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Localization of Sensor Nodes in Wireless Sensor Network Using Path Planning Mobile Anchors

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Abstract:- **Localization in wireless sensor network is an important problem as many applications need physical location of the sensor node accurately. Many localization method based on mobile anchor node have been proposed to calculate the location of the randomly deployed sensor node. In the proposed system, we present a path planning technique based on a single mobile anchor node and this is assumed to be provided with a GPS devices. The anchor node is in dynamic mobility and broadcast there location to other sensor nodes with the use of beacon messages. Once a sensor node enters the communication range of the mobile anchor node, it receives the beacon messages and estimates its individual location. As the result, a higher percentage of sensor nodes can determine their location than existing path planning methods.**

Keyword:- Localization, Mobile anchor node, GPS, wireless sensor network.

I. INTRODUCTION

A Wireless sensor network (WSN) consist of hundreds or thousands of nodes that are capable of sensing phenomenon in the environment, such as temperature, humidity, seismic waves, etc [1]. There are numerous applications of wireless sensor networks such as Environmental monitoring, animal tracking, fire detection, military surveillance etc. In most Wireless sensor network applications the location of the sensor node should be known accurately such as target tracking, fire detection in forest etc[3].

There are several important issues in wireless sensor network such as, localization, deployment and coverage. One of the most important issue is localization as it has to determine the geographical positions of sensors and Sensor nodes must be aware of their location for an event to take place.

Manual configuration is the basic solution of localization as the location of each sensor node should be known before deployment. The sensors are deployed by humans in the assigned location. As this solution requires labour for installation, this is in scalable. Therefore another solution for localization is that fixing every sensor node with a GPS and making use of the GPS signal the sensors can locate themselves .However, installing a GPS receiver for each and every sensor node increases the total cost and energy consumption of the network.

Due to these drawbacks of manual configuration and employment of GPS receiver, new localization framework was proposed. In this framework only small number of sensors in the network has the prior knowledge about their geographical positions and is called anchors. By making use of the location information about the anchor nodes the rest of the sensor nodes in the network that do not have the location information are able to determine their positions.

There are many localization methods that have been proposed for wireless sensor network which are broadly classified as range based and range free schemes. Radio connectivity constraints are used to determine the location of the sensor in range free schemes [4]-[5]. The node-to-node distances or inter-node-angles are used to calculate the sensor locations in Range based schemes [2]-[6]. To calculate the inter node distances and/angle they make use of infrared, X-ray or Ultrasound techniques. Therefore this method is more expensive and complex than range-free schemes. So most of the large scale wireless sensor network applications are preferring the range-free localization scheme.

Many number of fixed mobile anchors are used in most of the localization mechanism to find out the location of the sensor nodes within the network. In this network, if only 10 percentage of the nodes are anchor nodes, the cost of the network will increase rapidly. For reducing cost of deployment of the anchor several techniques have been proposed.

II. RELATED WORK

A. Range based and Range free Techniques

Distance or angle metrics are used to determine the location of the sensor node in Range-based schemes. Time of Arrival (ToA), Time Difference of Arrival (TDoA), Angle of Arrival (AoA), Received Signal Strength Indicator (RSSI) are the distance and angle metrics. Range-based techniques are highly accurate as compared to other techniques. But the main drawback is it should be provided with expensive hardware hence increasing the cost of the entire network and it requires lots of computation. Examples of this technique are DV-distance, DV-hop, and Euclidean distance [7], Multidimensional Scaling (MDS) Radio Interferometry Measurement (RIM) [3].

The information transmitted by nearby anchor nodes/neighboring nodes is used to identify the positions of the sensor node in range-free technique which is based on one hop or on triangulation basis. Examples are chord selection approach, three dimensional multilateration approach [6], centroid scheme etc. The critical issues of range-free technique are accuracy and communication overhead. Range free techniques are cheaper than range based techniques.

B. Mobile Anchor Localization

The beacon messages are transmitted by mobile anchor to determine the location of the sensor node proposed by Sichitiu and Ramadurai [9]. From beacon messages received signal strength indicator is used as one of the main parameter to estimate the location of the sensor node. Based on a single mobile anchor, a distributed localization scheme was proposed by Galstyan et al. [7]. A more robust and accurate localization solution can be obtained by using estimation techniques related to non parametric probabilistic mechanism. TOA technique is used in this approach for ranging and utilizes centroid formula with distance information to calculate the sensor node's position.

Based on trilateration localization scheme Han et al. [10] introduced a path planning scheme for mobile anchor. According to the equilateral triangle trajectory, the anchor node moves in the sensing field and broadcasts information about its position. Making use of the trilateration method sensor node will calculate its individual position. Based on the received signal strength distance between the anchor node and sensor node can be calculated. The main disadvantage of the RSSI ranging technique is inaccuracy. If the sensors are deployed indoors, walls would continuously reduce the precision of the method due to nonlinearities, noise, interference and absorption.

A technique based on connectivity-induced constraints [11] for finding out the unknown node location in sensor network. Known peer-to-peer communication in the network is modeled as a set of geometric constraints on the node positions. The solution of a feasibility problem for these constraints yields estimates for the unknown positions of the nodes in the network. One disadvantage of the method in [11] includes a central point of computation with the associated traffic overhead, scalability and reliability issues.

