QOS- Reliable Localization Protocol Using Drichlett Tessellation for WSN

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Summary
Localization is considered of great importance in the design and working of WSN. The current successful technology employed to solve the localization problem is the DV-Hop. This algorithm aims at converting distance to beacon nodes from hops to meters by computing the average size of the hop. The communication cost and energy consumption are the major disadvantages of this algorithm which limits its applications to small and middle sized networks. This paper explains about the efforts taken to the refinement of the existing DV-Loc algorithm which is a refinement of the DV-Hop algorithm.

Key words:
WSN, DV-Hop, Drichlett Tessellation, Localization.

I. Introduction

The advancements in low power electronic devices coupled with wireless technologies and sensors bring forth a new era. WSN's which are relatively of less cost and can be deployed at various settings to sense variety of properties like temperature, light, acoustics and pollution. In WSN to track or to locate the unusual events or changes we should be aware of the location of occurrence hence localization is important.

A widely accepted localization algorithm is DV-Hop Localization system which converts all the distance onto beacons from hops to standard measurement units using a correction factor which is the average size of the hop. A typical example of this is Ad-Hoc Positioning System [APS]. DV-Hop technique has its own advantages and few disadvantages. The considerable advantage is that it is resistant to the inaccuracies occurring due to Received Signal Strength and it involves only few beacon nodes and its calculation of distance from hops to other units results in errors.

In recent years, in order to better understand the drawbacks of D-Hop localization as well as to reduce its localization error, several extensions to original DV-Hop scheme have been proposed.[5-7]. Hop Terrain [5] was designed to decrease the final localization error by adding refinement phase to algorithm.

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In our paper we have used DV-Hop Localization system, our Drichlett Tessellation and reduce flooding and occurrence of errors in computing positions.

II. Problem statement

A WSN composed of 'n' nodes possessing a range of communication of 'r' units which are distributed in square filed such as Q= [0,s] * [0,s] because in Euclidean graph each node has Coordinate (x_i, y_i) ε R^2 in a 2D. For simplification we have considered 2D and symmetric communication such that for any two nodes u and v , u reach v if and only if V reach u . Consider a graph G=(V,E) ,V= { v_1, v_2, _ _ _V_n } set of sensor nodes and (i,j)ε E if V_i reaches V_j ,that is distance between V_i and V_j is less than r. w(e) ≤r, is the weight of the edge.

III. Localization problem

Considering a network which uses multi hop communication represented by graph,G = (V, E) with beacon nodes of position (x_b,y_b) , so we find all positions of unknown nodes (x_u ,y_u) and set these nodes into settled nodes. In our system the nodes present in the network receive the information about the beacon nodes and propagate the information about the position including the distance unit to the beacons. The algorithm complexity is determined by O(n(b+1)), here b represents beacon nodes and n represents nodes.

IV. Distributed Voronoi Localization algorithm

Our work which will include DV-Hop localization solution using Drichlett Tessellation limits the occurrence of flooding. In this we deploy beacon nodes along with unknown nodes in sensor field and are divided into levels. Let us consider taking the first four beacons at the first level and next four at second level and eight at the third level and 16 at the fourth level. We have four working levels.

1. The first level of beacon node will forward packets and save the position and hops from nodes to beacons.
2. When the node receives the packets they build a Drichlett Tessellation depending on the first level beacons position, if the distance from the node to more than one beacons are the same then we use Received Signal Strength Indicator to break the tie.
3. The average size of the hop will be computed for second level based on the first level beacon nodes position information same process will be taken over to identify the average size of the hop for other levels comparing the former level position node position.
4. After a timeout when no beacon packet is received the distance to beacon from hop to distance units based on calculating the average hop size obtained from the beacon nodes. Node checks whether the calculated position is outside the Drichlett tessellation if the calculated position is outside the Drichlett tessellation point the node rearranges its calculated position to nearest point inside the Drichlett.

This algorithm calculates the information about the position in different manner

1. Localization of node depending on its physical position calculated using multilateration.
2. If used in WSN applications nodes will be localized in Drichlett tessellation.

Analysis of complexity

We consider the beacon nodes in the first level as 4 then the number of second level will be the number of nodes of the former level and for the third level the number of nodes will be the total number of previous two levels 4+4=8, then the number of nodes is the fourth level if considering the number of nodes in the previous levels.

Cost of communication

In our algorithm the position level of the first level beacon nodes will be flooded, with nf a lower bound communication cost and when proceed to the consecutive steps a logarithmic factor would be found in flooding cost; communication factor changes to nf+ nlog b; where b is the total number of beacons comparing to the APS algorithm [4] the communication cost is n(b+1) we find the variation of Drichlett tessellation more scalable.

Cost of computation

This algorithm is considered cheaper than regular DV-Hop algorithm because it uses less processing resources.

- To calculate the Drichlett tessellation point the node needs b -1 float operations and b' represents the number of beacons with information which is of f + log (b-f) where f=4 is the beacon node at the first level and log b which is beacons from consecutive levels.
- The process of multilateration requires (b' + x/3)x^2 operations where x is number of unknown variables which x=2 and it is expensive and in DV-Loc algorithm b'=f+log (b-f) which is true but in APS it is b'=b. In this algorithm we don't have to calculate the Drichlett tessellation point of the node at every step because the no. Of hops to reach the beacon node can be used to locate the cell of the node. We have to just identify the nearest beacon which is o (b'). Thus our works prove that the cost of computation is lower than APS.

