# ENHANCED PERFORMANCE IN LOCALIZATION OF SENSOR NODES WITH IDTN ALGORITHM IN WIRELESS SENSOR NETWORKS

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**ABSTRACT:**
In this paper we introduce a Triangulation (IDTN) algorithm which produces the lowest mean-distance error as compared with other existing algorithms. In this algorithm we formed a triangulation with nearby sensor nodes in which anchor nodes and target nodes are in the deployed in the network area and the unknown nodes whose location to be estimated. Triangulation method proves better localization algorithm compared with other methods. Anchor nodes measures the RSSI of nearest neighbouring nodes, based on RSSI values IDTN method approximates the nearest neighbouring nodes and DT triangles are formed.

**KEYWORDS:**
RSSI (Received Signal Strength Indicator), Improved Dynamic Triangulation (IDTN), Wireless Sensor Nodes.

## I. INTRODUCTION:

The position of the sensor node is practically unidentified in the real time environment applications in WSN. Mobile user’s position estimation plays a vital role in wireless sensor network, for both indoor and outdoor environments. The creation of an amount of node localisation protocols in recent years has reflected the importance of physical space for sensor networks. However, the majority of these methods were created for “traditional” sensor networks, and they only cover a tiny part of the design space. We'll identify a critical area of the design space that is currently underutilized by existing techniques. Re-executing the localization algorithm on a regular basis is the easiest way to keep up-to-date location estimates. The most effective approach is calculated by a number of device parameters, including node mobility, tolerance for sketchiness, and the frequency at which a node desires a location estimate. *Wireless sensor networks (WSN)* differentiate themselves from other wireless or wired networks through sensor and actuator based on interaction with the environment (Wang et al., 2003). Many algorithms were proposed to approximate the accurate Location of sensor nodes but when the nodes are in motion, most of the algorithms failed to estimate the precise Position of Target nodes [1],[2],[3],[4].

We proposed triangulation method to find the accurate Location of unknown nodes, whose location is frequently changing, with this scenario it is highly problematic for the anchor nodes to estimate the exact location of targeted nodes, we addressed this problem and provided an optimal solution for the Localization of WSNs to identify its neighbouring mobile nodes frequently and updates the status of mobile nodes time to time.

The paper presented in following sections such as: in Section-II we discussed about distance measurement based on RSSI model, which estimates the received signal strength from anchor nodes, Section-III describes about proposed IDTN algorithm, and in Section-IV 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 [1],[2] LNS model is best suited for RSSI 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 $P_t$ the transmitter power, $P_r$ receiver signal power, the PL Exponent and the Path Loss Co-efficient which is in expressed in equations (1 & 2).

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

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

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 [1].

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 [1].

## III. Improved Dynamic Triangulation (IDTN) Algorithm

Improved Dynamic Triangulation Algorithm (IDTN) requires following steps:

*[1] Mapping Circle generation*

IDTN method finds the possible locations of the mobile users based on the equation

$$(x_{i-1}, y_{i-1}) = (x_i + d_i \cos\theta, y_i + d_i \sin\theta) \qquad (3)$$

Using the equation (3) mapping circles are generated by using the possible distances ($d_{2\theta}$ and $d_{3\theta}$) between mobile user and nodes.

*[2] Distance estimation of mobile user:*

IDTN finds the error between estimation distances $d_2$ and $d_3$ and possible distances ($d_{2\theta}$ and $d_{3\theta}$).

*[3] Approximation of the mobile coordinates:*

Algorithm finds out the cost functions at every θ angle and the angle θ increase $1^\circ$ each time. The Algorithm searches the min cost function, and the angle θ of min cost function is the estimation θ on the mapping circle. The θ on the mapping circle is the estimation location distance of the mobile user as shown in figure1.

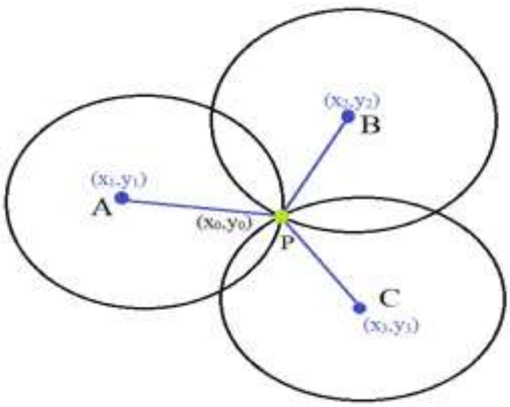


Figure1. Trilateration of nodes

The DTN location algorithm is as follows

- Finding the strongest RSSI signal and generating the mapping circle

$$d_1 = d_0 10^{\frac{RSSI_0 - RSSI_M}{10n}}$$

And mapping circle with the help of equation (3)