III. MOBILE ANCHOR NODES

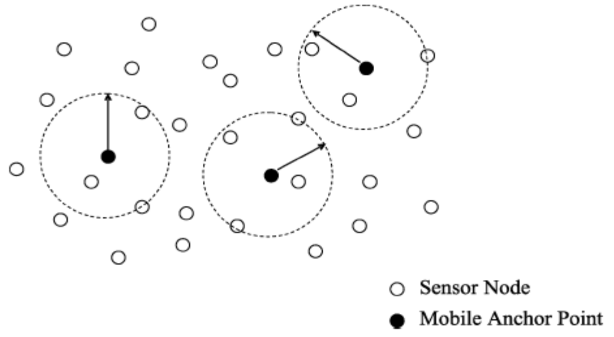

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Fig.1 Example of system environment

Fig.1 depicts a wireless sensor network environment consist of mobile anchor nodes and randomly deployed sensor nodes. Besides sensing the environment, the sensor nodes also have the computational power and memory to process the data and it will stay at their assigned location after deployment for sensing the environmental changes. Information can be exchanged between sensor nodes through wireless communication links and it can receive messages from neighbor nodes and mobile anchor node. For assisting the sensor nodes to determine their location the mobile anchor node will traverse through the entire network. The main assumptions required in proposed approach is first, mobile anchor node is provided with a GPS (Global positioning system) receiver and during the localization process it is able to broadcast beacon messages and also has sufficient energy to move. Second, the mobile anchor nodes are able to move themselves or other carriers such as robot or vehicles.

IV. PROPOSED APPROACH

The main idea of this paper is to eliminate the some of the drawbacks of existing localization systems. The main problem is more number of anchor nodes are using they are more expensive than the rest of the sensor nodes This means that, even if only 10% of the nodes are anchors, the price of the network will increase tenfold. Another observation is that after the unknown nodes have been localized, the beacons become useless; they no longer use their (expensive) GPS receivers. The reasoning mentioned above leads us to believe that a single mobile beacon can be used to localize the entire network.

To understanding the effectiveness of the proposed method we give a description of the localization method proposed by Ssu et al. [12]. In this method, a single mobile anchor node moves through the network and periodically broadcasting information about the current coordinates of the mobile anchor node and each sensor node receives location of the anchor. In [12], it is assumed that the communication range of the sensor node can receives messages (beacon message) from the mobile anchor node is bounded by a circle. To calculate the location of the sensor node using the fact that the perpendicular bisector of a chord of a circle passes through the center of the circle. For that minimum three beacon points required. Based on authors observation, when the length of the chord is short, the unsuccessful localization will increase(see Fig.2). To overcome this, an enhanced path planning mobile anchor based is developed.

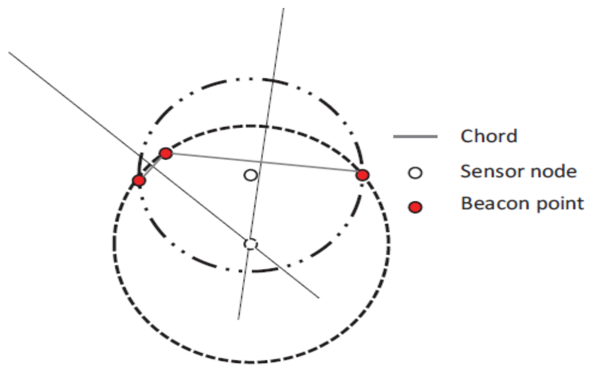

Fig.2. Short chord problem

A. Proposed mobile anchor path planning scheme

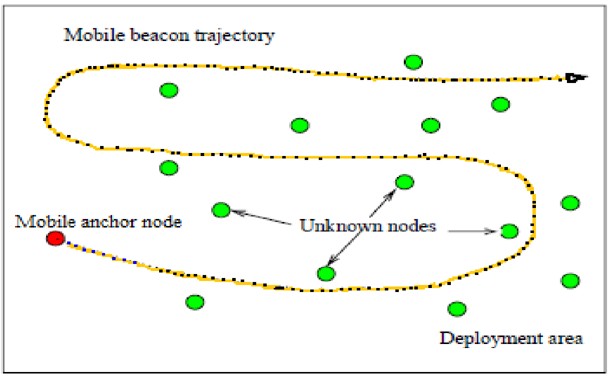

Fig.3. One single mobile anchor assisting in the localization of a sensor field.

Fig.3 depicts a wireless sensor network deployed over a geographical area. After deployment the anchor node moves in the entire sensor network in a predefined path while broadcasting beacon packets. The beacon messages contain the mobile anchor node id, location, timestamp. Any other sensor node receiving the beacon packet will be able to infer that it must be somewhere around the mobile beacon. On encounter of signal from anchor node within the transmission range, a beacon point is marked. The beacon point is considered as an approximate endpoint on the sensor node's communication circle. After three beacon points are obtained, an arc is formed using these three points. Once the arc is formed we can calculate the center point formed by the circle (arc is a part of the circle). Using the mechanism of multilateration technique and circle formulas the location of the sensor node is estimated.

If obstacles will appear in realistic environment network, it will obstruct the radio connectivity between the sensor node and anchor node. To handle obstacles in the network field, our proposed method is able to detect obstacles within its detecting range and it can block the trajectory of the anchor node. Based on obstacle detection technique [13] [14] the anchor node can identify that the obstacle is placed on the right or the left side of the current path.

V. CONCLUSION

We proposed enhanced framework for localizing the randomly deployed sensor nodes in wireless sensor network. Based on the location information from the single mobile anchor, the sensor nodes calculate their individual positions. The proposed framework is scalable, effective and efficient as the anchor node is made to move so it can cover the entire network area. All the sensor nodes are able to identify three or more beacon messages so as to calculate their location. Thus, the short chord problem in [13] is solved. Furthermore, it has been shown that all sensor nodes can determine their location in the presence of obstacles in the sensing field.

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BIOGRAPHIES

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