Sensing networks with location-based routing

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Abstract: In a wireless sensor network, we first combine check, track, and trace to incorporate various functional capabilities. Check indicates the ability to sense what is going on in the world. Tracking is locating objects in their current location, such as a hospital or warehouse. Trace refers to the ability of lock sensors, also known as smart points, to access the history of sensor measurements when they are not connected to the network. This thesis discusses the location-based routing protocol in wireless sensor networks. In this thesis, we propose a modified DV-hope approach for correcting distances between normal and anchor nodes. Localization error for individual nodes is improved when compared to the usual DV-hop, and total accuracy is enhanced. Localization algorithms have played a significant part in localization systems. During this phase, the position of all nodes in sensor networks is determined using various localization algorithms, with the help of distance and angle information from the distance or angle estimation component and node location from the position computation component. Researchers and scientists have introduced numerous localization algorithms in wireless sensor networks. Based on it, localization methods are divided into two categories: (I) range-free localization and (II) range-based localization. Range-based localization determines the position of all nodes using ranging information such as RSS, AOA, and TOA. Accuracy is good for range-based methods, but the cost is high due to the need for additional hardware such as antennas. Another disadvantage of range-based localization is that ranging data is influenced by external factors such as multipath fading and noise. In range-free localization approaches, the position of the nodes is determined using the connectivity between the nodes in WSN. As a result, the cost of using range-based localization is lower because no new hardware is required. Range-free localization algorithms are robust, which means that the connection information is unaffected by environmental influences. Therefore, we concentrate on range-free localization.

The suggested method improves localization error for individual nodes as compared to standard DV-hop, as well as overall accuracy.

I. INTRODUCTION

In the early 1970s, the United States military established the notion of wireless sensor networks. Following then, numerous theories and projects were introduced and implemented for WSN. The preliminary model of WSN with existing point-to-point transmission is known as the first generation of WSN. DARPA of the United States of America first introduced the DSN program in 1979. It is a new area in the vast spectrum of wireless networks that is specifically designed to measure small amounts of data, which is frequently obtained through sensor data. Temperature sensors or open-close sensors that provide SMS notifications when the door is open or closed. These small pieces of information are extremely significant to businesses because they provide insight into potential differences in business operations. We developed systems based on devices that are autonomous because they have a CPU, memory, sensors, and, of course, wireless connection, and they conduct a set of operations. In WSN, we mix check, track, and trace to incorporate various function capabilities. Check indicates the ability to sense what is going on in the world. Tracking is locating objects in their current location, such as a hospital or warehouse. Trace refers to the ability of lock sensors, also known as smart points, to access the history of sensor measurements when they are not connected to the network. Wireless sensor networks are becoming a significant study subject in today's society as wireless communications and micro electromechanical technologies progress. A wireless sensor network consists of sensor nodes that detect physical phenomena such as temperature, pressure, humidity, and vibration. Each sensor node delivers sensed data to the base station or central controller on a continuous or regular basis, depending on the application. There are two methods for monitoring a relevant region's node deployment, depending on its physical accessibility. If the region is physically accessible, regular deployment is achievable; otherwise, nodes must be deployed randomly via low-flying aircraft in the monitoring region.

In WSN, the base station (BS) sends queries to all nodes to monitor specified physical parameters in the network, and the other nodes provide responses.

Depend on application BS can send three kinds of queries are:-

[1] One time queries: In these nodes needs to reply current data to BS.

[2] Persistent queries: In these nodes needs to reply periodically to BS.

[3] Historical queries: In these nodes needs to reply historical data to BS.

Due of limited energy, the nodes respond to the BS in a multi-hop fashion. The primary purpose of a wireless sensor network is to collect data from the physical environment via sensing and communicate it to a central controller, making environment monitoring much easier. In WSN, nodes do not need to communicate directly with the central controller or base station, as they do in cellular networks. WSN nodes communicate with their local peers.

