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Performance Analysis of Range Free Localization Schemes in WSN-A Survey

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Abstract : In order to design an efficient sensor network, localization of nodes is an important aspect. Nodes present in the sensor network need to send and receive data in order to carry out the communication. For the communication to be carried out in an effective manner each and every node should be aware of the location of all the nodes present in the sensor network. Various localization schemes has been devised. In this paper, the comparative analysis of range free localization techniques are studied, discussing about its basic terminology and how the future work could be carried out.

Keywords : Localized, unlocalized, anchor nodes, distance, angle.

1. INTRODUCTION

Wireless sensor networks have a wide variety of applications such as environment monitoring, military applications, industrial and healthcare monitoring. In all these applications exchange of location information about the nodes is an important aspect. One of the most common approach to achieve localization is through GPS(Global positioning system). Apart from GPS, localization could be achieved through anchor nodes. Location aware anchor nodes help the unlocalized nodes to achieve localization.

2. LOCALIZATION

Localization is the process of obtaining the location information and exchanging it among the nodes present in a sensor network. Obtaining the location information and processing it in accordance with energy efficiency, cost and scalability is a challenging aspect in wireless sensor networks [1]. Localization schemes can be divided in to range based and range free schemes. Distance and angle between the localized nodes are the two parameters that would help to track the location of any unlocalized node. Accuracy, localization error, node density, scalability and capital cost are the parameters that decide on the efficiency of an algorithm [2]. Figure 1 describes how the basic localization process is carried out.

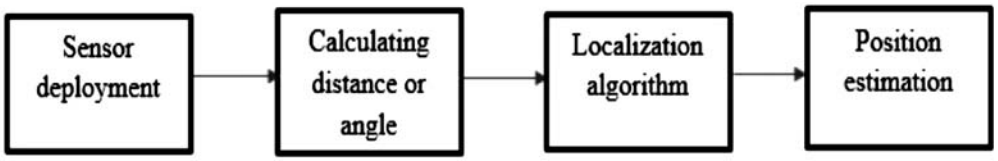

Figure 1: Localization process

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3. RANGE FREE LOCALIZATION

Usually localization is achieved in wireless sensor networks with the help of distance and angle information. Apart from distance and angle information range free schemes utilise hop count, triangulation and multilateration techniques to achieve localization [7]. DV-hop (Distance Vector), Amorphous, APIT (approximate point in triangulation), Centroid and Gradient schemes come under range free localization. Range free mechanisms are anchor based where the anchor nodes help the unlocalized nodes to achieve localization.

In [3] the authors describe that DV-hop algorithm is based on hop count, where the inter hop distance between nodes is calculated using the following formula

$$\text{Hopsize} = \sum\sqrt{(x_i - x_j) + (y_i + y_j)}/\sum h_j$$

In [4] according to the authors in amorphous algorithm all the nodes obtain the neighbour node's hop distance and the position estimation is done by computing the average of all its neighbour values.

In centroid algorithm, unlocalized nodes make use of anchor nodes surrounding them to estimate their position which is computed as centroid of all the anchor nodes surrounding it [5].

In gradient algorithm position estimation is done with the estimation of hop count which gets incremented as it propagates from one node to the other.

In [4] the authors have developed an algorithm named APIT in which location estimation is done by dividing the area in to triangular regions where the sensor nodes are deployed.

4. PERFORMANCE ANALYSIS OF RANGE FREE SCHEMES

Table I describes the simulation parameters and the simulation has been carried out a number of times to obtain average results which are used for performance evaluation. Table II describes the performance evaluation of the range free localization schemes based on various parameters

Table 1

Parameter List

Parameter	***Value***
Area of sensing field	800*800 m
Deployment	Random
Total number of sensor nodes	200
Total number of anchor nodes	40
Communication radius	200 m

Table 2

Performance Analysis

Algorithm	***Positioning Error***	***Anchor Heard***	***Accuracy***	***Scalaility***	***Cost***
Centroid	0.28498	Above 10	Fair	Yes	Los
DV-HOP	0.30731	Above 8	Good	Yes	Medium
Amorphous	0.21156	Above 8	Good	Yes	Medium
Apit	0.31168	Above 10	Good	Yes	Low
Gradient Algorithm	0.3388	Above 7	Average	Yes	Low

In [4] anchor heard refers to the average number of anchors heard by a node. It has been proved that amorphous and APIT attain a better performance when the anchor heard is below 7 and varies improperly when it is above 7.

