Energy Efficient Dynamic Nearest Node Election For Localizations of Mobile Node in Wireless Sensor Networks

Bhavya Ghai
Dept. of Information and Communication Technology
ABV- IIITM, Gwalior
M. P., India 474006
Email:bhavyaghai@gmail.com

Girish Pradeep Bindalkar
Dept. of Information and Communication Technology
ABV- IIITM, Gwalior
M. P., India 474006
Email:girishbindalkar@gmail.com

Sanjeev Sharma
Dept. of Information and Communication Technology
ABV- IIITM, Gwalior
M. P., India 474006
Email: sanjeev.sharma1868@gmail.com

Anupam Shukla
Dept. of Information and Communication Technology
ABV- IIITM, Gwalior
M. P., India 474006
Email: dranupamshukla@gmail.com

***Abstract*—To locate and find out the accurate position of a moving mobile sensor node is key component to establish a successful mobile wireless sensor network.In most cases its graphical representations were used to locate mobile node which is not acceptable when dealing with real time. We proposed an algorithm based on the RSSI and co-operative communication between nodes to find out the accurate localization of sensor node. The proposed algorithm increases efficiency in localization of the mobile sensor node in terms of time and Energy.**

I. Introduction

Due to the advancements in tracking and surveillance mechanisms, traditional wireless sensor network [1, 2, 3] has been replaced by mobile wireless sensors. In mobile wireless sensor network each node is constantly moving. Most of the challenges which arise in mobile sensors network are to localize the location of mobile node in real time environment and to calculate the distance between two nodes and angle of motion in each node. Most of the previous research work is just focused on finding the efficient location of the moving agents. The current paper covers both aspects so that each mobile node is easily located in physical space.

To achieve localization goal many different method such as convex program and DV-HOP [4] are used which have their own limitations. The proposed algorithm uses dynamic value of RSSI [5] and converts them in terms of distance and orientations to estimate position of mobile node. It also enhances the adaptive configuration based on position of mobile nodes. It is also notable that other equipment which uses ultrasonic sound and laser based sensor have their own limitations due to enhanced cost and energy requirements.

To locate randomly moving mobile agents we can measure the strength of the signal. If signal strength is strong, it means targets are near. If signal strength is poor, it means targets are not in coverage area. By using triangulation algorithm, we get the location in terms of (x, y) and its directions. Depending upon these parameters, Agent or unmanned vehicle can easily reach on its destination targets and easily track moving target agents. Our Proposed Algorithm also considers several technical issue such as single moving node localization, multiple node localization and maintain energy efficiency in network.

This paper based on the following previous research . In [6],Zenon Chaczko, Ryszard Klempous, Jan Nikodem2 discusses different localization methods such as ToA, TDoA, RSS algorithms, transfer localization function for base stations . In most algorithms, Angle of arrival and direction of antenna plays an important role in estimation of sensor position which effects the position of the sensor node and hence create error.

In [7], authors propose an approach to measure the distance using Rssi and Gps. In such a scenario, Atleast one node must have gps and every node must know their positions which they are unable to communicate with other nodes. The sensor with unknown positions is estimated by this algorithm. The algorithm gives accurate possible position but requires more cost and energy due to gps.

Qingjiang Shi, Chen [8] provides new approach of range free localizations by using semi definite programming method and Multidimensional scaling. It can used for relative as well as absolute localizations. This algorithm can only work with fewer anchor node and requires relatively uniform network with high connectivity. It's major advantage is that the method can keep the track of proximity of neighboring node to check networks is regularly active or not.

In [9], authors provides DV-HOP (Distance Vector Hop)

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algorithm. Dv-Hop is a simple localization algorithm which uses small number of anchor nodes which know their location and unknown node is estimated by using information they receive. DV-HOP can find out accurate positions in isotropy network but it fails in other networks.

In [10], Jie Zhan implements Signal Strengthening Dynamic Value (SSDV)algorithm on the basis of database of RSSI to estimate position of the mobile node in terms of the value of beacon nodes. Beacon nodes enhances accuracy in real time but they are a bit complicated to implement and they doesn't save energy in the networks .

In [11], authors discuss the mobile sensors networks application and routing protocols. In [12], authors discuss the energy aware sensor node relocation in mobile sensor network.

