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Optimized Localization of Wireless Sensor Nodes with RSSI in Wireless Sensor Networks

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Abstract:
In WSNs localization is an important issue for many applications as it increases the lifetime of the nodes, power consumption calculations, data routing etc., we optimized the localization of *Wireless Sensor Nodes* at a given network area where we used some known location Anchor nodes for better results. By considering the anchor nodes as reference nodes at given area, the localization of unknown sensor Nodes Location be able to be estimated, to approximate the sensor nodes triangulation method was adopted. In this paper Delaunay Triangulation (DT) method was implemented for exact estimation of unknown nodes in the network area. DT method proves better localization algorithm compared with other methods. Anchor nodes measures the RSSI of nearest neighbour nodes, based on RSSI values DT method approximates the nearest neighbour nodes and DT triangles are formed.

Keywords: *RSSI, Delaunay Triangulation, Wireless Sensor Nodes.*

I. INTRODUCTION:

In the recent years *Wireless sensor networks (WSN)* are the most vigorous investigate area from the past few years, as the demand for sensor nodes in real time applications are growing gradually. In WSNs the location of sensor nodes is the critical element in the deployed area where especially nodes are in motion, then it is very complicated to find the exact location of unknown node, and it's complicated to estimate how far unknown nodes away from the anchor nodes. Many algorithms were proposed to estimate the correct Location of sensor nodes but when the nodes are in motion, most of the algorithms failed to approximate the exact Location of Target nodes.

We proposed triangulation method to find the correct Location of unknown nodes, whose location is frequently changes with this scenario it is very difficult for the anchor nodes to estimate the exact location of targeted nodes, we addressed above problem to provide a optimal solution for Localization of WSNs to identify its neighbouring mobile nodes frequently and updates the status of mobile nodes time to time.

The proposed work we described in the following sections as: in Section-II we discussed about RSSI model based on the literature survey on different wireless sensor networks nodes localization techniques, which are exploited in Section-II, Section-III Grey prediction method, Section-IV describes DT triangle method, and in Section-V Simulation Results.

II. Distance Measurement based on RSSI model

The most widely used wireless network models are FSP model, Hata Model, LDPL model, TRGR model, Log-Normal Shadowing Model, etc [2]. As in paper [2] LNS model is best suited for RSSI

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measurement in wireless environment and the RSSI based Localization model not require any Hardware modules for the measurement of the localization, rather it only depends on the distance of nodes by using the Pt the transmitter power, Pr receiver signal power, the PL Exponent and the Path Loss Co-efficient which is in expressed in equations (1 & 2).

$$A_{RSS} = -10n\log_{10}(d_0) \quad (1)$$

$$RSS_0(i) = A_{RSS} - 10n\log_{10}(\frac{d(i)}{d_0}) + X_\sigma \quad (2)$$

Where $RSS_0(i)$ is the i^{th} sensor node Received power at d_0 and $d(i)$ is the i^{th} node. d_0 is the reference distance and n is the PL exponent, $X\sigma$ is a zero mean Gaussian random Variable which reflects the Random Variation in the Path Loss.

In order estimate Location error between the predicted distances to the actual distance, we need to find out the predicted distance of the i^{th} sensor node. Compare the original signal strength and predicted signal strengths of the unknown nodes in the network deployment area.

III. GREY PREDICTION METOD:

The GPM estimate the location of the target nodes with high accuracy of target nodes and in GPM model the predicted RSSI model is used in this paper and for tracing the mobile nodes GPM method is used for RSSI measurement, RSS from the target nodes are accumulated and the original RSSI of the nodes can be accumulated to estimate the strongest RSS from the above two signals, with this data generate a mapping circle for the nodes i.e. based on the equation (3)

$$(x_0, y_0) = (x_1 + d_1\cos\theta, y_1 + d_1\sin\theta) \quad (3)$$

Where d is distance from anchor node to the unknown node.

