of received signals from a mobile device to limit the location of a mobile device along a line. Thus at least two base stations are required to locate the mobile device by taking the intersection of two lines of directions from the two antenna arrays. The base stations have to be equipped with an antenna array or a directional antenna for calculations of the angle of the received signals. The localization algorithm uses the measured RSS to find a best matching location from the radio map and predicts if the MU is in the location

II. Related work

In a target tracking application, the sensor nodes which can sense the target at a particular time are kept in active mode while the remaining nodes are to be retained in inactive mode so as to conserve energy until the target approaches them. To continuously monitor mobile target, a group of sensors must be turned in active mode just before target

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reaches to them. This group of active sensors varies depending on the velocity of moving target and schedule from cluster head. Ultimately, target tracking in course of maintaining the balance between network resources like energy, bandwidth, and overheads is challenging.

Ring Overlapping Based on Comparison of Received Signal Strength Indicator (Chong Liu et. Al. 2007) in which every sensor node will have a series of overlapping rings to narrow down the possible area in which it resides. The signal strength a particular sensor node receives from a specific anchor is compared with the signal strength other anchors receive from the same anchor node are used to generate the rings. It does not map the received signal strength to absolute point to point distances Approximate Point In Triangulation (Yong Zhou et. Al. 2009) is a range free localization method. In this method the node chooses three anchor nodes from all other audible anchors and tests whether it is inside the triangle formed by connecting these anchors. APIT repeats the PIT test with different audible anchor combinations to get the required accuracy. After that it calculates the centre of gravity of all the triangles to find where the node resides. APIT can only evaluate finite number of directions and it makes incorrect decisions when three conditions exist. To track the pilgrim movement during Hajj (Mohamed Mohandes et. Al. 2012) a method is proposed with a dedicated delay tolerant wireless sensor network. In this method each pilgrim is given a mobile sensor unit which includes a GPS chip, a microcontroller and an antenna. Fixed network units are installed to receive and forward data from the sensor nodes. These fixed nodes are connected to a central server which maps the latitude and longitude to the geographical information system. Gateways are used to interface the WSN via internet to the central server. The main drawback of this system is the use of GPS in the sensor node takes much amount of power from the node

III. PROPOSED ALGORITHM

A. *Triangulation Method:*

Triangulation mechanism is an example for range based localization technique. It uses geometric properties of triangles i.e trigonometric laws, laws of sine and cosine to estimate the location. In this method, atleast two angles of an unlocalized node from two localized nodes are measured to estimate its location..

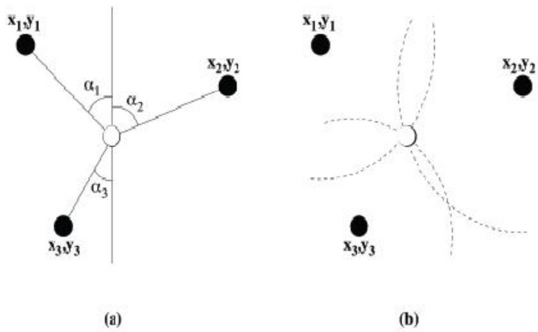

Fig1.a) Unknown location is found using three angle measurements (AoA) b) Unknown location found using the intersection of the radial measure from three known nodes(ToA)

The Figure 1 depicts the traditional triangulation method by which the location of the sensor node is found using Angle of Arrival method and Time of Arrival method

B. *Description of the Proposed Algorithm:*

Aim of the proposed algorithm for localization reduces the estimation error in finding the location and also the time complexity in computation is reduces as the mapping of strongest signals is taken into consideration.The proposed algorithm is consists of the following steps.

Step 1: Assumption

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Assume a sensor node say ‘S’ wants to calculate its location. The total number of sensor nodes is given as input and the simulation area is defined manually.

Step 2: Random Deployment of Sensor Nodes:
Inputted Sensor Nodes are randomly deployed and corresponding coordinates are found

Step 3: Collection of RSSI
Received Signal Strength from all the sensor nodes collected at unknown node ‘S’.

Step 4: Mapping of Signals
The Strongest signals from the collected signals are found and circles are mapped.

Step 5: Location computing
From step 4 only 3 values are taken to compute the location of the sensor ‘S’

Step 6: Estimation of node position
Finally the Euclidean distance from the reported location vector of the mobile device is generally regarded as being the correct estimate of the position of the sensor node.

