Cluster Based Location Searching Using Graph Theory

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Abstract **-** The locations of sensor nodes are essential to Wireless Sensor Networks applications. Researchers have proposed many localization algorithms for Wireless Sensor Network and verified them through simulators. In this paper, a system-level node location model that aims to validate proposed algorithms for wireless sensor networks in Matlab environment is proposed. This model can reflect the reality networks effectively. Using this model, researchers can verify the performance of the localization algorithms including run time, location error, and location node numbers.

Keywords**—**localization, wsn network, Matlab environment

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are ad-hoc networks, consisting of spatially distributed devices (motes) using sensor nodes to cooperatively monitor physical or environmental conditions at different locations. Devices in a WSN are resource constrained; they have low processing speed, storage capacity, and communication bandwidth. In most settings, the network must operate for long periods of time, but the nodes are battery powered, so the available energy resources limit their overall operation. To minimize energy consumption, most of the device components, including the radio, should be switched off most of the time [16]. Another important characteristic is that sensor nodes have significant processing capability in the ensemble, but not individually. Nodes have to organize themselves, ad-ministering and managing the network all together, and it is much harder than controlling individual devices. Furthermore, changes in the physical environment where a network is deployed make also nodes experience wide variations in connectivity and it influences the networking protocols

Wireless sensor networks (WSNs) are composed of spatially distributed autonomous devices using sensors to cooperatively monitor some phenomena [1]. These devices, called sensor nodes, are small-sized, low-cost, and low-power. Wireless sensor network has a wide variety of applications such as battlefield surveillance, target tracking, industrial process monitoring, environmental monitoring, intelligent transportation, precision agriculture, and disaster area monitoring. Wireless Sensor Networks (WSN) have gained world-wide attention in recent years due to the advances made in wireless communication, information technologies and electronics field. The development of low-cost, low-power, a multifunctional sensor has received increasing attention from various industries. Sensor nodes or motes in WSNs are small sized and are capable of sensing, gathering and processing data while communicating with other connected nodes in the network, via radio frequency (RF) channel. Wireless sensor network [1] are one of thecategory belongs to ad-hocnetworks. Sensor network are also composed of nodes. Here actually the node has a specific name that is "Sensor" because these nodes are equipped with smart sensors.

II. ARCHITECTURE OF SENSOR NODE

The wireless sensor nodes are the central element with limited computing and processing power in a wireless sensor network (WSN). It is through a node that sensing, processing, and communication take place. It stores and executes the communication protocols and the data processing algorithms. The quality, size, and frequency of the sensed data that can be extracted from the network are influenced by the physical resources available to the node. Therefore, the design and implementation of a wireless sensor node is a critical step. It is made up four basic components

1. A sensing unit,
2. A processing unit,
3. A transceiver unit and
4. A power unit

There can be application dependent additional components such as a location finding system, a power generator and a mobilize. Figure 1 presents the architecture of a sensor node.

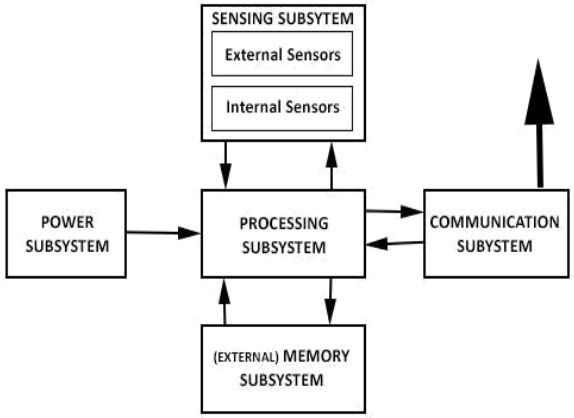

Fig.1: architecture of a sensor Node

Most of the sensor network applications, sensing tasks, and routing techniques need knowledge of the physical location of a node. Thus, it is common for a sensor node to be equipped with a location finding system. This system may consist of a GPS module for a high-end sensor node or may be a software module that implements the localization algorithms that provide location

information through distributed calculations

The locations of node are essential to Wireless Sensor Network applications. Only to know the positions of nodes, the information collected by nodes can provide the most value. Many models have been built to study the wireless sensor network. However, to our knowledge, no model is found to study localization algorithms. A platform to verify the performance of the localization algorithms is necessary. A system-level simulation model is better to measure the performance of the localization algorithms. A system-level simulation platform to study the localization algorithms in Matlab environment is proposed. This model is based on the real network and divided into multiple modules.

