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Energy Efficient Routing for Wireless Sensor Networks- A hierarchical Approach

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ABSTRACT

The popularity of Wireless Sensor Networks (WSN) has increased tremendously in recent time due to growth in Micro-Electro-Mechanical Systems & wireless communication technology. These Wireless sensor networks can be used for various applications, such as military, health & habitat monitoring, object tracking, fire detection, agriculture, and security. The main purpose of such networks is to collect information from the environment and deliver the same to the applications to determine characteristics of the environment or to detect an event. The sensor nodes are usually resource deficient with energy being the most critical of all the resources. These nodes in a wireless sensor networks are connected typically to a powerful controlling node called the base station. The base station is assumed to be connected to a stable power source and is not considered energy deficient, whereas all other nodes are battery powered. So, efficient use of energy resources in sensor nodes could extend the lifetime of the wireless sensor networks. The activity of sensing does not require much energy, it is the communication required for the delivery of the sensed data which causes most drainage of a sensor‟s battery. Therefore, the issue of energy saving is considered primarily in transmission and dissemination of data in sensor networks. Clustering techniques are important to save energy in a wireless sensor networks. It conserves communication bandwidth by avoiding redundant exchange of messages among nodes. It schedules activities in the cluster so that nodes can switch to the low-power sleep mode most of the time and reduces their rate of energy consumption.

I. INTRODUCTION

Growing field of wireless sensor networks a tool for understanding, diagnosis and combines communication tasks. With the mesh network protocols, sensor nodes in the physical world of cyberspace are expanding coverage of fiber forming a compound. Water flows to fill the submerged car, their purpose by jumping from node to node in any possible data communication method will try to find a network to connect to the grid. A minimum of one possibility, parts suppliers, hundreds of radical new technology opportunities while meeting the organization. Consumption of wireless sensor networks that collect and disassemble a large number of small parts is the ability to deploy. Military training and habitat tracking, and environmental conditions, supervision or monitoring the health status of the items in the scenarios used for wireless sensor networks. A simple equation based wireless sensor network model:

Sensing + CPU + Radio = Thousands of potential applications [1].

These sensors etc. thus providing temperature, light, and process data as phenomena to see and interact with is located in a remote area of the state understand the purpose of a natural way through channels other related marks are the network frequency. Understanding the need for this activity is to collect data and a sensor for sensing the batteries can cause drainage system, requiring less energy. A piece of information to move the sensor over a target price of energy properties as necessary for processing [2]. Here, the energy-saving triumph to win one of the biggest challenges. For most applications, the purpose of the battery can be used in a real environment for charging may be difficult or inconvenient. On the other hand, a sensor network to meet application requirements should be old enough.

As previously mentioned, the target because the sensor is small form factor and capacity is limited. Before wireless sensor networks, and protocols we need to be healthy is not very effective. Several studies suggest some sales route for achieving these goals has been conducted to address. The main challenges in the life of the network for the first time how to use sound in the roots, to win security deposit is very important. The purpose of the rooting process to reduce energy consumption, save energy, but also aims to balance the energy consumption is not only. Some fields will soon be dead, sensor networks, and will work out soon. Among the many sales channels, routing protocols are designed to increase cluster -... provide more energy-efficiency compared to others [7].

Clustering is one of the basic approaches for designing energy-efficient & highly scalable sensor networks. It

dramatically reduces the communication overhead, thus minimizing energy consumption and interference among the sensor nodes. By aggregating the sensor's data at a designated node called cluster head (CH), the total amount of data sent to the base station can also be reduced, saving energy and bandwidth resources. So, it is important to find out how to select the best candidates for taking up the role of cluster head?

Heinzelman et al. [8, 9] introduced Low Energy Adaptive Clustering Hierarchy (LEACH), a hierarchical cluster-based routing algorithm. This fully distributed and requires no global information network. However, one-hop communication in the top and sink cluster using live chat. Therefore, it is necessary to use a large network is not. In particular, the principal drug at random, dice very fast parts, which can lead to a person with minimum power losses can be. Head of the medicine evenly distributed throughout the network is determined by the selection of medicines for risk is difficult. Therefore, cluster heads to another part of the network and may be selected as a focusing head around and in order to collect not necessary.

