A Result Paper of Reducing the Energy Consumption of the Wireless Sensor Networks

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Abstract:
The nodes in wireless sensor networks are powered by limited batteries which tend to die out soon. Since these nodes are deployed in hostile environments for specific applications, when these nodes die out the replacement of their batteries becomes very tedious task. In past, many researchers have focused on improving the lifetime of the nodes. One of the prominent approaches practiced in past to achieve energy efficiency is the clustering of the nodes which involves selection of cluster head and data aggregation at cluster head. The concept of the clustering of the wireless sensor nodes has been defined in LEACH protocol. Apart from clustering the authors have also put forward the concept of root nodes. All the nodes in the network make a route via parent nodes to the root node. The formation of links between parent and child nodes is analogous to tree like structure with root node acting as trunk and various links from the root node to the other sensor nodes as its branches. The root node acts as one data aggregation point which collects data from the various parent nodes and forwards it to the base station for further processing. The proposed study presents an enhanced version of the routing scheme involving single root node as data aggregation point in the network. The proposed technique divides the network into various parts and describes the use of multiple root nodes in for each part of the network. The root node belonging to particular portion collects data from the members of that portion of the network and forwards the same to the base station. The data transmission among root nodes is achieved by multi hop scenario. The proposed scheme was simulated on NS2.35 and the performance of the network was measured in terms of packet delivery ratio, routing overhead and energy consumption. All these parameters have shown an improvement over the routing scheme involving single root node. The use of multiple root nodes in the network provides better load balancing in the network thus leading to lesser energy consumption and better performance of the network.

Keywords — WSN, HEED, LEACH, STEB, PEGASIS, BS, MEMS, GPS and PEZCA.

I. INTRODUCTION

Wireless Sensor Networks is a wireless network consisting of small nodes with sensing, computation, and wireless communications capabilities over short distances. Each sensor collects data from the monitored area and then it routes data back to the base station BS. The sensors can be placed in the field randomly or in a pre-determined manner. As wireless sensor networks consist of hundreds to thousands of low-power multi functioning sensor nodes, operating in an unattended environment, with limited computational and sensing capabilities. Sensor nodes are equipped with small, often irreplaceable batteries with limited power capacity [1]. WSN consist of hundreds or thousands of small, cheap, battery-driven, spread-out nodes bearing a wireless modem to accomplish a monitoring or control task jointly.

II COMPONENTS OF WIRELESS SENSOR NETWORKS

A. SENSOR

A sensor is an electromechanical device which can sense any many physical, motion, contact, presence/absence, biochemical and identification properties of any real object. It actually a Transducer in the concept of electronics which converts any sensed properties of object into equivalent electrical signal.

B. SENSOR NODE

Sensor Node are used to create Sensor network. This is the basic unit in a sensor network and is capable of performing some processing, gathering sensory information, and communicating with other connected nodes in the network[20]. The sensor nodes in a sensor network are usually resource constrained, which means they have limited energy, limited processing and memory capability as well as limited transmission range. A WSN consists of multiple sensor nodes is deployed carefully or arbitrarily over a given field. A sensor node typically comprises four parts: one or more sensors, a microcontroller, a wireless transceiver, and a power source. Batteries are commonly used to power nodes in a WSN deployment but have a finite energy budget. When the battery is depleted, a node cannot perform its function or participate in packet routing, which can isolate large areas of
the network. Charging or replacing batteries may be expensive and is difficult or even impossible under many circumstances. Therefore, the life of a sensor network is usually defined by the time interval between which a certain amount of critical nodes run out of their battery power [2].

C. SINK/BASE STATION

The base station is upper level of the hierarchical WSN. It provides the communication link between the sensor network and the end-user.

D. END USER

An end user is the person that a software program or hardware device is designed for. The end user can be contrasted with the developers or programmers of the product. End users are also in a separate group from the installers or administrators of the product.