In [2] accuracy is measured as percentage of sensor transmission range. Accuracy depends on range measurement errors and is affected by the number of anchor nodes present in the network and their placement in the network.

Scalability refers to the total number of sensor nodes deployed in the environment. It varies depending upon the application. Cluster based approach seems to be a better option with respect to scalability [2].

Cost refers to the price per sensor and some extra hardware which may utilised for obtaining the location information. In case of range based schemes extra hardware is needed for localization where as in range free schemes no such hardware is needed.

Positioning error refers to the location estimation error. It is otherwise called localization error. Localization error value shows how the estimated location differs from the actual location. Amorphous algorithm achieves better localization accuracy with the above specified parameters [3].

5. DESIGN FACTORS

It is more challenging to design a localization scheme for a sensor network application since all the limitations like battery power, processing rate, low memory and feasible data rates should be considered in to account[6]. The following are some of the important factors to be considered while designing new range free scheme:

A. Energy Efficient Localization Algorithm

Energy efficiency is an important aspect in any wireless sensor network application. Range free schemes discussed here are not able to achieve a better efficiency in terms of energy. An energy efficient localization algorithm would also help in increasing the network lifetime.

B. Accuracy

Incorrect position estimation would result in exchange of wrong location information. So accuracy should be considered as an important factor while designing a localization algorithm.

C. Anchor Node Density

Percentage of anchor nodes present in the network play an important role as it helps the unlocalized nodes to achieve localization. In general terms anchor node density should be high to achieve a better localization accuracy.

D. Anchor Node Placement

Anchor node placement in a network also plays an important role as the anchor nodes help the unlocalized nodes to obtain their location information through their beacon messages [9]. Anchor node placement should be done on consideration of the following metrics: anchor node localization error, coverage area and the scheme (trilateration or multilateration) utilised by the anchor nodes to achieve localization [8].

6. PROPOSED SCHEME

A combination of cluster head anchor node scheme could be utilised to devise an efficient localization algorithm. Sensors deployed in a random manner form a cluster. Anchor nodes deployed among the unlocalized nodes make use of amorphous algorithm to achieve localization and the placement of anchor nodes is done on consideration with the above specified metrics. Percentage of anchor nodes deployed is 20 since amorphous algorithm achieves better localization accuracy with this particular anchor node density. Once the anchor nodes present in each cluster achieve localization they send the obtained location information to their respective cluster head. After the exchange of location information with the cluster head anchor nodes will move on to sleep state and will return to active state only when the new node enters the cluster. When the deployed anchor node attains sleep state cluster heads with the help of recently localized

nodes helps the remaining unlocalized nodes present in the cluster to achieve localization through centroid algorithm. This particular scheme would help to achieve efficiency in terms of energy and accuracy since amorphous scheme is utilised in accordance with cluster head anchor node combination.

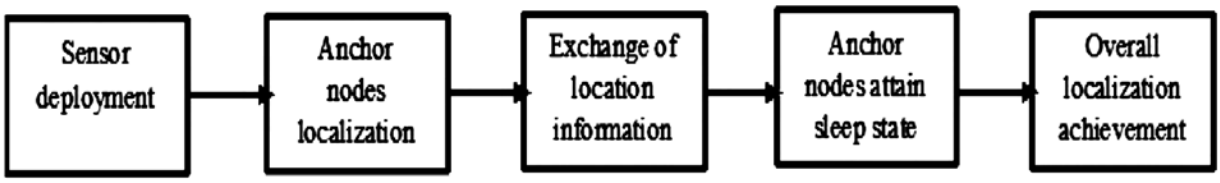

Figure 2: Proposed scheme flow chart

7. ALGORITHM

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Node _unlocalized

Node _localized

FOR EVERY (Node _curNode :_localized)

Node Location Information = Collect Location Information within the range Localized Node to
_curNode

 Node _unLocalisedNodes = getAll Unlocalised nodes within the range

                FOR EVERY (Node _curUnlocalisedNode: _unLocalisedNodes)

                        Collect Location information through amorphous algorithm.

                        Update the location information values to _curUnlocalisedNode

                        Add _curUnlocalisedNode to _localised

                        Remove _curUnlocalisedNode from _unlocalised

                END FOR

        _localisedNode Send Location information to CLUSTER HEAD

        _localisedNode  Goes to Sleep state

        Recently localised node goes to Active state

END FOR
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8. CONCLUSION

Thus an overview about the performance of localization scheme has been discussed in detail. This survey would give a clear idea about the performance issues involved in range free localization schemes which may be useful for a designer in designing a new range free scheme considering all these factors in to account.

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