INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

(Volume2, Issue3)

Available online at: www.Ijariit.com

A Novel Self Organizing Clustering Scheme for Clusters Setup

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Abstract— Wireless Sensor Networks (WSN) consists of nodes with limited power deployed in the area of interest. Nodes cooperate to collect, transmit and forward data to a base station. In WSN, clustering and scheduling techniques ensure collecting data in an energy efficient manner. In this work, we have reviewed many papers relating to clustering and scheduling of sensor network. After reviewing many papers and considering the latest one as the base paper we believe that the work done in it is the latest one, modifications in the work is suggested in this report. This proposal give the basic description of wireless sensor network and their importance in energy efficiency and give a brief about most famous protocol is describes leach and their improved version In this work we have proposed a novel self-organizing clustering scheme which considers the real time parameters for setting up the clusters for data collection. Unlike several proposed algorithm, this scheme reclusters the network only when CH fall below a threshold level. Repeated unnecessary clustering in every round depletes the energy of the network more quickly. We have introduced heterogeneity in the proposed work. By virtue of heterogeneity in terms of energy, lifetime of the network can be extended. An algorithm is functional if the area of interest is covered by active nodes. The period for which the network is functional is termed as persistent period in our work. Simulation results show that the proposed scheme is comparatively more energy efficient, scalable & robust and has longer persistent period. And later part of the proposal give the advantage and disadvantage of these protocols.

Keywords— WSN, LEACH PROTOCOL, OPTIMIZATION TECHNIQUE, DISTRIBUTED PROTOCOL, NETWORK ARCHITECTURE

I. INTRODUCTION

Wireless sensor network is an emerging field for research in today's world. Wireless sensor networks have vast potential for usage of sensor networks in different areas like military area, disaster management, sensing environment conditions such as temperature, humidity etc. Wireless sensor network is a collection of huge number of micro sensor nodes, which are generally deployed in such an environment where unattended operation is required by the application. Limitation of unchangeable power source (i.e. battery) has challenged the researchers to develop energy efficient protocols for the extending the lifetime of wireless sensor network.

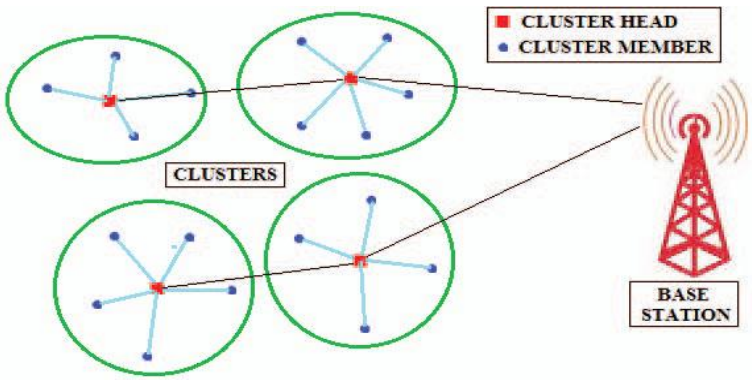

Figure: 1.1 Wireless sensor network architecture

In wireless sensor networks, as number of sensor nodes are used for communication, which mainly forms a sensing field, and sink.

1.1 Associated Problems

There are some design issues of clustering protocols which must be considered in order to design an efficient clustering/routing protocol. Some common issues are as follows:

