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Position Recognition using Advanced Clustering Methodology in WSN

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ABSTRACT: Wireless sensor network is the hot research topic for the researchers. Sensor will sense the physical information and sends the sensed information to the sink node or directly to the controller. Recognizing the position of the sensor node is one of the major issue in the sensor network as nodes are randomly deployed in the field. This paper proposes an advancement in the clustering approach so that the node positioning can be recognized easily with less energy consumption. In this a progressive algorithm is proposed in the selection of cluster head. Simulation results shows that the proposed work finds the position of all nodes accurately with less energy consumption.

Keywords: Sensor Node, Routing, Cluster, Energy Positioning.

I. INTRODUCTION

Wireless Sensor Networks combine simple wireless communication, minimal computation facilities, and some sort of sensing of the physical environment into a new form of network that can be deeply embedded in our physical environment, fueled by the low cost and the wireless communication facilities [1]. Typical sensing tasks for such a device could be temperature, light, vibration, sound, radiation, etc. The hoped-for size would be a few cubic millimeters, the target price range less than one US$, including radio front end, microcontroller, power supply and the actual sensor. All these components together in a single device form a so-called sensor node.. It is unlikely that there will be "one-size-fits-all" solutions for all these potentially very different possibilities. Most importantly, the low cost and low energy supply will require, in many application scenarios, redundant deployment of wireless sensor nodes. More important is the data that these nodes can observe.

Fig. 1 shows the schematic diagram of sensor node components. Each sensor node consist of 4 main units, sensing unit, processing unit, trasreceiver unit and power unit. Sensor node may also have mobilizer and position finding unit. The same figure shows the communication architecture of a WSN. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes interact with themselves to produce high-gradestatistics about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources.

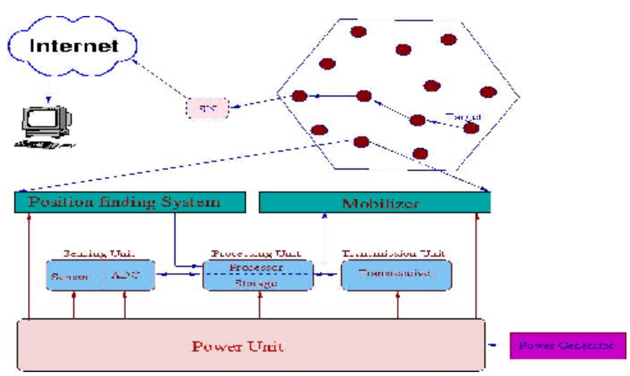

Fig. 1. The component of a sensor node.

Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s).A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data. Networking unattended sensor nodes may have profound effect on the efficiency of many military and civil applications such as target field imaging, intrusion detection, weather monitoring, security and tactical surveillance, distributed computing, detecting ambient conditions such as temperature, movement, sound, light, or the presence of certain objects, inventory control, and disaster management. Deployment of a sensor network in these applications can be in random fashion (e.g., dropped from an airplane) or can be planted manually (e.g., fire alarm sensors in a facility).

The working of each unit is as follows,

(i) Sensing units are typically composed of two subunits: sensors and A to D converter. The analog signals produced by the sensors based on the detected sensation are transformed to digital signals by the ADC, and then fed into the processing unit.

(ii) The processing unit, which is usually associated with a small storage unit, copes the ways that make the sensor node team up with the other nodes to carry out the allocated sensing tasks.

(iii) A transceiver unit joins the node to the network.

(iv) One of the most significant components of a sensor node is the power unit. A power-foraging unit such as solar cells may support power units.

Most of the sensor network routing techniques and sensing tasks require the knowledge of location with high accuracy. Thus, it is common that a sensor node has a location finding system. A mobilizer may sometimes be needed to move sensor nodes when it is required to carry out the assigned tasks.

All of these subunits may need to fit into a matchbox-sized module. The required size may be smaller than even a cubic centimeter, which is light enough to remain suspended in the air. Apart from the size, there are also some other stringent constraints for sensor nodes. These nodes must: Consume extremely low power, Low production cost and be dispensable, Autonomous and operate unattended, Adaptive to the environment. Since the sensor nodes are often inaccessible, the lifetime of a sensor network depends on the lifetime of the power resources of the nodes. Power is also a scarce resource due to the size limitations. For instance, as stated in [2], the total stored energy in a smart dust mote is of the order of 1 Joule. It is possible to extend the lifetime of the sensor networks by energy foraging, which means extracting energy from the environment. A solar cell is an example for the techniques used for energy foraging.