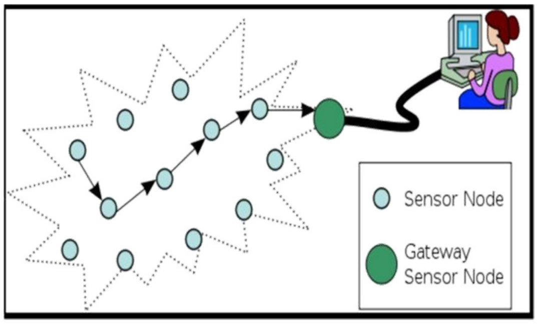

Fig.1 Typical Structure of the WSNs

II. PROBLEM DEFINITION

There are lots of methods has been introduced in the literature for localization. For some of them extra hardware is required which are depends on the range based information. Consequently these methods are not suitable due to additional cost. Later other methods which are based on connection not on range information. Thus these methods are suitable for WSN due to their no extra hardware and robustness. The most of methods (cancroids, APIT and CPE) which are based on connectivity needed at least three reference (or anchor) nodes in the neighborhood for obtaining the location of ordinary nodes. But in case of the DV-hop this condition is not required satisfy by each ordinary node. Thus by using the DV-hop ordinary node can obtain its coordinates even when it is having less than three anchors in neighborhood. In case of the random deployment various ordinary nodes does not have three neighbor reference nodes

III. PROPOSED METHOD FOR LOCALIZATION

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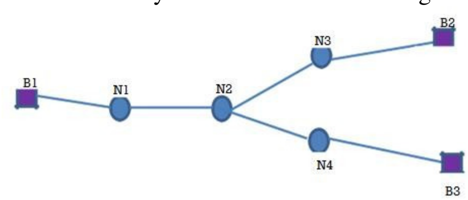

Fig.2 Example state of the network

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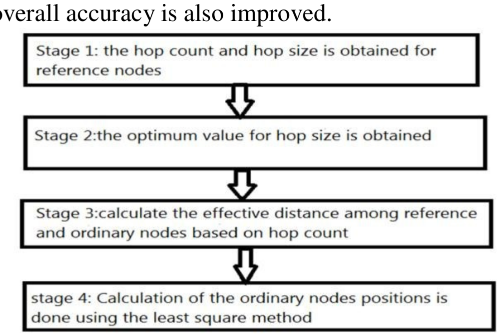

Fig.3 Stages of modified dv-hop

IV. EXPLANATION

The explanation of the above proposed scheme stages is given below:

Stage1: In this stage every anchor or reference node transmits a message to all the nodes in the network. The transmitting message contains the node id, hop count value and position of the reference node. After receiving the messages every node keeps the lowest value of the hop count from the every reference node and if node receives greater value of hop count from same reference node then it will reject that value. Whenever node send receive message to neighbours then it will increased the hop count value by one. This is the step one of the conventional DV-Hop. After the step 1 of conventional DV-Hop every reference node knows the position and hop count of the other reference nodes. The average value of the hop size for each reference node is obtained by using below equation 4.

$$hopsize_m = \frac{\sum_{n \neq m} \sqrt{(X_m - X_n)^2 + (Y_m - Y_n)^2}}{\sum_{n \neq m} hops_{mn}} \quad (4)$$

Where (Xm,Ym) and (Xn,Yn) are the co-ordinates of the reference node m and node n.

Hopsmnis the least value of the hop count among reference node m and n.

Therefore, this stage is combination of the step 1 and step 2 of the conventional DV-Hop.

Stage 2 :In this, hop size obtained in stage 1 is modified using the difference of actual and estimated distance among the reference node m and n, by using the below formula.

$Hopsize_m = Hopsize_m + \sum_{n \neq m}(actualdistance - estimateddistancemn/Hopsmn$ Equation 5

$WhereEstimateddistance = Hopsize_m * Hopsize_{mn}$

$Actualdistance = \sqrt{(X_m - X_n)^2 + (Y_m - Y_n)^2}$

(5)

Stage 3 :In this, effective distance for each ordinary node from the reference nodes is calculated based on hop count.