Θ the angle of target node to anchor node

IV. Delaunay Triangulation

There are many techniques are available for node's position estimation for localization process, example, Trilateration is the most widely used 2D Localization method which requires the distance information of 3 reference nodes then the target nodes position is estimated at the intersecting points of the target nodes encircles with the radius of the targeted nodes encircle with the reference nodes and in multilateration more than 3 reference nodes used to estimate the unknown node, distance estimation errors are minimized as compared to the Trilateration method.

In Triangulation technique the measured angles between the reference nodes to unknown nodes are formed. The unknown node estimates location using trigonometrically relations by the angles to each of the 3 anchor nodes which forms a triangle.

Delaunay Triangulation is a technique of Computational Geometry which is very useful in Wireless Sensor Network establishment, for a DT triangulation set of points P, number of triangles T of P satisfy the *empty circle criterion* if and only if T is a DT of P [15], where the *empty circle criterion*, for a given triangles T for set of points P, if the circumcircle of a triangle is an empty circle in the DT triangulation [15].

A Delaunay triangular in Trilateration is used to maximize the minimum angles in a triangle, to generate the DT triangles in a given network in which the nodes are randomly deployed in the network as shown in figure 1. The nodes are randomly distributed for 100*100 in this paper for easy implementation of the algorithm.

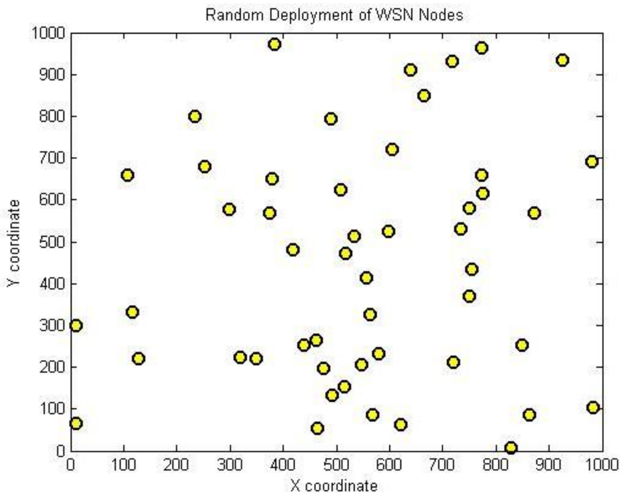

Figure1. Node deployment in the network

For the deployed nodes as shown in figure1, a DT algorithm is implemented to establish the DT triangles for the given nodes, initially only DT triangles are established without any DT triangle marking as shown in figure2. After DT triangles generation we marked the triangles with label for each triangle for identification purpose and to know how many DT triangles are established in a given network.

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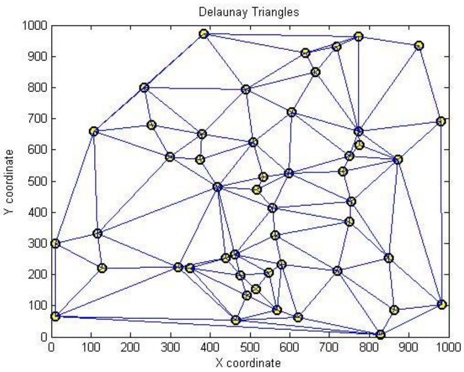

Figure2. Establishment of DT triangles

DT triangles are marked with labels for each of them to identify the DT triangles in the network as shown in figure3.