First, due to the relatively large number of sensor nodes, it is not possible to build a global addressing scheme for the deployment of a large number of sensor nodes as the overhead of ID maintenance is high. Furthermore, sensor nodes that are deployed in an ad hoc manner need to be self-organizing as the ad hoc deployment of these nodes requires the system to form connections and cope with the resultant nodal distribution especially that the operation of the sensor networks is un- attended. In WSNs, sometimes getting the data is more important than knowing the IDs of which nodes sent the data. Second, in contrast to typical communication networks, almost all applications of sensor networks require the flow of sensed data from multiple sources to a particular BS. This, however, does not prevent the flow of data to be in other forms (e.g., multicast or peer to peer). Third, sensor nodes are tightly constrained in terms of energy, processing, and storage capacities. Thus, they require careful resource management. Fourth, in most application scenarios, nodes in WSNs are generally stationary after deployment except for, may be, a few mobile nodes. Nodes in other traditional wireless networks are free to move, which results in.

Location-based protocols utilize the position information to relay the data to the desired regions rather than the whole network. Last category includes routing approaches that are based on the protocol operation, which vary according to the approach used in the protocol [2,4].

In this kind of routing, sensor nodes are addressed by means of their locations. The distance between neighboring nodes can be estimated on the basis of incoming signal strengths. Relative coordinates of neighboring nodes can be obtained by exchanging such information between neighbors. Alternatively, the location of nodes may be available directly by communicating with a satellite, using GPS (Global Positioning System), if nodes are equipped with a small low power GPS receiver. To save energy, some location based schemes demand that nodes should go to sleep if there is no activity. More energy savings can be obtained by having as many sleeping nodes in the network as possible. The problem of designing sleep period schedules for each node in a localized manner was addressed in .In the rest of this section, we review most of the location or geographic based routing protocols. Organization of the paper is as follows, section II describes about the routing protocols in the WSN, section III comprises of proposed protocol performance, section IV gives Simulation of the proposed work, section V provides the results and discussion of the paper and at last section VI concludes the paper with some future scope.

II. ROUTING PROTOCOLS IN WSN

This section includes, the state-of-the-art routing protocols for WSNs[1,5]. In general, routing in WSNs can be divided into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure. In °at-based routing, all nodes are typically assigned equal roles or functionality. In hierarchical-based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network [8-12].

A) Network Structure Based Protocols

i) Flat Routing. In flat networks, each node typically plays the same role and sensor nodes collaborate together to perform the sensing task. Due to the large number of such nodes, it is not feasible to assign a global identifier to each node. This consideration has led to data centric routing, where the BS sends queries to certain regions and waits for data from the sensors located in the selected regions. Since data is being requested through queries, attribute-based naming is necessary to specify the properties of data [13].

ii) Hierarchical Routing. Hierarchical or cluster-based routing, originally proposed in wire-line networks, are well-known techniques with special advantages related to scalability and efficient communication. As such, the concept of hierarchical routing is also utilized to perform energy-efficient routing in WSNs. In a hierarchical architecture, higher energy nodes can be used to process and send the information while low energy nodes can be used to perform the sensing in the proximity of the target. Hierarchical routing is an efficient way to lower energy consumption within a cluster and by performing data aggregation and fusion in order to decrease the number of transmitted messages to the BS. Hierarchical routing is mainly two-layer routing where one layer is used to select cluster heads and the other layer is used for routing.

a) Cluster Based Routing In WSN: Wireless sensor networks (WSN) are wireless network composed of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. Due to the deployment flexibility and maintenance simplicity, WSN applications have been seen in many areas. One of the most important design objectives of WSNs is to minimize node energy consumption and maximize the network lifetime. In recent years, clustered routing protocol has gained increasing attention from researchers because of its potential of extending WSN lifetime.

b) Location aware clustering: LEACH cluster head is selected using a threshold $T(n)$, as shown in Fig. 3, where $T(n)$ is calculated according to: $T(n) = p \Big/ \left(1 - p\left(r \bmod \left(\frac{1}{p}\right)\right)\right)$ If $n \in G$

In this formula, p is the percentage of cluster heads over all nodes in the network, i.e., the probability that a node is selected as a cluster head; r the number of rounds of selection; and G is the set of nodes that are not selected in round 1/p. As we can see here, the selection of cluster heads is totally randomly. The following figure shows the structure of clusters in WSN.