Research in this work to overcome limitations leaches effective implementation of routing protocols is to head to. In our approach, clusters are formed geographically. Each cluster will have its own cluster head. This overcomes the problem of non-uniform distribution of cluster heads in the network. To overcome the problems due to random selection of cluster heads, our approach selects cluster heads on the basis of residual energy of the nodes as well as minimum distance to the base station from the cluster heads. After each transmission the residual energy of the nodes is recalculated and then again comparing the nodes energy and selecting the node with maximum energy as the cluster head. This process will increase the network lifetime. This approach uses both single-hop & multi-hop transmission depending upon the distances to the base station. Therefore, it can be applicable for the networks deployed in large regions.

II. OBJECTIVES AND SCOPE

The main objective of this thesis is to propose hierarchical based routing protocol which is an improvement over LEACH protocol. This protocol is designed to prolong network lifetime. Prolonging network lifetime is the way to provide energy efficient WSNs. Most of the hierarchical routing algorithms, designed to prolong network lifetime, have been derived from the LEACH.

In WSNs, sensing, computation and communication are three parameters that consume power. Minimizing the communication cost is the primary concern while sensing and computation parameters are secondary objectives in designing of such networks. This is because communication cost is higher than sensing and computation costs. Hence, the objectives of the current work can be summarized as follows:

- Minimize the communication cost by using appropriate cluster head node selection mechanism. In hierarchical routing, cluster heads use more energy since they are responsible for data aggregation as well as communications inside and outside of the cluster.
- Avoiding the partitioning of the sensor network by selecting cluster heads based on residual energy.
- Dividing the network into equal areas, thereby providing equal distribution of cluster heads in the network.
- Use of minimum distance concept during transmission between nodes to cluster heads and cluster heads to other promising cluster heads or to the base station so that less energy will be wasted while transmission of data.
- Analyze & compare the network lifetime & residual energy of the nodes for different number of clusters using proposed hierarchical routing protocol.

III. PAST STUDY

The main objective of this study is to provide some knowledge about unique features of wireless sensor networks that make it different from other ad-hoc networks. This chapter also discusses its routing challenges & design issues. It also gives its readers brief idea about routing algorithms in wireless sensor networks & their characteristics.

In the recent past, a relatively large number of routing protocols have been developed for wireless sensor networks. In the following sections, current research on routing protocols for WSNs has been discussed. Akyildiz et al [10] says awireless ad-hoc network is a temporary network that is set up between peer nodes to satisfy an immediate need. Many protocols exist for wireless ad-hoc networks, are not suitable for WSNs due to the unique features of WSNs. According to, WSNs differ from ad-hoc networks in seven key areas, namely; network size, node density, node proneness to failure, frequency of topology changes, communication paradigm, resource constraints and node identification. Each of these areas is discussed below.

A. Network size

WSN can consist of few nodes up to thousands of nodes. On the other hand ad-hoc networks usually consist of less than a hundred nodes. A Bluetooth piconet (maximum 8 nodes) & wireless local area network (maximum 32 nodes) are example of wireless ad-hoc networks (WANET).

B. Node density

Node density in a WSN is usually high i.e. a large number of nodes will occupy relatively small area, while other WANETs mostly consist of only a few nodes in close proximity of each other. This is due to the size of nodes. The size of wireless sensor network node can be less than a coin while nodes in WANETs can be notebook, computers, palmtops or cellular telephones.

C. *Node proneness to failure*

A WSN might be deployed in a remote or inaccessible area, such as a jungle or a disaster area. In such circumstances the node proneness to failure is high due to possibility of nodes being damaged and failing. Nodes in ad-hoc networks have rechargeable energy supplies and are not subject to adverse environmental conditions that could damage them to the extent of not being able to function any longer.