III. CLUSTERING BASED ROUTING PROTOCOLS

Routing of data from source to destination is an important challenge in wireless sensor network. To route data from source to destination various models are proposed as follows.

1. One Hop Model: It is the simplest model where data is sending from source (sensors) towards destination (BS) directly [38]. No intermediate node participates to send the data to BS here. The figure 5 represents one hop model where all sensor nodes send data to base station directly. Based on one hop model direct communication protocol works.

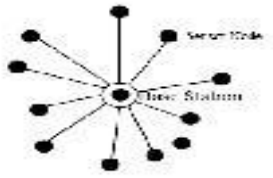

Fig.2: One hop model

2. Direct Communication Protocol: Direct communication protocol [1] is one of the simplest routing protocols in WSN. It is based on One Hop Model. In Direct communication routing protocol, each sensor nodes sends its data to BS directly. So if the BS is far away from the sensor nodes direct communication requires more transmit energy for each node. This will drain the energy level quickly of each node which reduce the system lifetime greatly. So it is only acceptable when the BS is closed to the sensor nodes or the transmit energy level of nodes is very large. It may be an acceptable and possiblyoptimal method of communication in WSN . The amount of energy used in figure 6 can be modeled using direct communication protocol is :

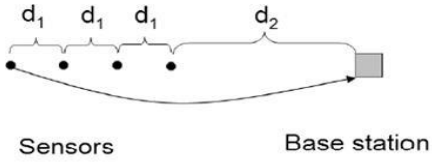

Fig.3: Simple linear network (direct communication)

While considering the network large in size, if direct routing is selected as a routing protocol to send the data from source (sensors) to destination (BS) then all nodes send data to BS directly. So the node which is at maximum distance from the BS will have to lost more energy than the nodes closed to BS. So after sending very small amount of data the far away nodes will die which leads to reduce network lifetime. That's why adopting direct routing protocol in large network is not feasible in WSN.

3. **Multichip Model:** In multichip model nodes choose their neighbours to forward data towards the BS. "This model is an energy efficient model of routing. [38]." Figure 7 presents the multi hop model. Minimum Transmission Energy (MTE) protocol works based on this multichip model.

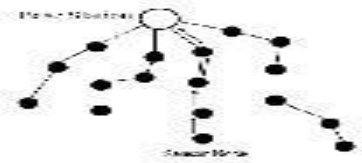

Fig.4: Multi-hop model

Clustering is an efficient approach that has been implemented in many communication protocols in wireless environment. In Cluster Based Model [3] network is grouped into different clusters .Each cluster is composed of one cluster head (CH) and cluster member nodes. "The respective CH gets the sensed data from cluster member nodes, aggregates the sensed information and then sends it to the Base Station.(BS).[3]." Cluster members do not communicate directly with the sink node. Thus minimizes the energy consumption and number of messages communicated to base station. "Ultimate result of clustering the sensor nodes is prolonged network lifetime.[3]". Figure 10 presents the cluster based model.

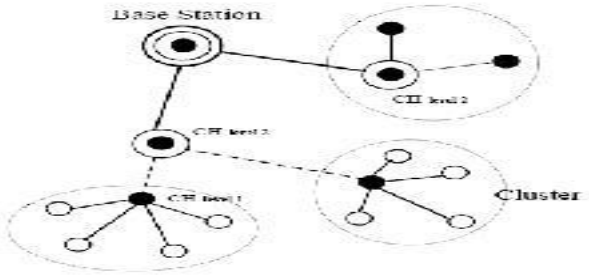

Fig.5: Cluster based model

IV. APPROACH AND ALGORITHM

In cluster based model, formation of clusters, selection of CH of each node and formation of schedule is an overhead. Besides this the CHs receive the data, aggregate the data and transmit the

data, so required energy is much more of each CH.

1. **Sensor Node:** It is the core component of wireless sensor network. It has the capability of sensing, processing, routing, etc.
2. **Base Station:** Base station is considered as a main data collection node for the entire sensor network. It is the bridge (via communication link) between the sensor network and the end user.
3. **Cluster Head:** The Cluster head (CH) is considered as a leader for that specific cluster. And it is responsible for different activities carried out in the cluster, such as data aggregation, data transmission to base station, scheduling in the cluster, etc.

