An Efficient Localization Scheme for Mobile WSN

Kailas Tambe, G. Krishna Mohan

Abstract--- Localization is an extremely important service in wireless sensor network and when nodes are mobile then it is the utmost challenge to keep the information of all nodes in the wireless sensor network. In last many years a good research has been conducted using many localization algorithms to provide solution for accurate positioning of nodes along with minimum energy consumptions by the nodes. But when nodes are moving continuously and positions are changing at every time period t then it might be difficult to localize all nodes at a time but it is achieved using trilateration techniques using cooperative approach among neighboring nodes of the network. In presented algorithm where each node is tracked by its current position after every fixed time interval period 't' which will keep track of nodes current position for time t as well also predicts its position for next period of t i.e. 2t. In proposed algorithm to keep the localization error minimum we have selected two neighboring nodes for each node and every node updates its current and predicted position after every fixed time interval period. The minimum distance can be calculated by performing trilateration among two neighboring nodes with unknown position node. Trilateration is mainly used in range based localization. These coordinate differences between current and predicted positions for time t and 2t time slot give us a localization error. With presented algorithm we have found the efficient time period where average localization error will be minimum with minimum energy consumption. In Future with quality of service parameter as Packet delivery ratio (PDR) and ultimately increased in throughput of the network can be achieved.

Keywords: Localization, AoA, PDR, TDOA, TOA.

I. INTRODUCTION

A Wireless Sensor Network (WSN) comprises an enormous low-cost tiny devices, or small sensor nodes, equipped with wireless communication and which supports several applications such as in health home building automation, surveillance security, and industrial application. Sensor node localization is an important and significant concern of the sensor network.

Task of determining the accurate location of the node is localization. In such application data is meaningful only when it with location information which plays crucial role in basic jobs such as military application, indoor localization, objects tracking, animal habitat monitoring. When density of nodes are high then the manually deployment is quite unrealistic and expensive. Subsequently, through location estimation techniques sensor nodes able to obtain their locations. Global Positioning System (GPS) is a utmost method used for localization[1-2].

In wireless sensor network two types of node we used i.e. anchor nodes who are aware about their location and other nodes those who are not aware about their locations they need to know their location. The main constraint is costs of nodes are the prime exertion for the range based localization. Node localization for static scenario is not a big task there are several ways are there to know the location but when the all nodes are moving and positions are changing continuously then it is a great challenge to find the location of all nodes. Localization can be done in such scenario using GPS, by attaching GPS unit to all nodes in the network it is a costly solution. Apart from that GPS will not give results in some cases like the atmospheric or topographical obstacles i.e. dark forest, large rows of highlands in such scenario line of sight (LoS) is not clear for GPS[1-3]. The size of node for deployment in many applications is need in small size but after adding GPS module and its apparatus size of the node will be bulky. Due to high power consumption from GPS module and constraint for limited battery life for the sensor node the life time of the network is reduced.

GPS is always suitable for the resources where no constraints are for hardware and climatic conditions are very good. GPS cannot be used with resource constraint and bad environmental condition. Due to such things which will work in this punitive environment which is dynamic in nature and must be easily deployable. Localization algorithm can give solution to such problems where localization accuracy will be increased and average localization error will be minimized with less energy consumption and can support to dynamic environment where all nodes are moving continuously.

To address this issue we have presented here an algorithm for localization which works on cooperative approach among all sensor nodes. Localization techniques are classified into range based and range free localization. Presented algorithm falls in range based localization. Before to proceed for implementation of the efficient localization algorithm need to understand all range based techniques such as RSSI, TOA, AOA, TDOA, trilateration and triangulation which will work under scenarios where every node is moving [3-4]. For implementation point of view we have chosen trilateration techniques where after every fixed period of time interval the location of the all nodes will update current location as well as predicted location for next interval period. It means we will get the current and predicted locations concurrently. The change between the expected position of nodes at previous interval of period and the actual location of nodes at next interval period known as a localization error. In our paper we tried to minimize the localization error. In range based technique till now various

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tactics has been presented with explicit hardware to improve accuracy by using distance and angle between two nodes.

Till now different approaches has been projected with hardware module fitted with nodes explicitly in range based technique to receive a fine accurateness by measuring distance or angle between two nodes where at low costs range free techniques provides coarse accuracy. In mobile wireless sensor network mobile anchor node that is aware about their position using GPS continuously moving across the sensor area and broadcast their locations after fixed time of interval. All unknown sensor nodes in the proximity of the anchor node receive the broadcasted message and based on the same they able to compute their current location.