- **Fault tolerance:** In WSNs some sensor node may fail due to lack of power or environmental interferences. This failure of sensor nodes should not affect the performance or functionality of WSN and the ability to sustain this node failure without any interruption is called fault tolerance.
- **Operating Environment:** The WSNs can be setup in different operating environments like in bottom of ocean, in a home or in a building, attached to a fast moving vehicle, in forests, etc. the characteristics of WSNs like lifetime, stability, should be different for different environments.
- **Power Consumption:** The transmission power required by multi-hop routing protocol should be less. The less the energy consumption is the more the lifetime of sensor nodes and therefore, as well as WSN network.
- **Data Aggregation:** Data aggregation is combination of data from different sources by using computation as it is less energy consuming then communication. In WSNs, sensor node generates significant amount of data, similar packets from multiple nodes can be aggregated so that number of transmissions would be reduced and energy efficiency would be increased.
- **Quality of Service:** The quality of service required by the application could be the length of time, energy efficiency, the data reliable, collaborative-processing and location-awareness. All of these factors will affect the selection of routing protocols for particular application.
- **Data Latency and Overhead:** There is some data latency caused by data aggregation, and multi-hop relays and also some routing protocols create excessive overheads to implement their algorithms, which is not suitable for some applications.
- **Node Deployment:** Node deployment is affects the performance of the routing protocol and is application dependent. The deployment is of two types: deterministic or self-organizing. In deterministic, the sensors are manually placed and data is routed through predetermined paths. In self-organizing systems, the sensor nodes are scattered randomly and the position of sink or the cluster head becomes an issue to energy efficiency of network.

1.2 Overview of Potential Solution

The routing protocols in WSNs can be divided into two categories: flat routing and clustering routing and this classification is based on network structure. In flat routing all nodes have same functionalities. They perform same tasks and the data transmission is done by multiple hops. On other hand, in a clustering or hierarchical protocol, nodes have different tasks and they are divided into groups called clusters. The clustering protocol is best solution that can resolve most of the problems mentioned above.

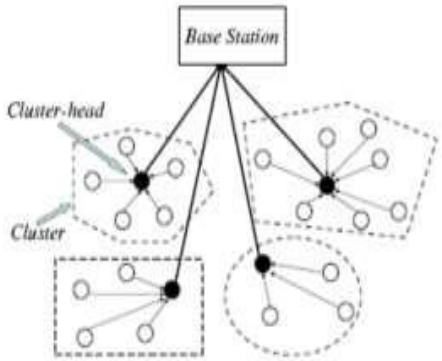

Figure: 1.2 Clustering in WSNs

In each cluster there is a cluster head (CH) which communicates with base station (BS), and other nodes called member nodes which collect and send data to the cluster head (Figure 1.4). The selection scheme for cluster head must be energy efficient and it must also be capable of maintaining overall stability of network.

1.3 Key Benefits of Potential Solution

Clustering routing protocols have a variety of advantages as follows:

- **More Scalability:** The CHs are responsible for data aggregation, information dissemination and network management. 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.
- **Data Aggregation/Fusion:** Data aggregation/fusion is a technique for WSNs to save energy. The most popular data aggregation/fusion method is clustering data aggregation, in which each CH aggregates the collected data and transmits the fused data to the BS. Usually CHs are formed a tree structure to transmit aggregated data by multi-hopping through other CHs which results in significant energy savings.
- **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. In addition, only CHs perform the task of data transmission in clustering routing scheme, which can save a great deal of energy consumption.

- **More Robustness:** Clustering routing scheme control the network changes comprising 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. In order to share the CH responsibility, CHs are generally rotated among all the sensor nodes to avoid the single point of failure in clustering routing algorithms.
- **Collision Avoidance:** In multi-hop clustering model, a WSN is divided into clusters and data communications between sensor nodes comprise two modes, *i.e.*, intra-cluster and inter-cluster, respectively for data collection and for data transmissions. Accordingly, resources can be allocated orthogonally to each cluster to reduce collisions between clusters and be reused cluster by cluster.
- **Fault-Tolerance:** Fault-tolerance is an important challenge in WSNs. In order to avoid the loss of significant data from key sensor nodes, fault-tolerance of CHs is usually required in this kind of applications, thus effective fault-tolerant approaches must be designed in WSNs. Re-clustering is the most intuitive method to recover from a cluster failure, though it usually disarranges the on-going operation. Assignment of CH backup is a viable scheme for recovery from a CH failure.
- **Guarantee of Connectivity:** Sensor nodes usually transmit data to one or more BSs via a single-hop or multi-hop routing in WSNs, thus sensor nodes that cannot communicate with any other sensor node will get isolated and their data can never be transmitted to the BS. Therefore, guarantee of connectivity is an essential goal of clustering routing protocols in WSNs. An important example is when some information concerning all the sensor nodes needs to be collected by a designated fusion node in clustering routing protocols.