D. *Frequency of topology changes*

The topology of WSN changes very frequently, due to factors such as node failures, nodes mobility and environmental interference. Topology changes can happen as frequently as every few milliseconds. In ad-hoc networks, nodes usually request to join the network and leave the network after a certain period of time which is rarely less than a couple of minutes.

E. *Communication paradigms*

Wireless sensor network mainly uses broadcast communication, whereas most wireless ad-hoc networks use point-to-point communications. Broadcasting is used in WSNs during set up and maintenance, discovery of neighbors and data transmission phase.

F. *Resource constraints*

The tiny and low cost sensor nodes are constrained in resources like energy, bandwidth, and memory. The ad-hoc network nodes (like laptops and PDAs) and cellular phone can get recharged easily. But it is impractical to recharge those unattended sensor nodes. The data rates in WSNs are up to a few kilobits per second while in ad-hoc networks rates are few hundred megabits per second. The memory of WSN nodes is limited to a few kilobytes, while in ad-hoc networks nodes can have gigabytes of memory.

IV. PROPOSED METHODOLOGY

Here we introduce an energy efficient hierarchical routing protocol which maximizes the lifetime of the sensor network & increases mean residual energy of the network.

A. *APPROACHES USED*

In the previous work, the LEACH architecture details were given. The LEACH algorithm has two phases: the setup phase and the steady phase. This chapter describes the proposed algorithm, which is also based on the principle of clustering technique. We have modified LEACH algorithm by using improved cluster setup & cluster head selection mechanism.

B. *Proposed changes in Cluster Setup Phase*

In the proposed protocol, clusters are formed geographically. The flat area is divided into the equal parts; nodes belong to the same part forms a cluster. In case of Non-hierarchical cluster formation, entire sensor area space will be used. But in other cases such as two, three & four cluster formation, sensor area space will be divided into equal areas. In case of LEACH this equal area segregation is not used.

C. *Proposed changes in Cluster head Selection Phase*

The cluster formation phase is followed by cluster head selection phase. We first calculate the residual energy of each node in the cluster. Then the energy of the nodes within a cluster is compared to each other. In order to do efficient communication, the node having maximum energy in the clusters is selected as cluster head. Since the cluster head performs data collection from various sensor nodes within the cluster, data aggregation & data transmission, they lose their energy very quickly. Due to draining activities being constraint on a cluster head; the cluster head is rotated among the sensor nodes of the cluster at every transmission round. After each transmission the residual energy of the nodes is recalculated and then again comparing the nodes energy and selecting the node with maximum energy as the cluster head. By rotating the cluster heads on the basis of residual energy, we can equally divide the burden of transmission & thereby increase the network lifetime.

In this approach we also use minimum distance concept during transmission. We calculate the distance between nodes to cluster heads and cluster heads to other promising cluster heads or to the base station. Then the minimum distance path is selected for the transmission so that less energy is wasted in transmitting data. Once the cluster head with shortest path is selected, they aggregate the data to be transmitted and then transmit it using shortest path.

D. *THE PROPOSED ALGORITHM*

The proposed algorithm can be summarized using following steps:

Step 1: Cluster Formation Phase

Cluster formation is done by dividing the area into equal parts. It will depend on the number of clusters. In case of Non-hierarchical clustering, entire area will be used. For First-level, Second-level & Third-level hierarchical routing, area will be divided into two, three & four equal parts respectively.

Step 2: Cluster head Selection Phase

Cluster heads are selected from each cluster on the basis of residual energy as well as the minimum distance to the next higher level cluster head or to the base station. Process of cluster head selection is shown in Fig. 3.2.

Step 3: Data Aggregation Phase

Once the cluster heads selection is done, data aggregation phase starts. Since sensor nodes might generate redundant data, this data can be aggregated to reduce the number of transmissions. This phase involves gathering of collected data by the cluster head from the sensor nodes & performing signal processing functions in order to get a composite signal.