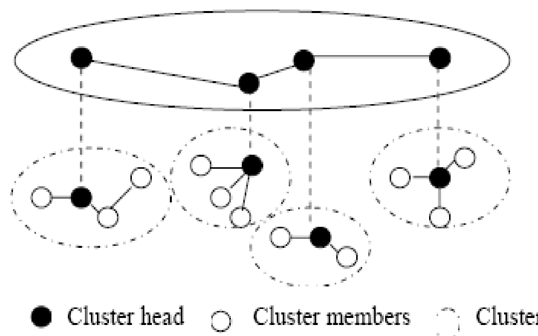

Fig. 2. Structure of clustered WSNs.

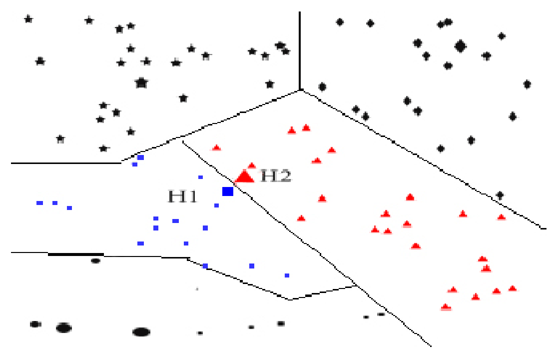

Fig. 3. Multiple cluster heads appear in a small region with LEACH protocol.

In addition, energy consumption is not considered as a factor in the above cluster head selection. In the reality, due to the environment where the nodes are deployed, the workload on data collection and transfer is different from node to node. Because node energy consumption is proportional to the amount and distance squared of data transferred, the more a node sends data and the farther it is away from the cluster head, the more energy is consumed with the node [13]. In Fig. 3, H1 and H2 are two cluster heads, nodes ■ and ▲ are their cluster members, respectively. H1 and H2are very closely located. According to data communication model, the energy that a cluster head consumes is the sum of that consumed in receiving data and that in sending data.

III. PROTOCOL PERFORMANCE

Wireless sensor networks vary with the network application and operational environment. LEACH protocol is suitable for the WSNs under the following assumptions [3]:

1) All senor nodes are identical and charged with the same amount of initial energy. All nodes consume energy at the same rate and are able to know their residual energy and control transmission power and distance. The energy consumption of transferring data from node A to node B is the same as that of transferring the same amount of data from node B to node A.

2) Every node can directly communicate with every other node, including the sink node.

3) The Sink node is fixed and far away from the wireless network. Thus we can ignore the energy consumed by the sink node. We assume that it always has sufficient energy to operate.

4) Every node has data to transfer in every timeframe. The data transferred by sobering nodes are related and can be fused.

5) Sensor nodes are static.

A) Algorithms

Algorithm is broken into rounds, and each rounds consists of following 4 phases:

(i) Advertisement phase

-Each node decides whether or not to become cluster-head

-Advertises itself as cluster-head

(ii) Cluster Set-up phase

-Each node decides to which cluster it belongs

-Notification to the cluster-head

(iii) Schedule Creation

-Cluster-head creates a TDMA schedule notifying each node when it can transmit

(iv) Data transmission

-Each node send data during their allotted time

i) Temporal distribution in cluster head selection

After the deployment of sensor nodes, we first acquire all nodes' location information and report it to the base station. The base station decides Delay (Si) for every node based on the geographic distribution of all sensor nodes. Delay (Si) = 0 for those in the region to start first. During the process, nodes need to send their location information to the base station: $S_i \rightarrow B: ID(S_i), Loc(S_i)$

The base station needs to send the delay information to each node $B \rightarrow S_i: ID(S_i), Delay(S_i)$

ii) Selection of cluster heads

Set Num (Give up) to 0. Start with the nodes in G1. If a cluster head is generated from G1, broadcast a *Hello* package and Num (Give up). $H_j \rightarrow Broadcast: ID(H_j), Hello, Num(Giveup)$

When nodes in G1 are finished, consider nodes in G2. Now the cluster heads generated in G1 are reference points. The distance between a node in G2 and any cluster head in G1 is a factor in selecting the node as a cluster head, as well as the random value of T(n). If all conditions are satisfied, then broadcast the Hello message and Num (Give up). $H_j \rightarrow Broadcast: ID(H_j), Giveup, Num(Giveup)$

Otherwise, only broadcast Num (Give up). When nodes in other region receives this message, they will increment Num (Give up) by 1, and then modify T(n) to increase the probability of being selected as cluster head. Repeat the above process until all nodes in the network are considered.