If (hop_countmn==1) then

dmn = shortest distance among reference node m and ordinary node n.

Else

dmn = Hopsizem * hop_countmn.

Where hop_countmn is value of hop count among ordinary node n and reference node m.

Stage 4 :In this, with help of the least square method coordinates of the ordinary nodes is obtained similar to the conventional dv-hop.

Performance :Performance of the proposed approach is evaluated in terms of the localization error per node and percentage localization error. The proposed approach provides better results compares to the conventional DV-Hop. Localization error and percentage localization error is evaluated using below formula:

$$Localizationerror = \sqrt{(X_m - x_m)^2 + (Y_m - y_m)^2}$$

$$percentagelocalizationerror = \frac{\sum_{m=1}^{n} \sqrt{(X_m - x_m)^2 + (Y_m - y_m)^2}}{n * R} * 100$$

Where (Xm, Ym) and (xm, ym) are the actual and estimated co-ordinates of the ordinary node, n is the number of ordinary node and R is the communication range of the node.

3.2 Proposed Weighted Clustered Response Approach

Topology of the WSN can be obtained at the central node or monitoring node by originating the topology discovery query to the all present node in the network. Nodes that receive the topology discovery query send the response message to the monitoring node. The response message can be send to the monitoring node in the form of direct, aggregate and clustering.

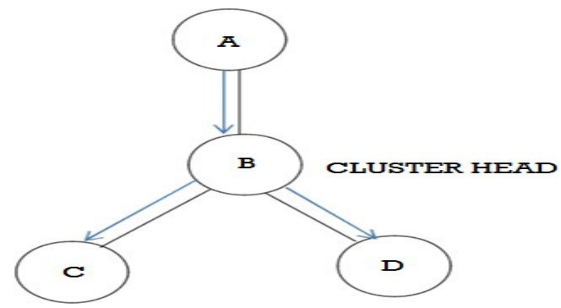

Fig.4 Structure of Clustered Response

In figure 3.3, monitor node A send the topology discovery query to the node B which is a cluster head and node B forward topology discovery query to all the nodes in the cluster. Finally collect the response from every node in the cluster and send it to the central or monitoring node A. In this way all nodes doesn’t required to send response individually or direct to the monitoring node. Among three ways of sending the response message clustering is preferred because of the overall message overhead is reduced. But in case of clustering the overhead depends on the number of clusters. Therefore as compare to the existing approaches efficient clustering is required to solve the problems. There are various limitations on the cluster based network and challenges such as durability of the clusters, efficient amount of clusters and less overhead for communication etc. In the proposed method, efficient clustering is proposed in which various parameters is used for the cluster head election so that above problems can be solved. These parameters are power of node, node mobility, total neighbor of node, rate at which node can send data, positions of neighboring nodes and distance among base station and node.

The proposed approach mainly divided in two steps:

(1) Information exchange: In this step all nodes communicate with each other to calculate the weight at each node and after calculation of weight each node share their weights with the neighbor nodes.

(2) Cluster discovery: This is an important step in which firstly nodes that have highest weight as compare to their neighbor nodes , announce itself as the cluster head and send cluster-finder query to their neighbors. The cluster head considered as black node and rest of the node in the beginning are white color. Those nodes receive the message from cluster head changed their color to the gray and send the message which received from cluster head nodes to their neighbor after waiting for some amount of time delay which is depend on the inverse of weights. Nodes which are receiving message fromgray node become the dark gray. Nodes which having the dark graycolor check their weight in

comparison of their neighbors and for those node weights are high acts as the cluster head and color become black. These nodes sends message to their about the becoming of cluster head and after this announcement node which having color white and dark gray change it to the gray. In similar way node that color is gray send the cluster-finder query in the network until become black or gray means that each node in the network need to be at least member of one cluster.