- Find out 2nd and 3rd strong RSSI signal and estimate the distance between mobile node and sensor node using

$$d_2 = d_0 10^{\frac{RSSI_0 - RSSI_1}{10n}}$$

$$d_3 = d_0 10^{\frac{RSSI_0 - RSSI_2}{10n}}$$

- Generate cost function

$$d_{2\theta} = \sqrt{(x_2 - d_1\cos\theta)^2 + (y_2 - d_1\sin\theta)^2}$$

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$$d_{3\theta} = \sqrt{(x_3 - d_1\cos\theta)^2 + (y_3 - d_1\sin\theta)^2} \quad Error_{1\theta} = |d_{2\theta} - d_2| \quad Error_{2\theta} = |d_{3\theta} - d_3|$$

- Find minimum cost function and angle $\theta_M$

$$CF_\theta = \sqrt{Error_{1\theta}^{\ 2} + Error_{2\theta}^{\ 2}}$$

- Finally find the local coordinates and global coordinates of mobile nodes

The MSE error is calculated using the equation (4),

$$MSE = \frac{1}{N}\sum_{i=1}^{N} \sqrt{(x_i - \hat{x})^2 + (y_i - \hat{y})^2} \qquad (4)$$

The nodes are randomly deployed in the network as shown in figure2, for a sample simulation we consider the network size as 100*100 in this paper for easy implementation of the algorithm.

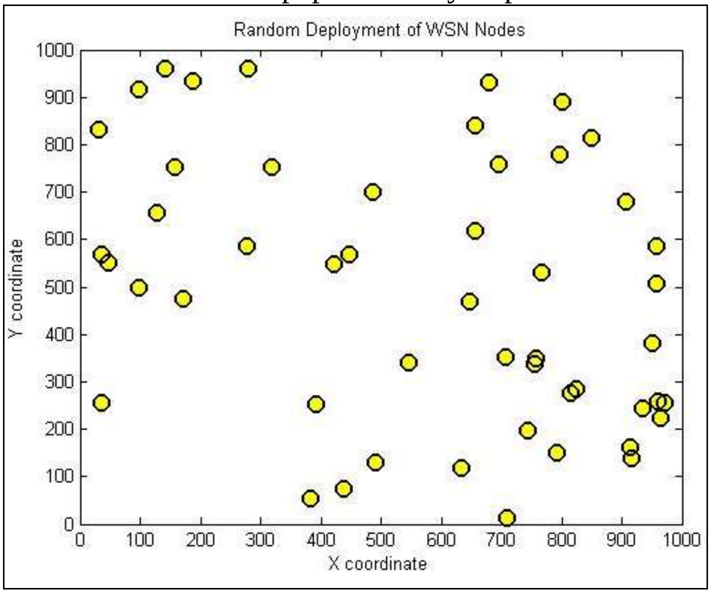


Figure2. Node deployment in the network

For the deployed nodes as shown in figure2, a IDTN algorithm is implemented to establish the IDTN triangles for the given nodes in the network [1].

## IV. 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 figure2, for the given nodes DT triangulation is formed first computed concentric circles by which the centre of the nodes are measured and for that triangles Labels are marked. As [1][2] 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. 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 figure3 mapping circles are generated based on RSSI signals and then IDTN triangles are formed.


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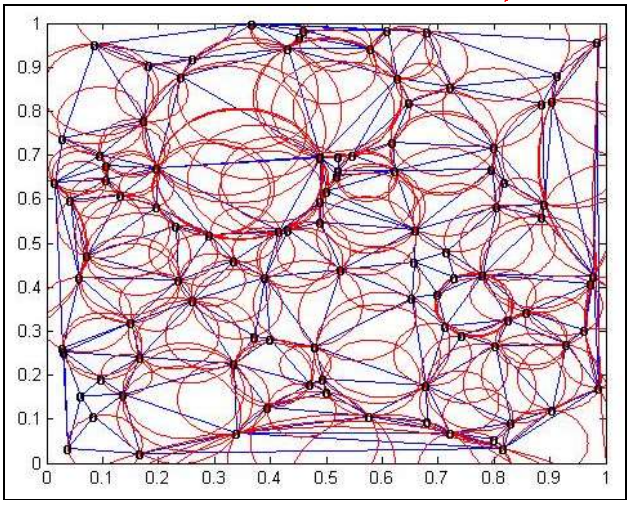

Figure3. formation of IDTN triangles

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 IDTN triangulation method where in the target nodes are estimated with IDTN method and the IDTN 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[1][2].