II. **LITERATURE REVIEW**

An **In[1]Pawan Singh Mehra et al** (2015) presents Clustering is one of the efficient techniques which not only help in protraction of lifetime of wireless sensor network but also make it scalable and robust. Subdivision of network into group of sensor nodes with a coordinator is called a cluster. Cluster members collect the physical data by sensing the environment and forward it to the coordinator which is generally termed as Cluster Head (CH). The period for which the network is functional is termed as persistent period in our paper. Simulation results show that the proposed scheme is comparatively more energy efficient, scalable & robust and has longer persistent period.

In[2]Sujee et al (2015) proposed that Wireless Sensor Network (WSN) technology used to sense various types of physical and environmental conditions with the availability of small and low-cost sensor nodes. Main drawback in WSN is limited battery power in the sensor nodes. Here, first analysed the basic distributed clustering routing protocol LEACH, which is in a homogeneous environment, then analysed with the heterogeneity concept in nodes to increase the life of WSN. Simulation results were obtained using MATLAB that shows the LEACH heterogeneous environment significantly reduces energy consumption and increases the total lifetime of the WSN than LEACH homogeneous environment.

In[3]Tavleen et al (2014) proposed that wireless sensor networks have become an important research area in the field of computers and electronics in the last decade. The original motivation for the development of wireless sensor networks was military applications such as battlefield surveillance. However there are number of other applications of wireless sensor networks such as healthcare monitoring, forest fire detection, environment monitoring, home automation.

In[4]Jyoti Rajput et al (2014) that Wireless Sensor Network Data Aggregation is an important technique to achieve power efficiency in the sensor network. In some application such as: wireless sensor network, data mining, cloud computing data aggregation is widely used. Because sensor node has limited battery power so data aggregation techniques have been proposed for wireless sensor networks. In this survey paper they described various protocols for securing aggregated data in wireless sensor networks.

In[5]Salim EL KHEDIRI Nejah NASRI et al (2014) described the LEACH-C. It is similar to LEACH protocol. In this, instead of nodes randomly self- selecting as a CH, the in LEACH performs a centralized algorithm. The sink collects location data from the nodes and they broadcast its decision of which nods are to act as CH. The overall performance LEACH is better than LEACH. But once the energy cost of communicating with the sink becomes higher than the energy cost for cluster formation, LEACH-C no longer provides good performance. Sinks may be located far from the network in most WSN applications.

In[6]Amit Sharma et al (2014)said that In WSN, it is too difficult to initialize the sensor nodes and manage the sensor networks due to the large number of sensor nodes, which may number tens of thousands. Moreover, in order to save energy, sensor nodes carry out data aggregation and compression before sending data to the base station, and execute energy efficient routing. So in this research work Amit Sharma Dr. S. N. Panda et al analyzed that cluster based routing technique is the best energy efficient routing technique comparing to any other techniques**.**

In[7]Joyce jose et al (2013) uses the data aggregation is a widely used energy-efficient mechanism in wireless sensor Networks (WSNs), by avoiding the redundant data transmitting to base station. The privacy of a sensor data ensures, it is known only to itself and the integrity guarantees sensor data has not tampered during data aggregation. The Integrity Protecting Privacy preserving Data Aggregation (IPPDA) protocols ensures robust and accurate results at the base station.

In[8]Abdulsalam et al (2013) proved that Weighted Low Energy Adaptive Clustering Hierarchy Aggregation (W-LEACH), is a centralized data aggregation algorithm. As in LEACH, W-LEACH is consists of two phases. In the setup phase, W-LEACH first calculates a weight value, □□, and assigns it to each sensor. The selection of CH is based on the calculated weights, such that the higher the weights the better the chance for them to be CHs. unlike LEACH, W-LEACH does not take into consideration whether or not this sensor was a CH for previous near rounds In steady-state phase, the candidates for sending data to CHs are also chosen based on their weights, such that sensors with less weight are better candidates to send data to their CHs to make sure that the areas with low densities and far from their CHs are covered.