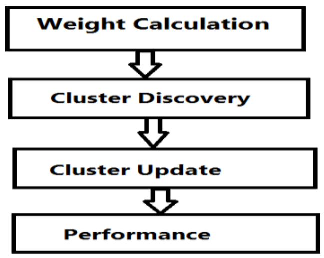

Fig. 5 Block Diagram of Proposed Approach

V. SIMULATION TOOLS MATLAB

Names come from the matrix laboratory. Matlab initiates at the University of the Mexico written by the Cleve Moler The Matlab in fortran language. Further matlab developed in the math works Inc. In this development the main or core part is written in c and graphical user interface written in java programming language. We can run matlab on various platforms such as Windows, Linux and Mac os.

Matlab is very powerful tool for doing the numerical methods of all kinds. Matlab began as tool for doing the linear algebra. Since array is required lots of functionality even though still has the kind of linear algebra field too it can do just about any problem we need to address. It runs on the platforms which are nice and some built in tool box are present in the matlab. If want to add more functionality in matlab then we have to purchase the tool box which are not freely available. These tool boxes are useful for solving problem of the optimization, control methods and image processing etc.

Matlab User Interface:

It is not as the graphical user interface (GUI) oriented as it might be custom too. It is quite powerful and so encourages us to stick with it for while we can have command line orientation. In matlab we can simply open the command line window and type the command the command, we get the output so therefore it is more interacted in this case. But problem will arise when we want to store results. Any how we can save the output but input can't be store. The ways to interact with matlab is m-files or scripts. It has .m file extension. In matlab in-built editor also there so we can easily type the programs and get output by running the .m scripts.

Strengths of the Matlab

- Matlab is very easy user can learn it easily.
- In matlab with the help of the matrix operations optimization of the code easily performed.
- Any computation can be performed as like the calculator and error can easily find and fixed.
- Initially matlab is a procedural but later functionality of the object oriented are added.

NS2

NS2 is event driven, object oriented simulator in which whole process is interpreted as the group of events and which are executed in predefined order. By using this simulator we can forecast the performance of the proposed system and we can also see that how proposed system performing in the comparison of the previously developed and implemented schemes. NS2 was originated at UCB Berkeley and maintenance is done at the USC. The mainly this project is developed to use by researchers and educators for their research work. It is freely available on internet means open source tool.

Program in NS2 contain four kinds of scripts:

- TCL Script which is common and simple script language (.tcl)
- Trace file (.tr)
- Network Animator(NAM) (.nam)
- Awk Script (.awk)

Usage of the scripts

.tcl and .awk files are created by the programmer. .tr and .nam both are bring out automatically when .tcl and .awk files are executed.

.tcl

It has the code for Node creation ,Node configuration Communication establishment between nodes creating of .tr and .nam files Executing .nam and .awk files.

.nam

Events in the .tcl script are traced and entered into .nam file. This generated code will produce the animation in Network Animator Window (NAM).

.tr

Events in the .tcl script are traced and entered into .tr file. It contains many lines. Each line comprises number of fields, each separated by the space. Each line specifies an event. Frequently used fields are explained below:

.awk

AWK script is used to extract the required information from the code available in .tr file as the .tr file has the many fields. Output of awk script will give the performance measures and also the x and y parameters to be plotted in a graph.

VI. PERFORMANCE ANALYSIS SIMULATION RESULTS

The proposed localization technique is simulated in matlab 2012b and then proposed topology discovery scheme is simulated in ns2. Here, performance is compared with the existing approach. The simulation results are given below:

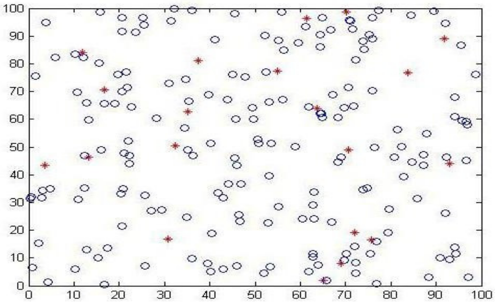

Fig. 6 Distribution of the nodes

In above figure, the anchor nodes and unknown nodes are deployed in 100*100 areas. By changing the different parameter such as anchor nodes and communication range of the nodes, simulation is done for percentage localization error.