Cluster: It is the organizational unit of the network, created to simplify the communication in the sensor network.

i. Advantages of Clustering:

- Transmit aggregated data to the data sink
- Useful Energy consumption
- Scalability for large number of nodes
- Reduces communication overhead
- Efficient use of resources in WSNs

ii. Disadvantages of clustering:

Dynamic nature (how different parameters of cluster formation is to be determined) of cluster is a difficult task in cluster based touting protocols in wsn.

iii. Protocols:

Based on the Clustering approach various routing protocols have been implemented in wireless networks. The cluster based protocols are graph theory.

iv. Algorithm of Set up phase: Cluster Head Selection:

- Decision to be cluster head based on-
  a. Suggested percentage of CH for the network determined a priori.
  b. Number of times a node has been a CH so far.
- Decision to be a CH is made by a node n choosing a random number (rand) between 0 and 1

If the random number rand <T(n)
The node becomes cluster head otherwise it's the turn of other nodes. Where T(n) is defined as follows:

$$T(n) = \begin{cases} P / 1- P*(r \bmod 1/P) & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where P is the desired % to become a CH, r is the current round; D is the set of nodes which have not been selected as CHs in the last 1/P rounds.The nodes which have been selected as CH in round 0 will not be selected as CH again in next 1/P rounds. After 1/P-1 rounds all nodes will be eligible to become CH.

V. PURPOSED MODULE AND SCENARIO

The data routing in wireless sensor network is realized on the links comparison base. The considered links between a sender and a receiver can be compared in terms of the length, link quality or residual energy of the node pairs. Nevertheless, the path with the smallest investigated value is selected as the route for the data delivery. For the discovering of the optima route between two nodes in the graph data structure, a Matlab implementation of Dijkstra's algorithm can be used. The Dijkstra's algorithm is implemented within a Short Path function that is included in graph Theory Matlab tool.

Algorithm: E=createNbrTable

```
1: row=1;
2: for all node pairs
3:   x=abs(x_i-x_j);
4:   y=abs(y_i-y_j);
5:   dist=sqrt(x^2 + y^2);
6:   if dist_{i,j}<R;
7:     plot([x_i, x_j], [y_i, y_j]); % draw edge
8:     E(row, 1)=ID_i;
9:     E(row, 2)=ID_j;
10:      E(row, 3)=dist_i, j;
11:      row++;
```

⇓ E matrix

ID_i	ID_j	$dist_{i,j}$
1	2	15.65
1	3	9.21
1	8	21.54
2	1	15.65
2	8	11.12
⋮	⋮	⋮

Fig. 6. Pseudo code of layout visualization and E matrix definition. E matrix is illustrated bellow code

The gr Short Path function takes an E matrix of neighbors, source i and destination j node as an input arguments. It returns a DSP matrix with the shortest path between all node pairs in the network. Furthermore, it returns ansp vectors with the nodes constituting the shortest path between nodes i; j. The E matrix

must have an exact form for the correct grShortPath algorithm processing. It contains three columns, where the first two columns contain the all nodes in the network that are neighbors of each other and third column contains the Euclidean distance in meters between them. The E matrix can be created during the network layout printing, see Fig. 7. As was mentioned before, the link lengths between all node pairs are compared with the uniform radio range R and if the condition di;j< R is accomplished the link is displayed. The E matrix is created within this condition since all required parameters such as IDs of two neighbors and their distance d is known and condition of lengths is accomplished. The context of the E matrix is visualized also in Fig 8. If the link quality or residual energy is to be used instead of the distance between nodes for the route establishment, the information in the third column of E matrix can be substituted by the required information. Then the path between two nodes is selected as the path with the highest quality or path with the maximum energy. Fig. 9 shows results of the described functions. Source file Cluster's for the WSN routing can be found in