In[9]Sharma et al (2012) a distance based Cluster head selection algorithm is proposed for improving the sensor network life time. This protocol achieves a good performance in terms of lifetime by balancing the energy load among all the nodes. This clustering technique helps to prolong the life of wireless sensor network, especially in hostile environment where battery replacement of individual sensor nodes is not possible after their deployment in the given target area. Therefore, the proposed technique to distribute the role of the cluster head

(CH) among the wireless sensor nodes in the same cluster is vital to increase the lifetime of the network. This algorithm uses a distance based method for providing the cluster head selection. Clustering techniques also provide good load balancing, and in-network data aggregation.

In[10]Monica R Mundada et al (2012) paper, "A study on Energy Efficient Routing Protocols in Wireless Sensor Networks" study routing protocols in WSNs are application specific, it was led to the development of a various protocols. According to network structure, routing techniques can be classified into three categories: data-centric, hierarchical and location based routing. In this it present a survey of state-of-the-art routing techniques in WSNs according to all the three categories and epitomize these routing techniques and bring out the advantages and disadvantages according their application domain. Conclusion shows that it was highly scalable and thus used in a number of applications and uses the sensor nodes intelligently to route data. It optimizes the logic behind these protocols and followed by the constraints.

In[12]Yajie Ma, YikeGuo et al (2011) proposed an –local spatial clustering algorithm for sensor networks. By measuring the spatial correlation between data sampled by different sensors, the algorithm constructs a dominating set as the sensor network backbone used to realize the data aggregation based on the information description/summarization performance of the dominators. In order to evaluate the performance of the algorithm a pattern recognition scenario over environmental data is presented.

In[13]El khediri et al (2010) says "Synchronization issues in Wireless Sensor Network", talked about LEACH (Low-Energy Adaptive Clustering Hierarchy) in which they utilized random based rotations of local cluster. It is used to distribute the energy for balancing the load. LEACH was used to enable scalability and robustness for non-static networks and add data fusion into the routing protocol for reducing the amount of data. It was able to transmit to base station and performs experiments with larger number of nodes (thousands), and also to conduct test other node.

In[15]Arijit Ukil et al (2010)said that it is more important in the case of Wireless Sensor Networks (WSNs) where collected data often requires in-network processing and collaborative computing. In this paper, analyzes a scenario where data aggregation needs to be done in privacy-preserved way for distributed computing platform. There are number of data sources which collect or produce data. The data collected or produced by the sources is private and the owner or the source does not like to reveal the content of the data. But the collected data from the source is to be aggregated by an aggregator, which may be a third party or part of the network, where the data sources belong.

In[16]Jamal N. Al-Karaki Ahmed E Kamal (2009) explained that LEACH randomly selects a few sensor nodes as cluster heads(CHs) and rotate this role to evenly distribute the energy load among the sensor in the network. In LEACH, the cluster head nodes compress data arriving from nodes that belong to the respective cluster, and send the aggregate data to BS in order to reduce the amount of information that must be transmitted to base station.

III. EXPERIMENTAL RESULTS

The results obtained from proposed LEACH protocol shows improvement in number of rounds, stability of network as well as throughput of the network.

The FND (First Node Dead) also known as stability period is at 2728th round means that the network is stable up to 2728 rounds. The LND (Last Node Dead) also known as instability period is at 6903th round also it shows that network lifetime is about 6903 rounds by using original LEACH protocol.