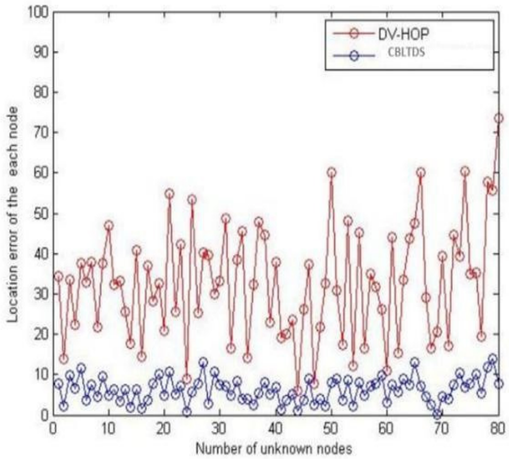

Fig.7 Comparison graph for localization error for each unknown node

In the above figure, for each node the localization error is compared between CBLTDS and existing approach. Here, x-axis shows the number of unknown nodes and y-axis shows the location error of the each node. Error is calculated for 80 unknown nodes in the presence of the 20 anchor nodes and communication range is 50m.

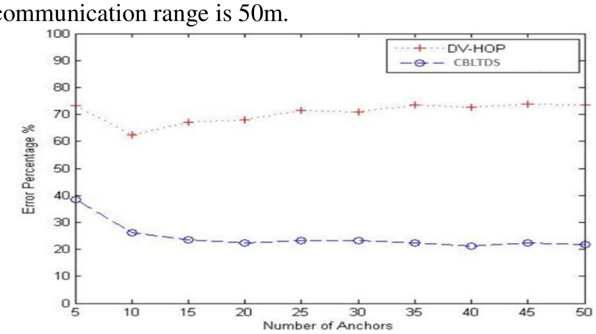

Fig. 8 Error percentage verses varies number of anchor nodes

In the above diagram, it shows that error percentage with varies number of the anchor node for CBLTDS verses existing conventional DV-Hop, when number of the nodes is 200 and communication range is 100m.

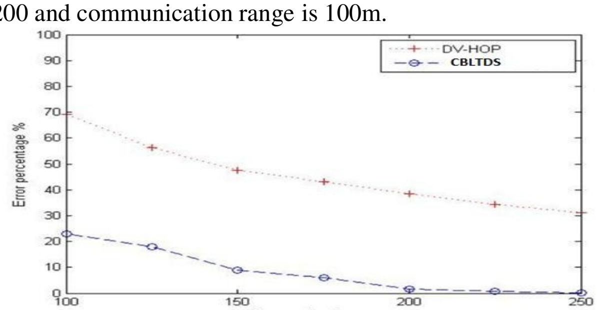

Fig. 9 Error percentage verses varies communication range

In above diagram, when number of the nodes is 200 and anchor nodes are 20, error percentage (y-axis) with varies communication range (x-axis) for CBLTDS verses existing conventional DV-Hop.

Table 1: Simulation Model

SIMULATOR	Network Simulator 2
NUMBER OF NODES	15
TOPOLOGY	Random
INTERFACE TYPE	Phy/WirelessPhy
MAC TYPE	802.11
QUEUE TYPE	Queue/Droptail/Priqueue
QUEUE LENGTH	50 Packets
ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	Tworay Ground
ROUTING PROTOCOL	AODV
TRANSPORT AGENT	UDP
APPLICATION AGENT	CBR
SIMULATION TIME	50seconds