The rest of the paper is organized as follows: section II discusses the proposed system in details. Section III discusses the algorithm of the proposed method. Experiments and results are given in section IV. At last we are concluding the work in section V

II. Proposed Method

The current work uses Received Signal Strength (RSSI) to localize mobile nodes and create energy efficient architecture for network. At initial stage when mobile nodes enter into range, the node send signal and wait for response. As response arrives from the receiver nodes, the algorithm measures RSSI and convert them into distance. From available distance, the nearest three nodes are activated and rest of the nodes are deactivated. The proposed system can be implemented through the following steps:

1) Calculate Signal Strength
2) Select Nearest three nodes
3) Calculate location of mobile nodes

A. Calculate Signal Strength

The localization of mobile sensor node can be done by using received signal strength. The RSSI method helps to find out the estimated calculation of the distance in between two sensors .The radio propagation model converts the RSSI into distance which predicts which node is nearer and helps in providing path to mobile nodes for future navigation. Although there are some limitations of RSSI but its cost efficiency attracts most researchers. We focus on these techniques to calculate distance between sensors. Generally the signal strength can be calculated by using following formula

$$R = 10n\log_{10}(d) + v \quad (1)$$

Here equation (1) represents the received the signal strength and d denotes distance. Typically propagation constant v =2 for free space. In practice, the RSSI and Distance can be estimated by using transmission power and the receiving power based on following formula.

$$(Tx/d)^2/Rx = 1 \quad (2)$$

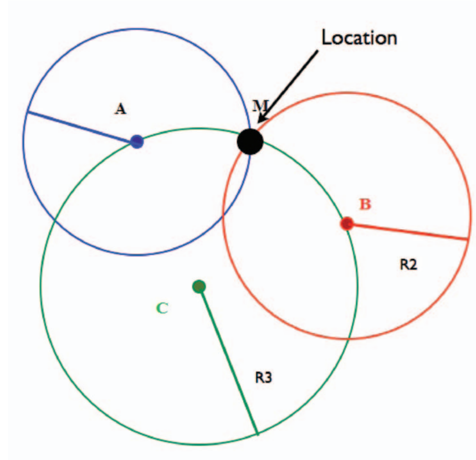

Fig. 1: Representation of Trailaterations

Equation(2) represents the relation between Transmission power, receiving power and distance between sender and receiver node. But here distance between sender and receiver node is unknown, hence we convert Equation 1 and 2 and now we have new empirical formula to calculate distance.

$$d = 10^{(Tx+gt+gr-Rx)/20}/(41.88 * f) \quad (3)$$

Here Tx is Transmission power, Rx is Receiving power, d is distance between sender and receiver node, f is frequency, gr is receiver's antenna gain, gt is transmitter's antenna gain.

1) Select Nearest three nodes: After deriving distance from the Received signal strength methods, The program finds out the nearest two static nodes based on distance. By using this mechanism the algorithm activate only two nodes and other nodes will be disabled which has great advantage in the saving energy. Now in sensor network only two static nodes and one Mobile node are activate while remaining nodes are in sleep mode.

2) Calculate location of mobile nodes: The Distance derived by RSSI is used to calculate location of mobile node with the help triangulations algorithm which is one of general method to locate wireless sensor node. Three node and mobile node take part in triangulations. The total number of nodes selected for triangulations form cluster node which is denoted by Ci.

$$C_i = \{(x_i, y_i), (x_j, y_j), (x_k, y_k)\} \quad (4)$$

(x_i, yi) represents coordinates of node i. Now we expand the above formula to calculate the position of the mobile node represented by the co-ordinate (xm,ym). To calculate xm, ym the best Trigonometric formula is

$$xm = d\cos\theta ym = d\sin\theta \quad (5)$$

θ is the Angle of arrival. The efficiency of the triangulation depend upon Angle of arrival which sometimes create errors in localization. Hence we modified above Technique. The

location of the Mobile node can be found out by using Trilateration as shown in Figure4. Trilateration algorithm represent the connection between three nodes(A,B,C)and circumference. The radius is equal to the distance between them represented by (R1,R2,R3).
The updated location of Mobile node M can be calculated by using following Quadratic equations.