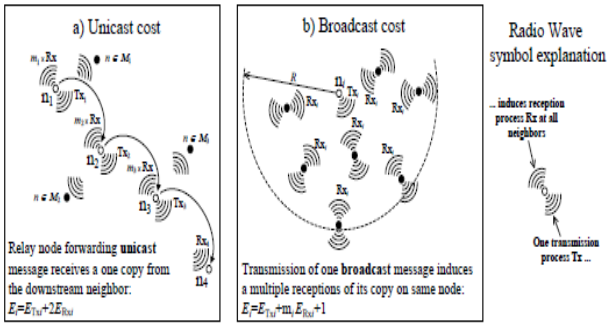

Fig.7: Cluster based communication

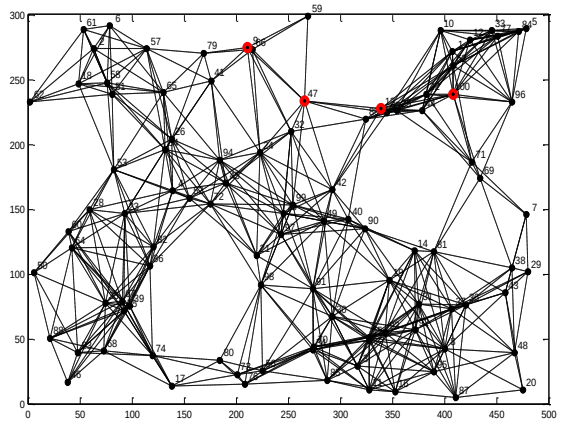

Fig.8. Network layout with the highlighted shortest path estimated by the gr Short Path function and making of cluster

100 nodes are randomly distributed within the square area of 300 m × 500 m, where the base station is positioned [50, 50] of the network. In figure 1, Clusters are selected randomly in each round so that energy load is distributed evenly and prolong the network lifetime. Number of CHs formed in each round is shown below.

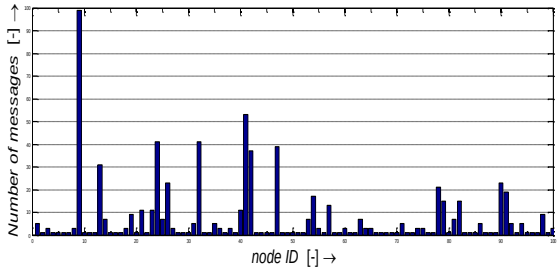

Fig.9: Real cluster formation chart

WSNs are very useful such as military surveillance, environmental, traffic, temperature, pressure, vibration monitoring and disaster areas. All the nodes have to send their data towards BS often called as sink. Usually nodes in WSN are power constrained due to limited battery, it is also not possible to recharge or replace battery of already deployed nodes and nodes might be placed where they cannot be accessed. Nodes may be present far away from BS so direct communication is not feasible due to limited battery as direct communication requires high energy. Clustering is the key technique for decreasing battery consumption in which members of the cluster select a Cluster Head.

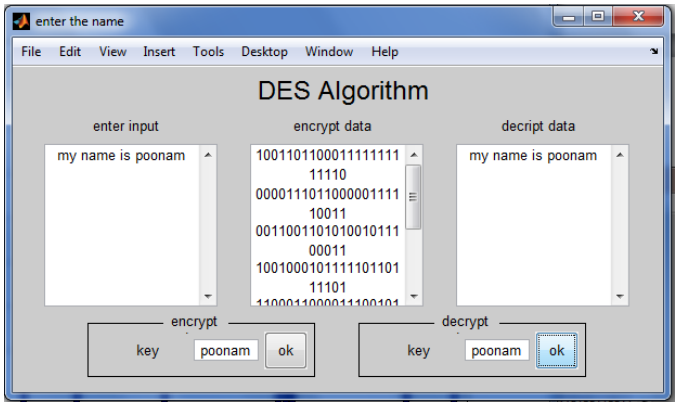

Fig.10: DES cryptography

In this paper, we evaluate the performance of Clustering algorithms on the basis of stability period; network life time and throughput for heterogeneous WSNs.Cluster perform well under three level heterogeneous WSNs containing high energy level difference between normal, advanced and super nodes in terms of stability period.We focus on the performance of Clustering

algorithms on the basis of stability period, network life time and throughput for WSNs.

We evaluate the performance of clustering algorithms on the basis of stability period, network life time and throughput for different level of heterogeneous wireless sensor networks. We analysis the performance of protocol on the basis of prolonging stability period, network life time of nodes alive during rounds for numerous three level heterogeneous networks. Information from sensor nodes is forwarded to cluster heads (CHs) and these CHs are responsible to transmit this information to base station (BS) which is placed far away from the field

VI. REFERENCES

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