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Increasing efficiency of wireless sensor network using decentralized approach

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ABSTRACT: *Sensor networks* are collection of sensor nodes which co-operatively send sensed data to base station. Clustering in wireless sensor networks (WSNs) is an important technique to ease topology management and routing. Clustering provides an effective method for prolonging lifetime of a WSN. The different clustering algorithms also differ in their objectives. This paper proposes energy efficient clustering schemes for wireless sensor networks. Clustering sensor nodes into small groups is an effective method to achieve scalability, fault tolerance, load balancing, routing etc. The simulation results demonstrate the effectiveness of proposed protocol in term of energy and routing ovrhead.

Keywords: *wireless sensor networks, clustering, network lifetime.*

I. INTRODUCTION

Wireless sensor network is a well-known area for exploration now days, because of the extremely recent advances in technology which have made conceivable the production of intelligent, autonomous, and energy efficient sensors that can be deployed in large numbers to shape self-arranging and self-mending WSNs in a geographical area. Wireless networks are gaining popularity due to its versatility, simplicity and extremely moderate and cost sparing establishment. It comprises of numerous battery-controlled devices, outfitted with one or a several sorts of sensors, equipped for wireless communication, data storage, and limited amount of computation. A Wireless Sensor Network (WSN) is a wireless network consisting of a large number of small devices called sensor nodes which are densely deployed in an unattended environment with the capabilities of sensing, wireless communications and computations. These nodes which are very little in size consist of sensing, data processing and communicating components. The nodes in a wireless sensor network are normally deployed on an ad-hoc basis with proper and careful planning. Sensor nodes are deployed in areas of interest to cooperatively monitor physical or environmental conditions, such as sound, vibration, temperature, pressure, motion, electromagnetic disturbance, etc.

Numerous examination studies have demonstrated that the hierarchical network routing and the clustering mechanisms make significant improvement in WSNs in reducing energy consumption and overhead. Clustering protocols can reduce communication overhead since they do not have to manage the location information of sensor nodes. As a result, it allows nodes saving more energy leading to a longer network life time.

II. CLUSTERING IN WSN

Wireless sensor networks are considered as energy-limited and application-specific. Each battery-power sensor node is a constrained device with a relatively small memory resources, restricted computational power, and limited communication capability. Thus, to maximize the network lifetime, energy conservation is of paramount importance in the research of sensor networks. WSNs are usually employed to cover a very large area and thus need to be in touch with far away base station. Clustering is an effective topology control approach in WSNs which can increase network scalability and lifetime. In Clustering, the sensor nodes are apportioned into distinctive groups. Each one cluster is overseen by a node alluded as group head (CH) and different nodes are alluded as cluster nodes. Group nodes don't speak straightforwardly with the sink node. They need to pass the gathered information to the cluster head. Group head will total the information, gained from cluster nodes and transmits it to the base station. In this way it minimizes number of messages imparted to base station.

The power management schemes of wireless sensor networks have attracted high attention in recent years. Much published research has addressed all kinds of issues related to them. According to energy consumption protocols in Wireless sensor networks can be classified as flat, hierarchical and location based

routing protocols. In flat network routing all nodes have the same functionality. They work together to carry out sensing and routing tasks. In hierarchical routing entire network is divided into a number of clusters to achieve energy efficiency and stability.

The clustering infrastructure has following components:

Sensor Node: It is the centre segment of remote sensor system. It has the proficiencies of sensing, transforming, steering, and so on.

Cluster Head: The Cluster head (CH) is acknowledged as a pioneer for that particular group. What's more it is answerable for distinctive exercises did in the cluster, for example, information conglomeration, information transmission to base station, planning in the group, and so on.

Base Station: Base station is acknowledged as a fundamental information accumulation node for the whole sensor system. It is the scaffold (by means of correspondence connection) between the sensor system and the end client. Regularly this node is recognized as a node with no force obligations.

Cluster: It is the organizational unit of the system, made to streamline the correspondence in the sensor system.

III. CLUSTERING PARAMETERS

There are some basic parameters regarding clustering procedures in WSN.

1. Intra-cluster communication: In some initial clustering approaches the communication between a sensor and its designated CH is assumed to be direct (one-hop communication).However, multi-hop intra-cluster communication is often (nowadays) required, i.e., when the communication range of the sensor nodes is limited or the number of sensor nodes is very large and the number of CHs is bounded.
2. Nodes and CH mobility: If we assume stationary sensor nodes and stationary CHs we are normally led to stable clusters with facilitated intra-cluster and inter-cluster network management. On the contrary, if the CHs or the nodes themselves are assumed to be mobile, the cluster membership for each node should dynamically change; forcing clusters to evolve over time and probably need to be continuously maintained.
3. Cluster formation methodology: In most recent approaches, when CHs are just regular sensors nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination. In few earlier approaches a centralized (or hybrid) approach is followed; one or more coordinator nodes are used to partition the whole network off-line and control the cluster membership.
4. Cluster-head selection: The leader nodes of the clusters (CHs) in some proposed algorithms (mainly for heterogeneous environments) can be pre assigned. In most cases however (i.e., in homogeneous environments), the CHs are picked from the deployed set of nodes either in a probabilistic or completely random way or based on other more specific criteria (residual energy, connectivity etc.).
5. Multiple levels. In several published approaches the concept of a multi-level cluster hierarchy is introduced to achieve even better energy distribution and total energy consumption (instead of using only one cluster level). The improvements offered by multi-level clustering are to be further studied, especially when we have very large networks and inter-CH communication efficiency is of high importance.