$$(x - x_i)^2 + (y - y_i)^2 = di^2 \tag{6}$$

$$(x - x_j)^2 + (y - y_j)^2 = dj^2 \tag{7}$$

$$(x - x_k)^2 + (y - y_k)^2 = dk^2 \tag{8}$$

Modified above equations we get following two linear equations :

$$\begin{aligned} 2(x_j - x_i)x + 2(y_j - y_i) &= (di^2 - dj^2) - (xi^2 - xj^2) \\ &\quad -(yi^2 - yj^2) \\ 2(x_k - x_i)x + (y_k - y_i)y &= (di^2 - dk^2) - (xi^2 - xk^2) \\ &\quad -(yi^2 - yj^2) \end{aligned} \tag{9}$$

$$xm = \frac{\begin{vmatrix} (di^2 - dj^2) - (xi^2 - xj^2) - (yi^2 - yj^2) & 2(y_j - y_i) \\ (di^2 - dk^2) - (xi^2 - xk^2) - (yi^2 - yk^2) & 2(y_j - y_k) \end{vmatrix}}{\begin{vmatrix} 2(x_j - x_i) & 2(y_j - y_i) \\ 2(x_k - x_i) & 2(y_k - y_i) \end{vmatrix}} \tag{10}$$

$$ym = \frac{\begin{vmatrix} 2(x_j - x_i) & (di^2 - dj^2) - (xi^2 - xj^2) - (yi^2 - yj^2) \\ 2(x_k - x_i) & (di^2 - dk^2) - (xi^2 - xk^2) - (yi^2 - yk^2) \end{vmatrix}}{\begin{vmatrix} 2(x_j - x_i) & 2(y_j - y_i) \\ 2(x_k - x_i) & 2(y_k - y_i) \end{vmatrix}} \tag{11}$$

III. Algorithm

A. *Initializations*

In this step, Sender Node starts to transmit the message that consists of transmitted signal(Tx). Receiver use RSSI calculations to estimate the distance from sender.

B. *Nearest Node Selections*

Each Node accepts message from sender and exchange it with its neighbor node about its estimated location and connectivity with network. If neighboring node doesn't exchange information then that node is classified as unwanted node and it become inactive. Only few neighboring nodes have information from which only 3 nodes are selected based on proximity from the sender. Remaining nodes in network are deactivated.

C. *Trialaterations*

As soon as possible nearest nodes are selected on the basis of distance from its neighbour which then take part in Trailaterations. The number of Trialateration depends upon number of active nodes. In each iteration, location of node is estimated. In the end, Finest location is calculated based on the location which appears for maximum time.

IV. THE EXPERIMENTAL RESULTS AND OUTCOMES

To perform the experiment, we can create wireless sensor networks based on the Waspmote device. In the environment, Each device is considered as Beacon node capable of sending data through router. The Data collected by each becon node is send via router. We again create new experiment to make our wireless sensor network as fast Data sender. We add android mobile in the network as the router so that network can work on Multihop piconet based architecture. By using android phone as our router we send gathered data on any device or on internet. By using android as router and Waspmote node in our wireless Sensor network we get following three advantages:-

1) Store data to local Database
2) Send data to External Database
3) Send data over internet to any device

To continue our experiments we arranged node as shown in Figure.

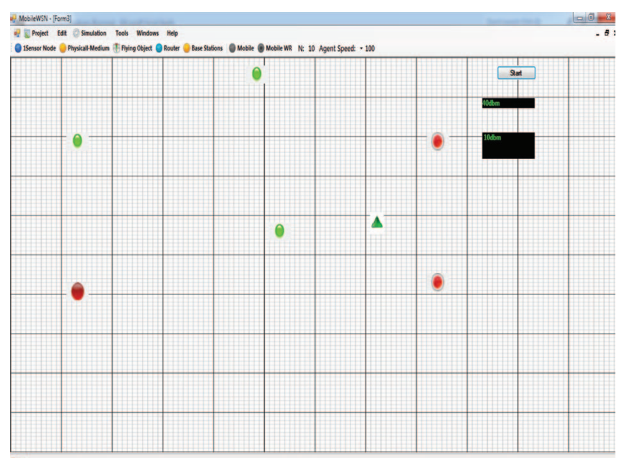

Fig. 2: Stimulator (Node representations)

At each time interval of 2 sec Mobile nodes represented by green arrow moves from its positions and wait for 4 sec to receive Signal and finds out nearest node. Green color node represent selected nearest node. At each interval and for every position 15 readings are considered and rest of the values are discarded. The Rssi and distance values as shown in the table 1.

Figure3 shows RSSI vs Distance graph. Green line refers to linear Fitting. The Y-axis represents the RSSI value in Dbm and distance is displayed on the X axis .The Experimental

TABLE I: Comparison table of original distance and calculated distance using RSSI value

S. No.	RSSI(-dbm)	Calculated Distance	Original Distance
1	62	8	9
2	72	11	13
3	63	16	10
4	86	24	22
5	79	18	14
6	83	20	18
7	88	27	14

result is only the estimated values obtained From the Receivers nodes .