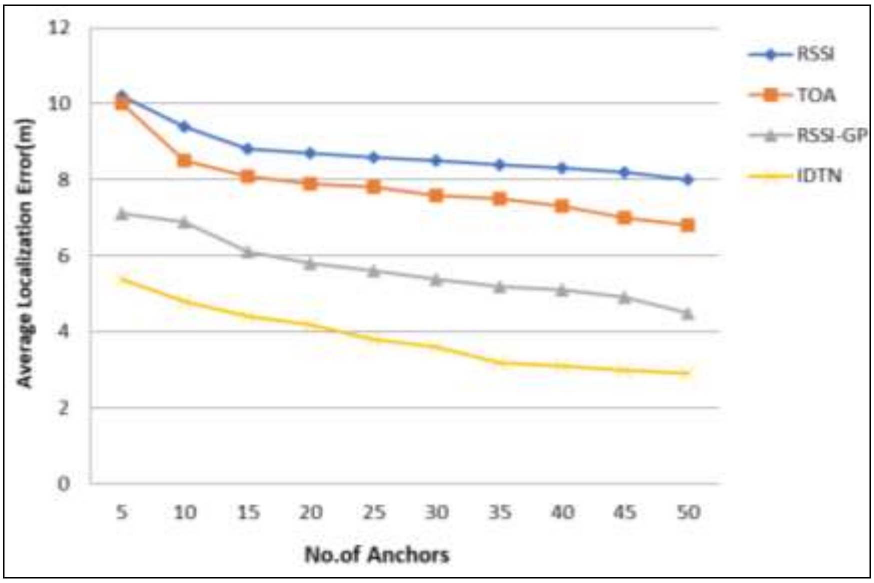


Figure4. Number of Anchors vs average localization Error

The figure4 shows that the proposed algorithm ITDN exhibits better performance with RSSI, TOA, and RSSI-GP algorithms. The simulation results shows that IDTN algorithms over localization shows enhanced performance than other methods as described in table1&2.

Table1: Localization error with anchor nodes

| Anchor Node Count | Localization Error | | | |
|---|---|---|---|---|
| | Mean | Median | 90th percentile | Std. dev. |
| 6 | 0.486 | 0.432 | 0.713 | 0.253 |
| 7 | 0.354 | 0.378 | 0.693 | 0.173 |
| 8 | 0.293 | 0.278 | 0.492 | 0.142 |
| 9 | 0.223 | 0.244 | 0.454 | 0.119 |
| 10 | 0.215 | 0.21 | 0.431 | 0.113 |


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| | | | | |
|---|---|---|---|---|
| 11 | 0.22 | 0.216 | 0.441 | 0.121 |
| 12 | 0.236 | 0.225 | 0.469 | 0.136 |

In table2 simulation results of mean, median, standard error and standard deviation of various existing algorithms are shown. As per the data analysis IDTN exhibits good performance.

Table2: Comparison of Localization error with DBL, RSSI, RSSI_GP and IDTN algorithms

| **Method** | **Localization Error** | | | |
|---|---|---|---|---|
| | **Mean** | **Median** | **Std.Err.** | **Std. dev.** |
| **DBL** | 0.021 | 0.072 | 0.103 | 1.032 |
| **RSSI** | 0.44 | 0.508 | 0.249 | 4.321 |
| **RSSI_GP** | 0.143 | 0.082 | 0.011 | 0.192 |
| **IDTN** | 1.299 | 1.302 | 0.004 | 0.082 |

Table3: Comparison of Localization error with DBL, RSSI, RSSI_GP and IDTN algorithms with Anchor count

| **No. of Anchors** | **RSSI** | **TOA** | **RSSI-GP** | **IDTN** |
|---|---|---|---|---|
| 5 | 10.2 | 10 | 7.1 | 5.4 |
| 10 | 9.4 | 8.5 | 6.9 | 4.8 |
| 15 | 8.8 | 8.1 | 6.1 | 4.4 |
| 20 | 8.7 | 7.9 | 5.8 | 4.2 |
| 25 | 8.6 | 7.8 | 5.6 | 3.8 |
| 30 | 8.5 | 7.6 | 5.4 | 3.6 |
| 35 | 8.4 | 7.5 | 5.2 | 3.2 |
| 40 | 8.3 | 7.3 | 5.1 | 3.1 |
| 45 | 8.2 | 7 | 4.9 | 3 |
| 50 | 8 | 6.8 | 4.5 | 2.9 |

## V. Conclusion

We estimated the location of mobile nodes with RSSI measurement and IDTN method to reduce the range errors in estimating the location of target nodes, the IDTN localization algorithm for WSNs improves the accuracy when compared to the other localization algorithms, when the mobile nodes change its location, we have to simulate the algorithm once again to establish the new IDTN values and new values of RSSI with this the estimation accuracy is improved.

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