Performance assessment

We perform a comparison between the APS algorithm which can also be termed as the DV-Hop algorithm.

Methods used

We have used a sensor field with 92 x 92 m^2 which has 256 nodes where 32 has been chosen as beacon nodes in our simulation experiment which was performed using NS2. The simulation results are based on MicaZ sensor nodes which uses 802.15.4 standard and a communication range which is 15 m fixed for every node. The curves on the graph represent the average values and the bars represent 95 % confidence for 33 seeds.

Analysis of errors

Cumulative error represented by percentage of nodes (y-axis) with an error smaller than parameterized value (X-axis) the sharp curve in the graph depicts that most of the nodes have a smaller error because the algorithm directs the occurrence of errors to the Drichlett tessellation cell. The fig 3b and 3c represents a one directional arrow from true position to the computed position.

Network scale impact

We analyze the scalability by altering the network size we populate the nodes with constant density of 0.03 nodes/m^2. The similarities in both the algorithms are the fixed size of the beacon nodes remain 32. The graph in 3[d] represents the packets sent in this algorithm is relatively small when compared to APS and increases slowly.

Beacon scale impact

When the density of the node increases it leads to localization error it could be dealt with deploying additional beacon nodes in the network to minimize the localization errors. But deployment of beacon nodes increases the cost of communication.

V. Relevant findings

Various works have been proposed for localization problem APS [4] is an example of distributed multihop DV-Hop Localization system. Hop Terrain [5] is similar to APS. It calculates the position of the node in APS, DV-Hop and has a betterment phase where localization errors are reduced.

RPE-Recursive Position Estimation helps to determine the information about the position recursively beginning from nodes to beacons but this is suitable only for low density networks.

DPE is another relevant algorithm which uses only the direction of recursion and eliminates few problems of RPE. Localization with mobile beacons [11], the mobile beacons broadcast the message with current co-ordinates in the sensor field. It calculates the position relying on relevant co-ordinates and RSSI distance estimation.

Other works like convex optimization [12], multidimensional scaling [13] or semi definite programming [14] are useful to solve localization problem in a centralized manner.

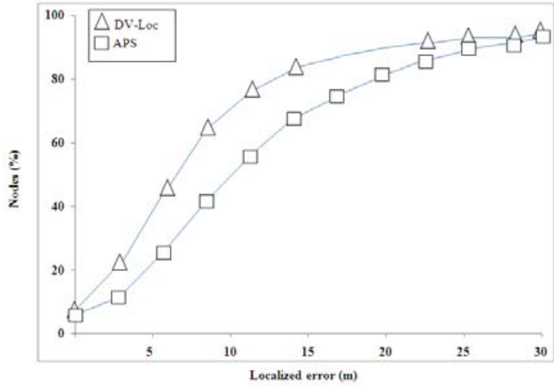

Fig 1: Cumulative error

We consider the nodes being deployed in distributed grid and the random zero Gaussian error disturbs the location of node and the nodes tend to occupy the sensor field uniformly.

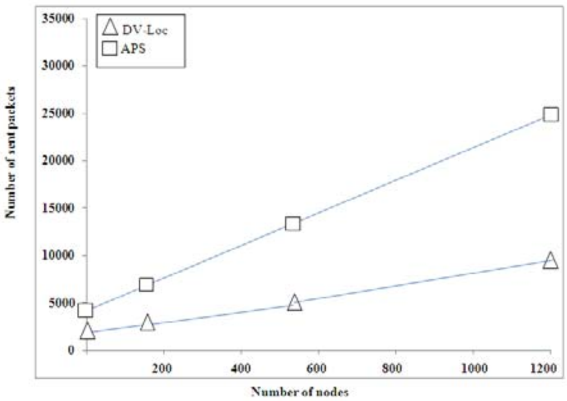

Fig 2: Network scale.

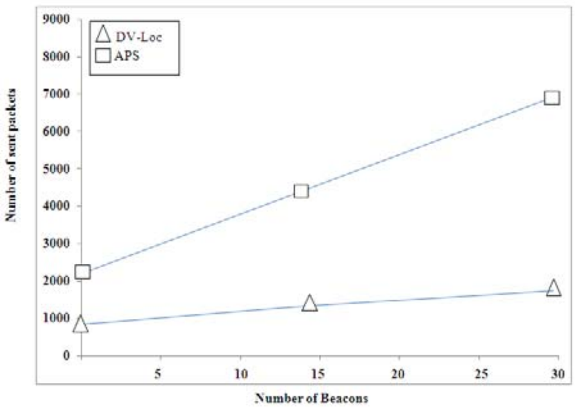

Fig 3: Beacon scale

VI. Future direction and conclusion

In a paper we have employed Drichlett Tessellation and it is a refinement of DV-Loc. It uses the Drichlett tessellation and helps in development of robust and scalable WSN. Our works prove that our algorithm helps in reducing the errors occurring during localization and utilizes the less processing resources than the other algorithms.

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