II. RELATED WORK

In [1], authors proposed a clustering algorithm which based on cell combination for the networks. Sensor nodes are distributed densely and the energy of sensor nodes is always limited. In that clustering algorithm, the monitoring region is divided into hexagonal cells by considering the geographic location information of nodes. Each cluster consists of at least seven hexagon cells. Nodes with the same cluster identity form a cluster and the cluster head in each cluster is elected from the central cell of each cluster. The shape of the cells consider nearly circular in order to improve channel reuse and energy efficiency.

In [2], authors proposed an energy efficient clustering algorithm which based on virtual area partition in heterogeneous networks environment where the maximal transmission power of each node may be different. Authors found that VAP-E can balance the load between clusters, enhance the energy efficiency of sensor nodes, prolong the lifetime of networks, and improve the efficiency of communications. Authors also compare this algorithm with respect to LEACH and LEACH-E and found that VAP-E can enhance the stability period and network life time with the same simulation condition.

In [3], authors proposed a Power-Efficient Zoning Clustering Algorithm (PEZCA) which uses two algorithms: classical LEACH (Low-Energy Adaptive Clustering Hierarchy) and PEGASIS (Power-Efficient Gathering in Sensor Information Systems). In this algorithm, base station consider at a center of the scenario and the scenario area is divided into multiple fan shaped regions and the clusters closer to the base station have smaller sizes than those farther away from the base station. Thus CHs (cluster heads) nearest to the BS (base station) can preserve more energy for inter-cluster data transmission. PEZCA provide more balance in energy consumption and life time of network comparisons to LEACH.

In [4], authors combined voting method and clustering algorithm, and developed new clustering schemes for secure localization of sensor networks. Authors also found that the newly proposed approaches have very good performances on localization accuracy and the detection rate of malicious beacon signals. In this scheme, malicious beacon signals are filtered out according to the clustering result of intersections of location reference circles. Authors used a voting-on-grid (VOGC) method instead of traditional clustering algorithms to reduce the computational cost and found that the scheme can provide good localization accuracy and identify a high degree of malicious beacon signals.

In [5], authors optimize music based Meta heuristic optimization algorithm which is analogous with a music improvisation process where musician continue to polish the pitches in order to obtain better harmony. By which it optimizing the energy consumption and minimizing intra-cluster distance of the network. In this the base station computers and allocates nodes into clusters according to the information of their residual energy and location. The operation has two phases: clustering setup and data transmission. That algorithm provides improvement in term of power consumption and network life time over LEACH protocol. With a small network diameter, energy consumption of the network is almost same when using different clustering protocols.

In [6], authors proposed algorithm PEGASIS that is a chain based protocol provide improvement over LEACH algorithms. In PEGASIS, each node communicates only with a close neighbor and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Using greedy algorithm, the nodes will be organized to form a chain, after that BS can compute that chain and broadcast it to all the sensor nodes. Energy saving in PEGASIS over LEACH takes place by many stages: First, in the local data gathering, the distances that most of the sensor nodes transmit are much less compared to transmitting to a cluster-head in LEACH. Second, only one node transmits to the BS in each round of communication. PEGASIS outperforms LEACH by limiting the number of transmissions, eliminating the overhead of dynamic.

III. ALGORITHM

1. First the network will be divided into four equal parts.

2. The Base station will first choose root nodes, one from each portion of the network. The root node will be the one having highest residual energy and smaller distance to the base station. The smaller distance tends to choose root node closer to the base station so that root node does not have to send data collected by it from the sensor nodes to the larger distance.

3. Now Base station will inform the four root nodes about the starting time and the length of the time slot. It will also inform the root nodes about the nodes in their respective zones.

4. Instead of base station broadcasting this information to all the nodes in the network, it will
send the information to the root nodes which will inform the nodes about its ID and also broadcast the information to the nodes about the starting time and the length of the time slot in their respective portions of the network.

5. Now all the nodes in each portion have to exchange the information about their neighbor nodes with each other. For this each node will inform about its neighbors to the root node. The root node will have all the information of the nodes’ neighbors. It will disseminate the same information to all the members.

6. A node in one portion will not exchange information about the neighbors located in other portion of the network.

7. Each node tries to select a parent with the coordinates from its neighbors on the basis of following criteria.
   1. The distance between its parent node and the respective root should be shorter than that between itself and the root.
   2. Each node chooses a neighbor's as its parent. And if the node can't find a neighbor then, it selects the root as its parent.