IV. CLUSTERING PROTOCOLS

Several protocols have been proposed with time to maximize the sensor network lifetime by adopting cluster-based network architectures. These algorithms are mostly heuristic in nature and aim at generating the minimum number of clusters such that any node in any cluster is at most d hops away from the cluster head. Most of these algorithms have a time complexity of O(n) , where n is the total number of nodes. Many of them also demand time synchronization among the nodes, which makes them suitable only for networks with a small number of sensors.

One of the well-known clustering protocols is called LEACH. LEACH is a cluster-based protocol that includes distributed cluster formation in which the nodes elect themselves as cluster heads with some probability. The algorithm is run periodically and the probability of becoming a cluster head for each period is chosen to ensure that every node becomes a cluster head at least once within 1/P rounds, where P is the predetermined percentage of cluster heads. LEACH organizes its operation into rounds, where each round consists of a setup phase where clusters are formed and a steady state phase that consists of data communication process. LEACH provides significant energy savings and prolonged network lifetime over conventional multihop routing schemes, such as the minimum transmission energy (MTE) routing protocol [2]. However, LEACH does not guarantee that the desired number of cluster heads is selected and cluster heads are not evenly positioned across the network.

HEED (Hybrid Energy Efficient Distributed) protocol is the clustering protocol. It uses residual energy as primary parameter and network topology features are only used as secondary parameters to break tie between

candidate cluster heads, as a metric for cluster selection to achieve load balancing. In this all nodes are assumed to be homogenous i.e. all sensor nodes are equipped with same initial energy [6].

HEED has four primary objectives: (i) prolonging network lifetime by distributing energy consumption, (ii) terminating the clustering process within a constant number of iterations, (iii) minimizing control, and (iv) producing well-distributed cluster heads.

Another clustering protocol which enhances the network lifetime is Power-Efficient Gathering in Sensor Information Systems (PEGASIS) which uses a greedy algorithm to organize nodes into a chain, so that each node transmits and receives from only one of its neighbours. In each round, a randomly chosen node from the chain will transmit the aggregated data to the base station and reduce the number of nodes that communicate directly with the base station.

V. CLUSTERING ADVANTAGES

Clustering routing protocols have a variety of advantages, such as more scalability, less load, less energy consumption and more robustness.

More Scalability: In clustering routing scheme, sensor nodes are divided into a variety of clusters with different assignment levels. The CHs are responsible for data aggregation, information dissemination and network management, and the MNs for events sensing and information collecting in their surroundings. Clustering topology can localize the route set up within the cluster and thus reduce the size of the routing table stored at the individual sensor nodes.

Less load: Many clustering routing schemes with data aggregation capabilities require careful selection for clustering approach. For clustering topology, all cluster members only send data to CHs, and data aggregation is performed at the CHs, which help to dramatically reduce transmission data and save energy.

Less Energy: Consumption: In clustering routing scheme, data aggregation helps to dramatically reduce transmission data and save energy. Moreover, clustering with intra-cluster and inter-cluster communications can reduce the number of sensor nodes performing the task of long distance communications, thus allowing less energy consumption for the entire network.

More Robustness: Clustering routing scheme makes it more convenient for network topology control and responding to network changes comprising node increasing, node mobility and unpredicted failures, etc. A clustering routing scheme only needs to cope with these changes within individual clusters, thus the entire network is more robust and more convenient for management.

VI. MOTIVATION

The main goal of cluster-based routing protocols is to improve energy efficiency in network nodes and increase network lifetime. Network organization to be more efficient with clustering and energy consumption is distributed in entire network. The main research issue regarding such protocols is how to form the clusters so that the energy consumption and contemporary communication metrics such as latency is optimized. In this study our main objectives will be:

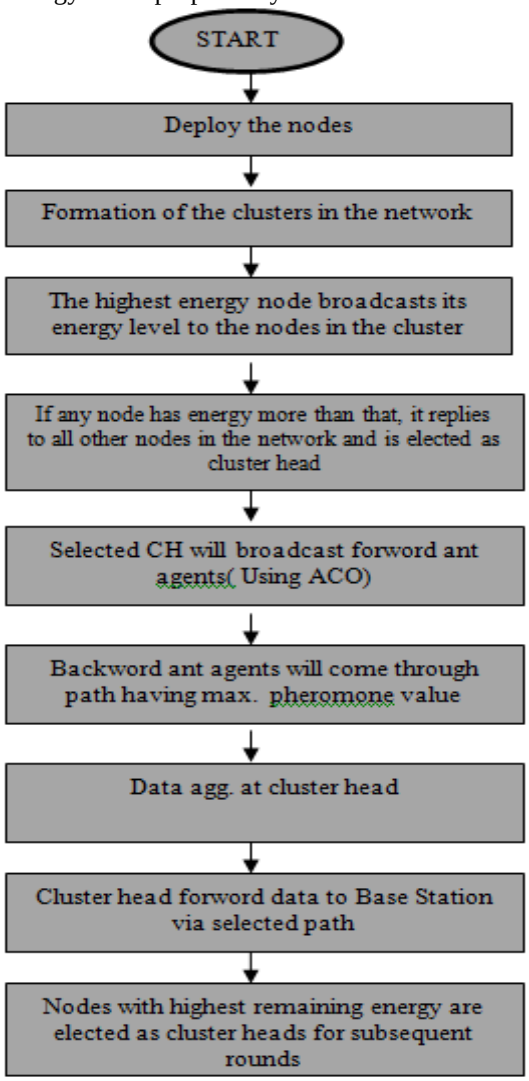
1. Selection of cluster heads in the network by base station and analyse the performance of the network.
2. Electing cluster heads using decentralized technique.
3. Routing the data to the base station among cluster heads using multi hop technique.

VII. PROPOSED SCHEME

One of the most important challenges of WSNs design is develop a method or protocol so that the randomly deployed numerous sensor nodes behave in a collaborative and organized way. Each sensor node wants to maximize its own utility function. In addition, the entire network needs balance in resource assignments to perform in a way that is useful and efficient. So it becomes extremely important to design a method which can save energy of the nodes so that nodes in the network may work for long duration and the lifetime of the network can be increased.

The paper takes into consideration the concept of cluster of cluster heads within a cluster. The high energy nodes in a cluster form a cluster of cluster heads among themselves. The base station is mainly responsible for selecting the cluster head nodes in the network. However, when the base station is situated at the corner of the network, the selection of cluster head nodes by the base station demands significant amount of energy on the part of cluster heads also, since receiving the messages over the larger distance requires the radio to consume more energy as compared to short range communication.

The flowchart explains the methodology of the proposed system:



VIII. RESULTS

This section presents the simulation results. The proposed approach has been simulated in NS2.35 and the results show the energy graph and the routing overhead comparison.

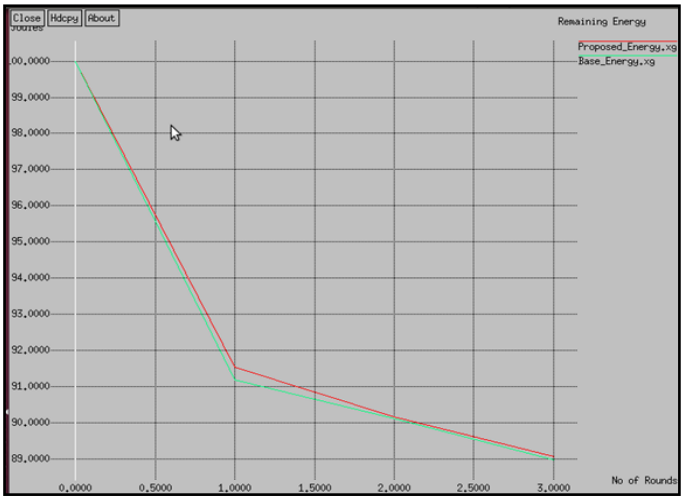


Fig. 1 Remaining Energy

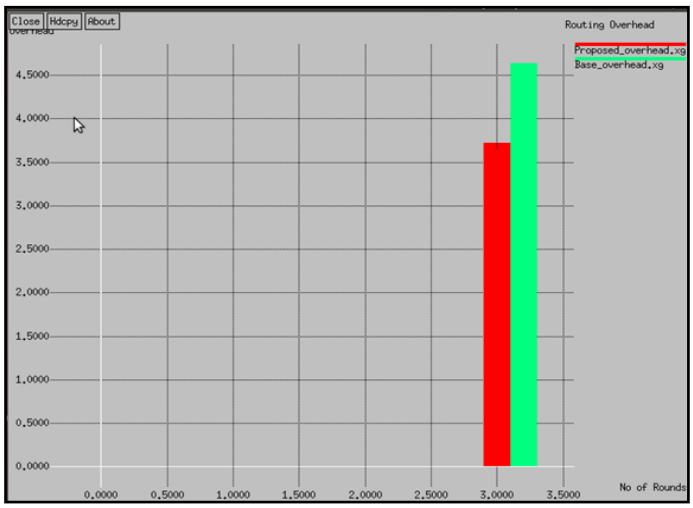


Fig.2 Routing Overhead

IX. CONCLUSION

In this paper, a comprehensive overview of clustering in wireless sensor networks has been presented. The paper presents that wireless sensor network consists of a large number of sensor node. And these nodes are resource constraint. That's why energy of the network is limited so the various approaches or protocol has been proposed for increasing the energy efficiency of the wireless sensor network.

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