To do localization for the stationary nodes many algorithms were available but while nodes are mobile its quite challenging. In this algorithm every node maintains a list of neighbors in its proximity and by making a pairing with two nearest neighboring nodes. This presented localization algorithm solves a set of trigonometric equations for the coordinates of the unknown node's location.

To avoid communication overhead by using antennas to assess the position of nodes and giving the routing data and its comparative location to neighbors in the network. Unknown nodes are those who do not know their location and can compute their location from anchor nodes along with predicted location for the moving node's direction to achieve a better accuracy as outcomes. By keeping utilization of minimum energy along with efficient location estimation of the sensor nodes. Entire network lifespan can increase by saving the energy of all sensor nodes with selective approach algorithm [5-6].

II. PROPOSED NODE LOCALIZATION ALGORITHM

The position of each moving node needs to be traced regularly over the period of time after fixed interval period. Predicted position of a node that is moving with constant speed v at instance of time at t seconds will be on the circle where centre of the circle is nodes current location and product of the speed and time of the node. Here challenge is to discover the actual location of every node at fixed time period 't'.

Localization Algorithm

The localization algorithm is presented hereby where the starting location of all nodes will be from random point and moves continuously with some fixed speed. All nodes are able to send and receive the data about their location of neighbors.

This algorithm needs some prerequisite and assumptions. In this scenario node density is to be maintained in the network to have at least two neighbors in their proximity. As Fengqui Y. et.al.presented the starting locations placement is done randomly for all nodes. As we know that every node must be maintained a list of neighboring nodes so that using cooperative approach where distance between this two nodes can be calculated using Angle of Arrival (AoA),Time of Arrival (ToA), Time Difference of Arrival (TDoA) and Received Signal Strength Indicator (RSSI), etc[5].

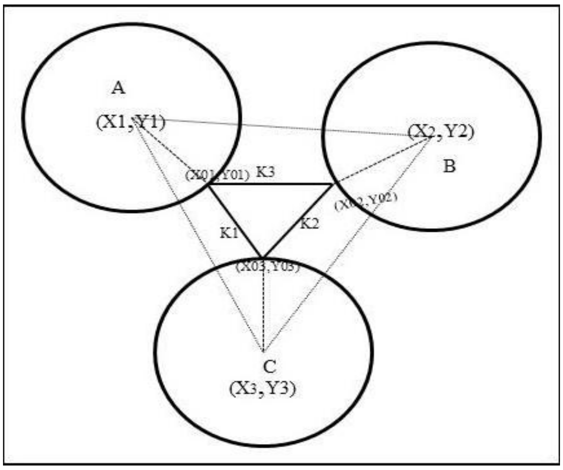

Fig. 1. Neighboring Nodes estimating position

In figure1 node A, B and C are each other's neighbor and $(x_{1,}y_1)$, $(x_{2,}y_2)$,$(x_{3,}y_3)$ are location of the nodes respectively.

From Figure 1, we find the trigonometric equations as follows:

$$(x_{01} - x_i)^2 + (y_{01} - y_i)^2 = R \quad (1)$$
$$(x_{01} - x_{02})^2 + (y_{01} - y_{02})^2 = k_3 \quad (2)$$
$$(x_{01} - x_{03})^2 + (y_{01} - y_{03})^2 = k_1 \quad (3)$$
$$(x_{02} - x_{03})^2 + (y_{02} - y_{03})^2 = k_2 \quad (4)$$

Here i = 01, 02, 03.

Whereas coordinates of the predicted positions are denoted as a $(x_{01,}y_{01})$, $(x_{02,}y_{02})$,$(x_{03,}y_{03})$ for circle a, b and c respectively. By solving such trigonometric equation we will get six unknown coordinates values.

III. THE PROPOSED ALGORITHM DESCRIPTION

Step 1: After every fixed interval period of t seconds, all nodes send a beacon message which consist of the node id and their current position.

Step 2: On reception of beacon message from neighboring nodes, every nodes prepare a list of neighbor in their proximity and maintain a list of neighbors.

Step 3: Ultimately all nodes also has the information of list of neighbors of their immediate neighbors.

Step 4: To apply trilateration methods need to select any two nodes from their neighboring list to find the exact position.