IV. SIMULATION RESULTS

The wireless sensor network for pilgrim tracking has been evaluated with several different nodes. Simulations are carried out in MATLAB In pilgrim tracking scenario, the terrain is restricted and hence the range based localization is used. The Received Signal Strength Indicator values from several nodes are collected and the stronger signals are mapped. From those signals again the two stronger signals are taken for triangulation method and thus the location of the unknown node is found. The scenario dimension is taken as 500m x 500m. In this experiment sensor nodes are varied from 50 to 250 nodes and the collected RSSI values in every experiment is analyzed according to the distance of the sensor nodes. The position of the unknown sensor nodes are calculated from the found data. The figure below shows the scenario for the node positioning of sensor nodes as well as the unknown sensor node location.

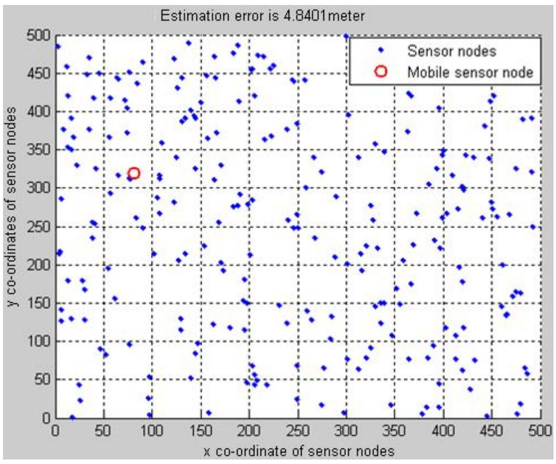

Fig. 2. Plot with 250 sensor nodes and its estimated error for unknown sensor nodes

The simulated output gives the values for received signal strength indicator with respect to the distance of the sensor nodes. Received Signal Strength Indicator is an estimate of average received power. The strength of received

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power from a signal can be used to estimate distance because all electromagnetic waves have inverse-square relationship between received power and distance as shown in the following expression:

$$Pr \propto \frac{1}{d^2} \qquad \text{--------(1)}$$

where Pr is the received power at a distance d from the transmitter.
The figure 3 shows the graph plotted between received signal strength received at the unknown node with respect to the distance

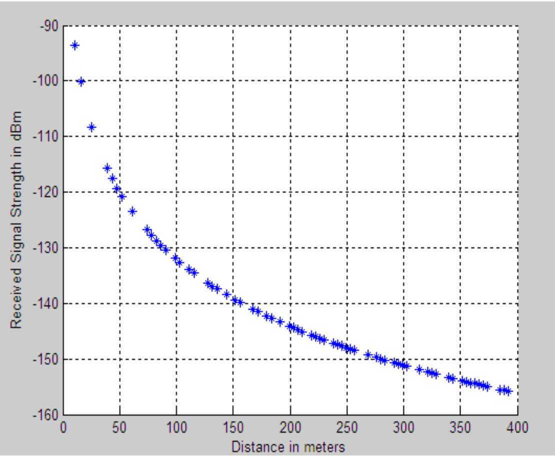

Fig. 3. Received Signal Strength versus Distance

The estimation position of the sensor node calculated using the procedure as given. For example, assume two access points X and Y and a mobile device Z. Access point X reports mobile device Z with an RSS sample of x_1. Almost simultaneously, access point Y reports mobile device Z with an RSS sample of y_1. These two RSS reports can be represented as location vector of (x_1,y_1). Assume that during the calibration phase, a large population of location vectors of the format $F(x_2,y_2)$ were populated into the location server calibration database, where F represents the actual physical coordinates of the recorded location. The location server can calculate the Euclidean distance d between the currently reported location vector (x_1,y_1) and each location vector in the calibration radio map as follows:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad \text{-----(2)}$$

The estimation error for different nodes are tabulated below:

No: of Sensor Nodes	Average Estimated Error	
	MTA	Triangulation
50	0.42915m	0.91132m
100	0.52834m	1.5277m
150	0.66627m	1.7488m
200	0.80062m	2.2791m
250	1.0741m	4.8401m

Table 1: Comparison between Modified Triangulation and Traditional Triangulation method

From table 1 it is clear that as the number of sensor nodes increases the estimated error also increases but by the use of modified triangulation method the error is minimized when compared with the traditional triangulation method. Also the computational time gets reduced by mapping the strongest signal alone for the computation purpose rather than selecting random nodes.

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V. CONCLUSION AND FUTURE WORK

The modified triangulation algorithm (MTA) for pilgrim tracking and its working are presented in detail. The performance of this algorithm is analyzed with the help of Received Signal Strength Indicator. It is found that MTA performs quite better than the traditional triangulation technique. Also the average estimation error and computation time is less when MTA is used as it is analyzed with different number of sensor nodes. The future work has to be extended with several other parameters taken into consideration in a real time

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