IV. SIMULATION

A) Simulation Scenario and Parameters

In order to evaluate the performance of different algorithms, we use two scenarios to simulate the algorithms. In scenario1, the region size is 100 meters by100 meters, the number of nodes is 100, and the BS is located at⌢50 ’175); In scenario 2, 400 sensor nodes are distributed in a 200 meters by 200 meters region and the BS is geographically located at⌢100 ’250).

B) Simulation Results

(i) Performance measurements: In a wireless sensor network, the computing capacity and stored energy of a node is very limited. In particular, the limited energy affects the lifespan of information quality of the network. For this reason, we evaluate the algorithms based on the efficiency of the network energy consumption. We use two performance indices:

(ii) Lifespan: The lifespan of a sensor network is the time span from the beginning of the network operation to the instant that the network can no longer provide readable information, measured in the number of rounds. It can be measured in three ways: FND (First Node Dies), HNA (Half of the Nodes Alive), LND (Last Node Dies).

(iii) Data accuracy: The accuracy of data received by the BS. The more the data is received, the high the accuracy after data fusion. The data accuracy is measured by the total data sent by all nodes in the lifespan of the network.

C) Analysis of Simulation Results

We compare the performance of the original LEACH clustering protocol and our progressive clustering protocol. The lifespan of the new progressive clustering protocol is longer than that of the original LEACH protocol. The data transferred with the new protocol is1/3 more than that with the old protocol, and the lifespan of the network with the new protocol is almost doubled compared with that of the old protocol.

D) Simulation Model

In this simulation model we consider "N" number of nodes in the area of length "L" and breadth "B" . In our model we consider parameter such as battery life of each node which is varied over an arbitrary range of values.

In the synthetic scenario simulation "N" nodes are randomly placed in L*B square meter field. Each node transmits a maximum of "P" packtes at various times during simulation and their transmission range is "R" meters. If suppose one node is used in one route then it should not be used in other route to avoid collision of data while transmission. To achieve this we use a status factor which indicates the status of each node.

.Algorithm A

Begin

1.Get max_nodes.

2. Get the position of each node(z[].x,z[].y[])

3. Consider node with a nodeid=0.

4. Find the distance between nodeid and all other nodes.

Distance =sqrt{(y2-y1)^2+(x2-x1)^2)}X1 and y1 are position of current node, x2 and y2 are position of the node from which the distance is to be calculated.

5. If(the distance <transmission range)

Then

If(z[node_un].nodeenergy>th)

Then update the neighbor's of current node in neighbor table

6. Repeat the above steps for all other nodes.

End.

Explanation**:** First take the maximum number of nodes from user. Then get position of each node. Consider the first node with value of zero. Find the distance of node from all neighbor nodes by the distance formula. If the distance is within the transmission range and node energy is greater than the threshold energy then update the neighbor's of current node in neighbor table.

Algorithm B

Begin

1.Get source and destination node id's from the user(source=sr, destination=d)

2.Get all information about each node and its neighbor from neighbor table

Z[i].nb[j]==1:j is neighbor of i

3.Check for destination if destination is neighbor of source then display direct path from source to destination

4.From the source node start finding the route to destination, first consider the neighbor's of source node, check there status and then select the node with highest energy(node energy==z[].node energy).

5.Next make that node as source and continue the same access till the destination is reached.(Repeat step4)

6.The nodes which are used in previous route are kept in sleep mode (status factor==1:s[i].b==1;which means that node i is in sleep mode) so that these should not be used in next path.

7.Again same procedure is applied to find the different possible paths from source to destination and store the each path in route array in the sequence as follows.

8.Hop count: energy available: path from source to destination

9.Store all possible paths in a structure z[].rout[]

End.

Explanation: Get the source and destination node id's from the keyboard and collects all information about each node and its neighbors table. If destination is neighbor of source then display as direct path from source to destination. From the source node start finding the route to destination, first consider the neighbor's of source node, check there status and then select the node with highest energy. Next make the node as source and continue same process till the destination is reached. The nodes which are used to previous route are kept in sleep mode; the same procedure is applied to find the different possible paths from source to destination.