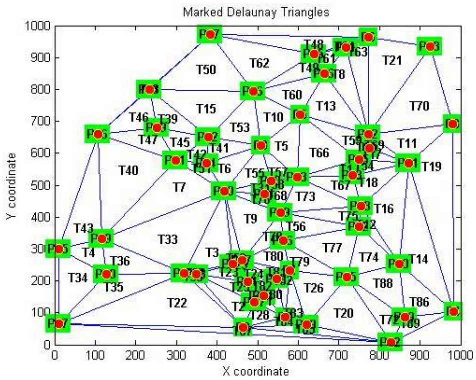

Figure3. Marked DT triangles

V. Simulation Results

The performance of the optimized algorithm was tested by using MATLAB and the proposed parameters for simulations are network area as 1000m X 1000m in 2D plane. Nodes = 50-250 which are randomly deployed as shown in figure1, for the given nodes Delaunay triangulation is formed as shown in figure2, for the established DT triangles we marked Labels for each triangle as shown in figure3 for marking labels we first computed concentric circles by which the centre of the nodes are measured and for that triangles Labels are marked. For RSSI measurements the reference distance d_0 is chosen here randomly, and the path loss exponent n=4, and the RSSI is measured under simulated AWGN for both predicted and weighted predicted RSSI measurements and the results are plotted as shown in figure4 and figure5 where in each plot the RSSI is plotted with AWGN noise to differentiate the measured RSSI signal performance. With the simulation results we came to know that the RSSI value depends on the distance and the PL exponent '*n*' values and as size of the network increases the difference between the original RSSI to predicted value of RSSI are varying due to fading, shadowing and multipath effects, a small variation in node position there is a significant change in RSSI values.

As shown in figure4 the signal strength in dB versus Received Signal Strength (RSS) is plotted between the original RSS signal with predicted RSS signal values, the graph clearly indicates that the predicted RSSI signal level are very close to the original signal strengths.

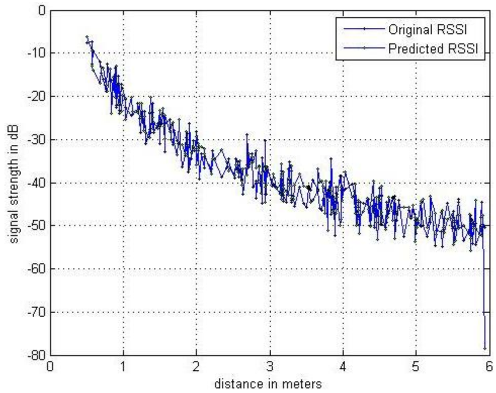

Figure4. Predicted Received Signal Strength

The figure(5) shows that the weight predicted RSSI measured signal levels are more closely approximate to the original RSSI signal values as compared to the predicted RSSI values this can be achieved with the DT triangulation method where in the target nodes are estimated with DT method and the DT triangles are formed, from that nearest neighbour nodes are estimated and with these data the nearby target nodes are found then the RSS is measured from those nodes, the predicted values are very close to the original values thereby the accuracy of node localization is improved.

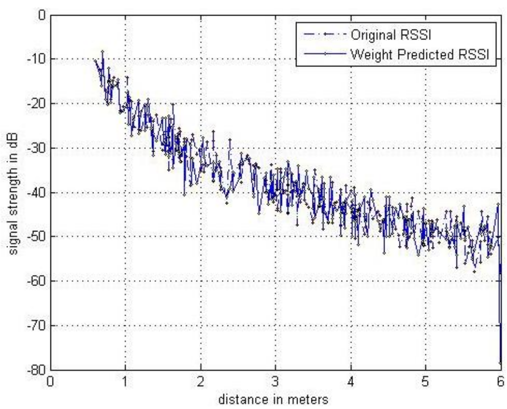

Figure5. Weighted predicted RSSI

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VI. Conclusion

We estimated the location of mobile nodes with RSSI measurement and DT triangulation method to reduce the range errors in estimating the location of unknown mobile nodes, the DT localization algorithm for WSN along with the grey prediction and weighted prediction algorithms to improve the accuracy when compared to the other localization algorithms, when the mobile nodes changes its location we have to simulate the algorithm once again to establish the new DT triangles and new values of RSSI with this the estimation accuracy is improved when comparing with only RSSI algorithm. We here conclude that our optimized node localization algorithm is useful for best routing in WSN nodes.

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