Step 5: By solving given computation for$(x_{i,}y_i)$, where i=1 to 5. If the results are the unique, the location information is correct. If any difference in results need to repeat step no.3 to step 5 .

$$d = \sqrt{(x - x_i)^2 + (y - y_i)^2} \quad (5)$$

In presented algorithm we used set of nodes are moving with constant speed estimates the location data of neighbors of neighbor. Where all nodes start randomly with fixed constant speed *v*. To obtain the distance amid nodes we used trilateration technique to compute location of unknown node.

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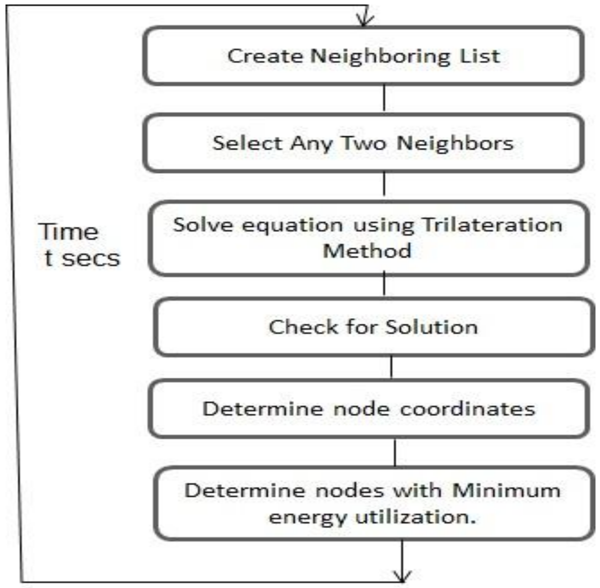

Fig 2: Proposed Algorithm steps.

As shown in figure 1 the distance as a length AB, BC and AC computed and from this the location of node will be obtained. Once predefined fixed interval time period of interval 't' seconds the all steps will be repeated. To fix each nodes position they choose a neighbors from their neighbor list as shown in figure 2and get it fix the position. Same time while fixing current location of node also predicts its predicted position using nodes speed v and the time period interval 't', here we get the predicted position. For next time interval of 2t result value will be computed as a actual output position of node. Here will get the localization error as a variance between the actual location as well as predicted position of the node [7-9].

IV. EXPERIMENT SETUP

Simulation Scenario

Here while setting up an experiment the scenario we have taken as localization of mobile nodes where the positions of nodes are moving in arbitrary direction continuously [10]. We considered the size of network as 100*100 in simulation scenario where node density is chosen as 6 nodes. The range of communication is chosen for communication between two nodes over the maximum distance is 6.5 m [11-13] .

Here in the scenario all nodes are moving with fixed speed, where the location of each node is calculated after every fixed interval of time 't'. AT every interval of time 't' algorithm gives us one predicted location and another is actual location. We considered as estimated position i.e.$€_i$and real position i.e. $£_i$. Here localization error denoted as τ_i can be determined using the difference between the actual and predicted position i.e. $\tau_i = |£_i - €_i|$

Localization error will be calculated for each node and then by averaging the error of localization for all nodes it is called as ALE.

ALE can be calculated by taking root- mean -square error of all nodes divided by number of nodes present in the network. Here by taking the difference between the coordinates of predicted location and actual location for that interval value of each node [15-16].

Node Configuration

Sr. No.	Parameter	Details
1	llType	LL
2	macType	Mac/802_11
3	ifqType	Queue/DropTail/PriQueue
4	ifqLen	50
5	antType	Antenna/OmniAntenna
6	propType	Propagation/TwoRayGround
7	phyType	Phy/WirelessPhy
8	channelType	Channel/WirelessChannel
9	topoInstance	$topo
10	energyModel	$opt(energymodel)
11	rxPower	0.6,0.8
12	txPower	0.9,1.2
13	initialEnergy	$opt(initialenergy)
14	agentTrace	ON
15	routerTrace	ON
16	macTrace	OFF

V. RESULTS AND ANALYSIS

In this result and analysis we got result for each node on different time interval. To do analysis we used output file which is generated from system. This analysis can be done by two ways i.e. node based approach and time based approach. We will check it by doing analysis on node based approach.