Step 4: Data Transmission Phase

After data aggregation, data transmission phase begins. The aggregated data is transferred from the cluster heads to the other cluster heads or to the base station.

After the transmission phase, residual energy of the nodes is recalculated; then again cluster heads are selected. We equally divide the burden of transmission by rotating the cluster heads on the basis of residual energy which will lead to increased network lifetime.

V. RESULT AND CONCLUSION

In this experiment sensor nodes are distributed within an area of 300m x 300m. The base station is placed at the origin, i.e., (0, 0). The initial energy of each node is 200 Joules. The position of the other nodes is randomly generated by the simulating software.

The sensor nodes in the network are formed into clusters of different sizes of one, two, three & four. Fig. 4.2 indicates the Non-hierarchical cluster formation using proposed routing technique. Likewise, Fig. 4.3 & 4.4 shows the simulation result of the cluster formation using proposed hierarchical technique for two (First-level) & three clusters (Second-level).

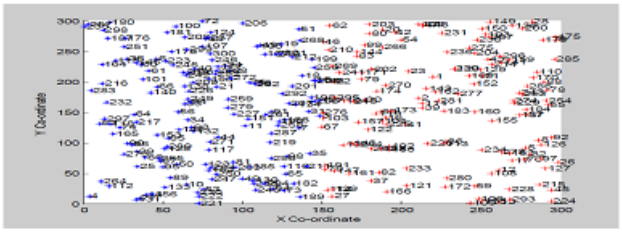

Fig. 1 Non-hierarchical cluster formation

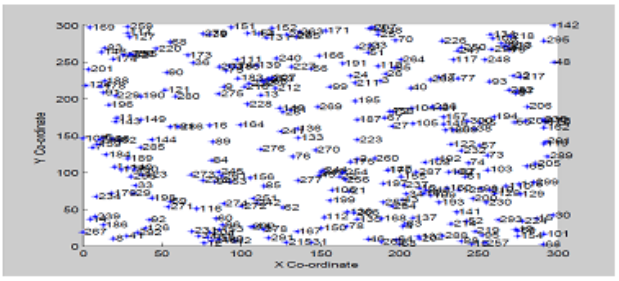

Fig 2. First Level hierarchical cluster formations with two clusters

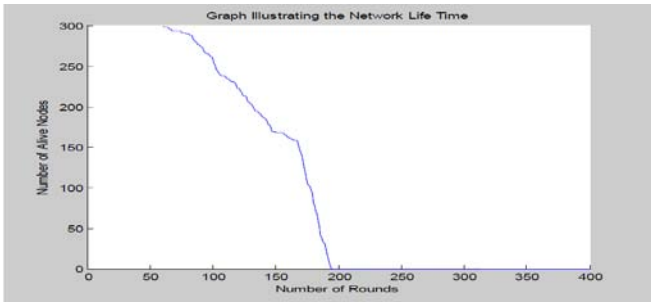

Fig 3. Network lifetime graph for First-level hierarchical Routing protocol

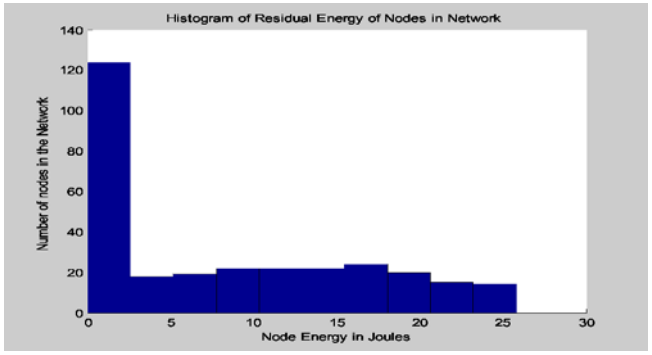

Fig 4. Histogram of residual energy for Non-hierarchical routing protocol

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