E) Simulation Procedure

Consider the simulation procedure as follows

Begin

1.Generate the network topology with the given number of nodes.

2.Update the information of all nodes in network.

3.Discover all possible routes for given source and destination nodes.

4.Apply the proposed model to send the data from source to destination.

5.Compute the performance of the system.

End**.**

F) Simulation Inputs

To illustrate some results of simulation, we have taken N=50,L=50 and B=50,R=10meters, rate_change_pos=0, threshold energy=5.

V. RESULTS AND DISCUSSION

In this Section, as a measure of performance we analyze the simulation results of our proposed scheme. The results that we will present here demonstrate the effectiveness of our approach. We have run the experiment for several times, and the results presented here are an average of those experiments.

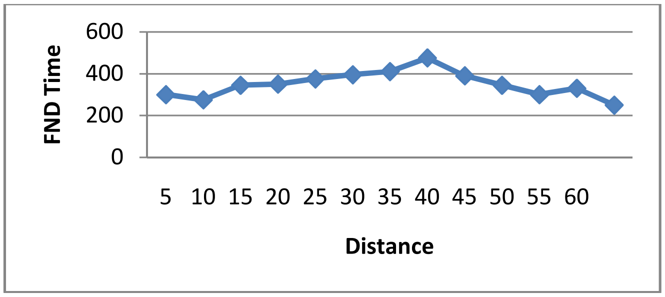

Fig. 4. FND VsThe distance between cluster heads.

Fig. 4 represents the change of First Node Dies over the distance between cluster heads. The lifespan of the network increases when the distance between cluster heads increases and reaches the cap when the distance is around 35 and 40. As we can see, the lifespan of the network increases when the distance between clusters heads increases. Fig. 5 shows the change of Half Node Dies over the distance between cluster heads. As we can see, the lifespan of the network increases when the distance between cluster heads increases. After that, when the distances increases further, the number of cluster heads goes down, and the energy consumption of the network goes up, which leads to the decline of the lifespan and data accuracy.

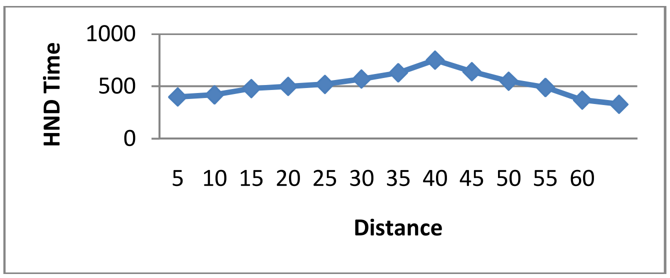

Fig. 5. HND vs the distance between cluster heads.

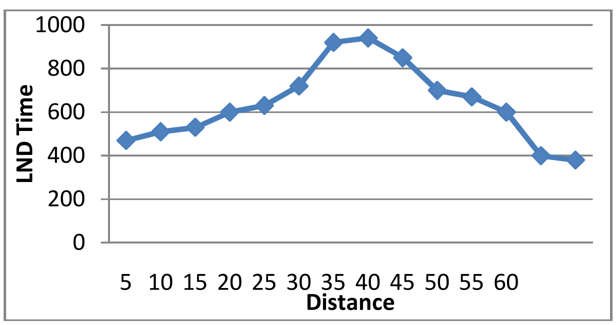

Fig. 6. LND vs the distance between cluster heads.

Fig. 6 shows the change of Last Node Dies over the distance between cluster heads. As we can see, the lifespan of the network increases when the distance between cluster heads increases. After that, when the distances increases further, the number of cluster heads goes down, and the energy consumption of the network goes up, which leads to the decline of the lifespan and data accuracy.

VI. CONCLUSION

Cluster head selection is a main concern in clustering based routing. Cluster head should be selected in such a way that it should cover all the nodes in the cluster as well as it should be near to the sink node in order to prolong the overall network lifetime.

To solve this problem, we proposed a progressive algorithm for the cluster head selection. Simulation results show that our algorithm is much more efficient and can double the lifespan of a wireless sensor network. Such results are obtained under additional conditions, i.e., known location information and ability to adjust data transmission power based on distance. The algorithm can be easily implemented.

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