8. After the parent nodes have been selected the data transmission will start from the leaf nodes. Leaf nodes are those which do not have any child nodes connected to them.

9. Third phase is the data collection phase. After the routing tree is constructed, each sensor node collects message to generate a data packet which are to be transmitted to BS. In a time slot, only the leaf nodes try to send their data packets. After a node receives all the data from its child nodes, this node itself serves as a leaf node and tries to send the fused data in the next time slot.

10. Here if there is communication interference for a parent node, every leaf node sends a beacon which contains its ID to its parent node at the same time. Three different situations may happen and they divide all the parent nodes into three types.

   1. For the first situation, if no leaf node needs to transmit data to the parent node in this time slot, it receives nothing.
   2. In the second situation, if more than one leaf node needs to transmit data to the parent node, it receives an incorrect beacon.
   3. In the last situation, if only one leaf node needs to transmit data to the parent node, it receives a correct beacon.

11. Within this segment, the leaf nodes which can transmit their data are to be confirmed. The parent node chooses one of its child nodes to transmit data in the next coming segment. For the third situation, the parent node tells this leaf node to transmit data in the next segment.

12. Once the data has been collected by the root nodes, the root nodes in the upper portion of the network will collect data from the lower portion of the root nodes and transmit it to the base station.

IV. SIMULATION AND RESULTS

![Energy Consumption](image1)

![Routing Overhead](image2)

![Packet Delivery Ratio](image3)
RESULTS

Fig. 4.4 Nodes Deployed in the Network and the network will be divided into four equal parts

Fig. 4.5 All the nodes in the each portion have to exchange the information about their neighbor nodes with each other. For this, each node will inform about its neighbors to the root node. The root node will have all the information of the nodes’ neighbors. It will disseminate the same information to all the members.

Fig. 4.6 Next phase is the data collection phase. After the routing tree is constructed, each sensor node collects message to generate a data packet which are to be transmitted to BS. In a time slot, only the leaf nodes try to send their data packets. After a node receives all the data from its child nodes, this node itself serves as a leaf node and tries to send the fused data in the next time slot.

Fig. 4.7 Once the data has been collected by the root nodes, the root nodes in the upper portion of the network will collect data from the lower portion of the root nodes and transmit it to the base station.

V. CONCLUSION AND FUTURE WORK

The proposed study aims at increasing the lifetime of the wireless sensor network. It proposes the concept of using multiple root nodes to collect data from various portions of the network. The proposed scheme as well as existing scheme (which describes the use of single root node as data aggregation point) were simulated in NS2.35 and the results were analyzed on the basis of energy consumption, packet delivery ratio and routing overhead. Energy consumption reflects the lifetime of the network. The proposed scheme showed an energy consumption of 70 Joules whereas the existing scheme showed an energy consumption of 80 Joules. The reason behind the lesser energy consumption is attributed to the fact that when multiple root nodes collect data from different portions of the network, the load gets distributed. Also, choosing the root nodes not only on the basis of remaining energy but also taking their distance from the base station into account would lead to selecting the root node closer to the base station. Thus the root nodes selected would be sending data to the base station over a shorter distance, thus the energy consumed would tend to get reduced. Another parameter analyzed was packet delivery ratio which would reflect how successful is the data transmission in the network also showed an increase in the value for the proposed scheme. The third parameters namely routing overhead showed a value of 4.5 for the proposed scheme and 17.9 for the existing scheme. Lesser the routing overhead better is the performance of the network. Since routing overhead represents number of control messages required to be sent in the network to receive the data messages in the network, its lower value would reflect that less amount of routing is required in the network and better is the link quality. The proposed scheme allows the root nodes to transfer data to the base station over multi hop scenario. Multi hop communication tends to reduce the routing overhead in the network since the links are better than one hop communication. Thus it can be fairly concluded that proposed scheme has improved the performance of the network and increased its lifetime. This scheme can be further modified along with clustering scheme to improve the network’s performance in…
future. Also this scheme can be compared against various energy efficient schemes to analyze its effectiveness.

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