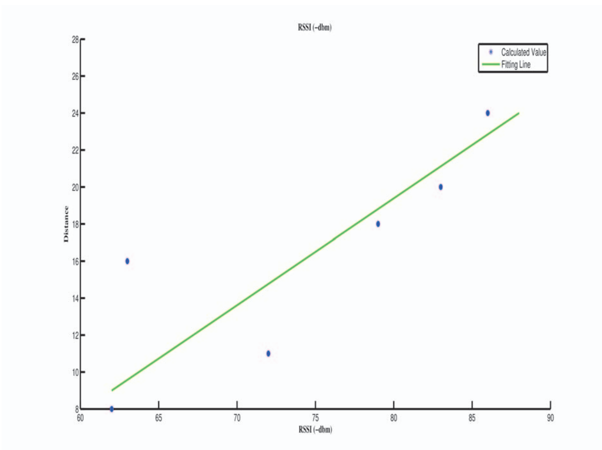

Fig. 3: Linear Fitting Curve between RSSI-DISTANCE

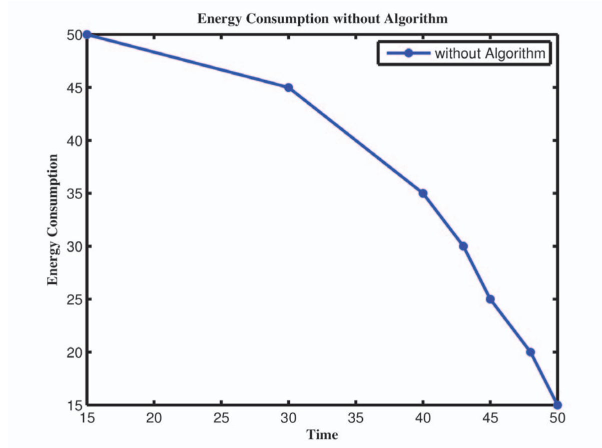

Fig. 4: Energy Consumption using Test Algorithm

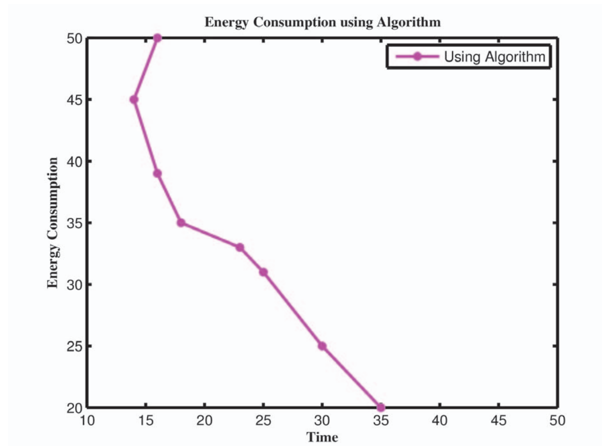

Fig. 5: Energy Consumption using our proposed Algorithm

V. Performance

A. Low Energy Consumptions

The Energy of wireless sensor Network depends on the number of active nodes. As the number of active node increases available energy in the network decreases. In the proposed algorithm, number of the active nodes is always less than remaining deactivated nodes. Hence less energy is consumed by the networks. Figure4 and Figure5 represent graph of a energy consumption using test algorithm and our proposed algorithm.

B. Performance And Network Failures

As in the entire network, Number of activated nodes are relatively less so the network traffic or packet loss automatically decreases. Routing and path optimization for sending data does not require extra efforts. Overall, Our proposed algorithm enhances performance of the network and the chances of network failure are reduced

VI. Conclusion

The current research is focused on the localization of mobile nodes in sensor Networks which are specially used for tracking and surveillance. It is an emerging field in engineering and has variety of applications in military, Area Exploration, Target Tracking,etc. The current investigation uses advantage of RSSI to locate the mobile node successfully by maintaining low energy in wireless sensor Networks. The distance measured by using RSSI value is approximately equal to the distance between nodes in real physical world.

VII. Future Scope

In the Future, we may increase the number of mobile nodes and investigate performance. We may also use customized flocking algorithm so that multiple moving nodes can communicate with each other and navigate simultaneously. Artificial Neural Networks can be used to find out exact,fast and reliable location of mobile node based on available location data. We can also work on motion tracking based research to keep track of mobile node which help target tracking in Surveillance System.

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