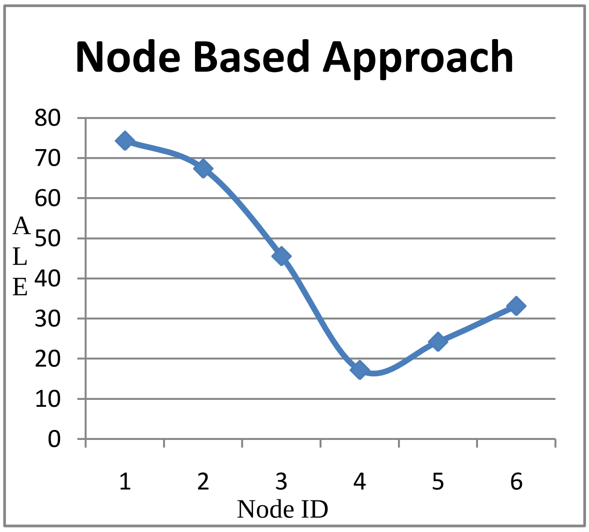

Fig 3: Node based Analysis

As shown in Figure 3 graph for node based analysis, localization error for all nodes taken into consideration and after taking average of all nodes on different interval time period. On node 4 the localization error is minimum. It means at different time interval after taking average of localization error for all nodes we found node 4 is getting minimum localization error over all time intervals prescribed in scenario.

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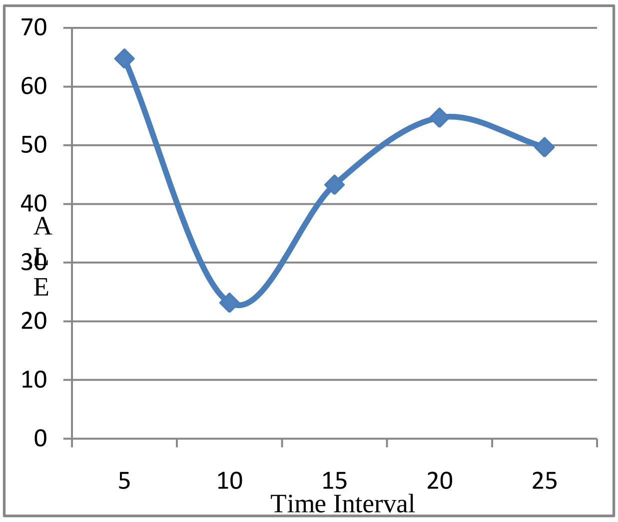

Fig 4: Time Based Analysis

In this result and analysis we got result on different time interval for all nodes. To do analysis we used output file which is generated from system. This analysis can be done by considering time based approach. We will check it by doing analysis on different time interval used in scenario. As shown in graph of figure 4 for time based analysis approach, at which time interval nodes gives minimum localization error out of all time interval period. As shown in graph localization error is gradually decreasing and its lowest value for time interval 10 where nodes average localization error is minimum. If we use this time interval efficiently for localization we will get the minimum value for localization error for all nodes.

As far as energy consumption calculation is concerned our objective is very clear that we want to identify at what time interval which node gives minimum localization error with minimum energy consumption.

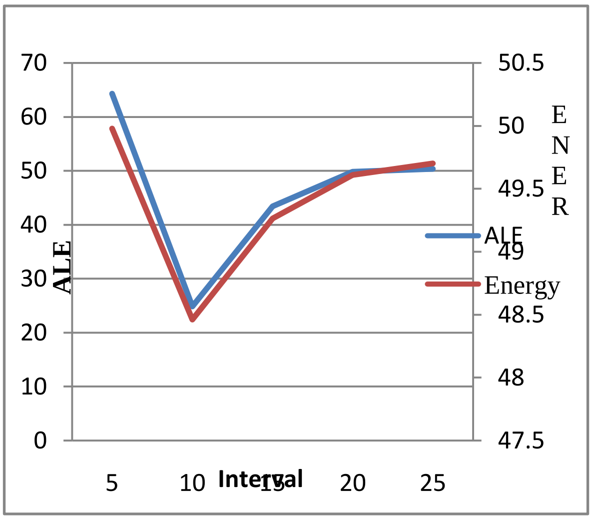

Fig 5: Minimum Consumption of Energy with Minimum ALE

We have used energy model with 50 Jules for each node at start and after completion remaining energy with each node for different time period. As shown in figure 5 on time interval 10-15 msec is giving minimum consumption with minimum Average Localization Error (ALE).

VI. CONCLUSION

We presented an algorithm for the mobile WSN, where the available localization algorithms are not suitable for given scenario. Hereby making pair with two neighboring nodes using cooperative approach of trilateration method in iterative fashion. We found the effective and efficient time interval for the average localization error with minimum energy consumption. In future efficiency will be optimized by taking more neighbors for fixing the location of unknown node, four neighboring node will give more scope to go with accuracy which will help to reduce the localization error.

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