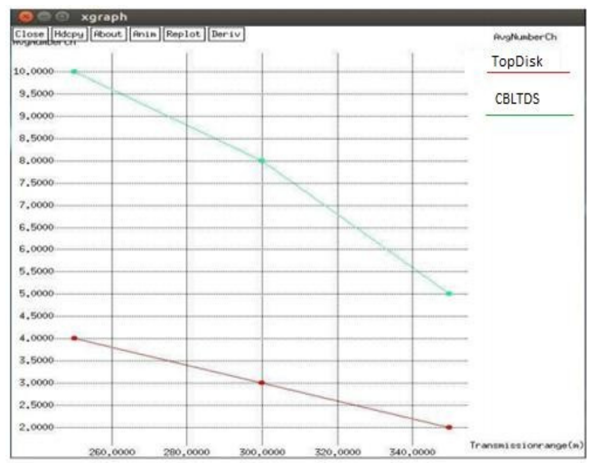

Fig. 10 Average cluster head verses transmission range

In above diagram, it shows that the average cluster head (y-axis) with varies communication range (x-axis) for the CBLTDS verses existing method TopDisc.

In below diagram, it shows that the ratio of cluster head(x-axis) with varies number of nodes(y-axis) for CBLTDS verses existing method TopDisc and ratio of cluster head is calculated by using the below formula:

Ratio of Cluster heads = Number of cluster Head / Total Number of Nodes * 100

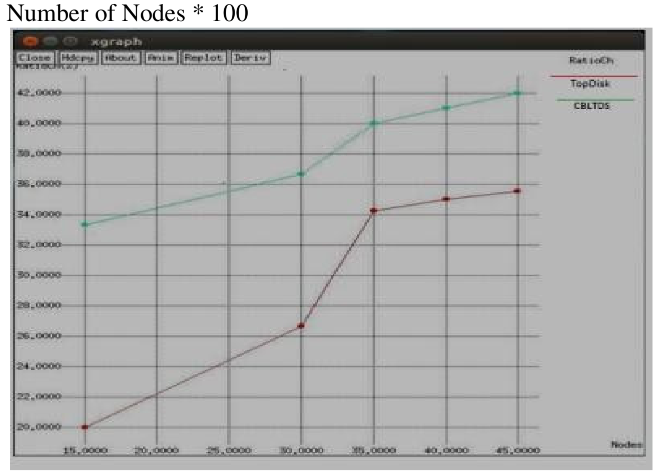

Fig.11 Ratio of the cluster head verses number of nodes

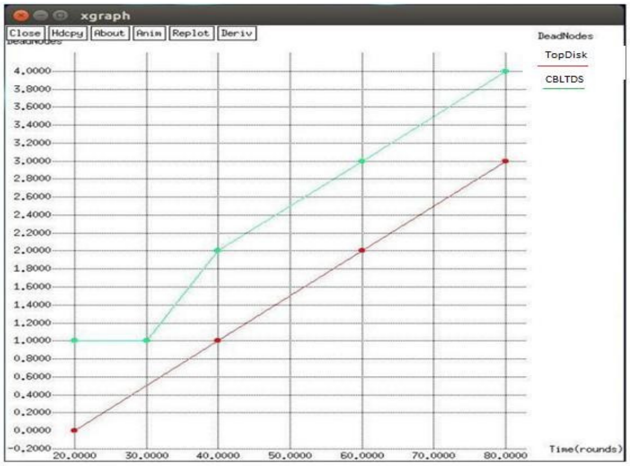

Fig 12 Number of dead nodes verses rounds

In above diagram, it shows that the number of dead node (y-axis) within the time (x-axis) for CBLTDS is less as compared to the existing approach TopDisk. So that lifetime of the network is increased of CBLTDS.

VII. CONCLUSION & FUTURE SCOPE OF WORK

Conclusion

This thesis proposes a modified DV-Hop method for localization and a weighted clustered response strategy for topology discovery in wireless sensor networks.

Simulation results reveal that the proposed approach for localization has the lowest error when finding each unknown node's coordinates. As a result, when the anchor nodes and transmission range are changed, the localization method's accuracy in terms of average localization error improves when compared to standard DV-Hop. The proposed method for topology discovery in WSN outperforms the previous methodology in terms of average cluster heads, cluster head ratio, and network longevity, implying that the topology discovery method is also more stable. As a result, clustering is triggered less frequently for topology discovery..

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