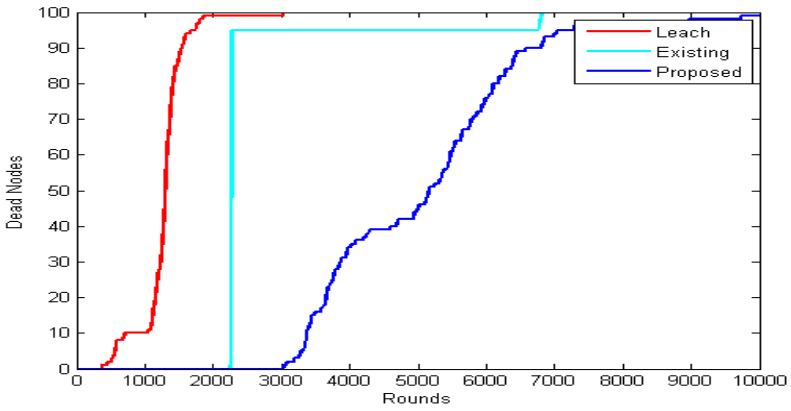

Figure 1.3 Nodes dead during rounds in proposed LEACH PROTOCOL

The Figure 4.2 showing nodes dead during rounds plot for Proposed LEACH protocol. The FND (First Node Dead) also known as stability period is at around 3007th round means that the network is stable up to 3000 rounds. The LND (Last Node Dead) is at around 7546th round also it shows that network lifetime is about 7500 rounds by using proposed LEACH protocol.

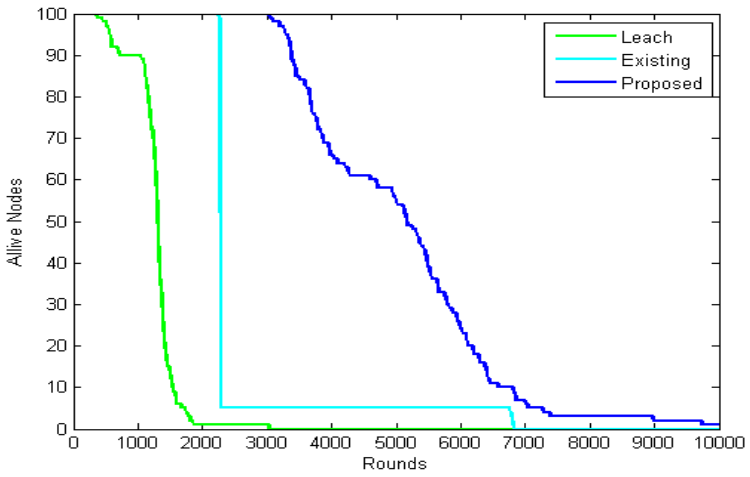

Fig 1.4 Nodes alive during rounds in proposed LEACH PROTOCOL

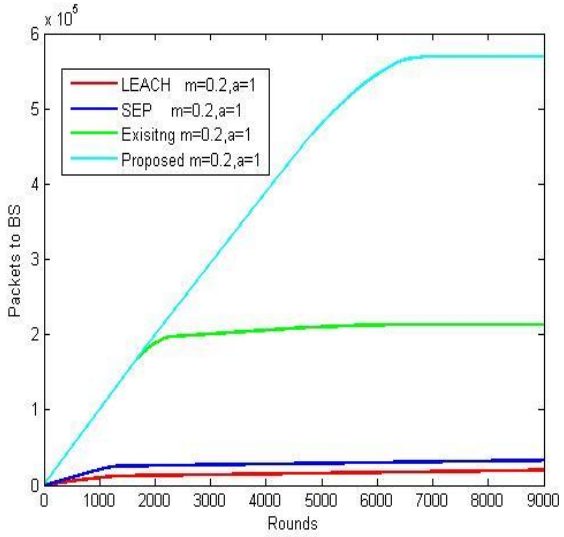

Fig 1.5 Packets to BS v/s no. of rounds plot comparison

TABLE I
Simulation Results

Protocol	**Round** ***(Stable period)***	**Round** ***(Persistent period)***
LEACH	2023	2233
PAWAN et al.	2728	3208
PROPOSED	3007	5012

The results are obtained by several hundred simulations, which are carried out to achieve normalized values. The proposed work has 35% longer stable period than LEACH and 44% better persistence period than LEACH.
Total throughput or packets sent to base station during several rounds are 68250.
The total energy efficiency is increased by 70% in proposed approach as compared to several other approaches.

IV. CONCLUSIONS

In this research a purely LEACH that better utilizes the most valuable network resource (energy) in WSN is introduced. Improved LEACH outperforms the probabilistic-based models we have considered, by guaranteeing that a fixed number of cluster-heads are elected per round. At different rounds cluster-heads are elected using the local information of their residual energies within each clusters to choose the appropriate cluster-heads. As discussed earlier, IMPROVED LEACH has been able to distribute the energy consumption in the WSN evenly among the nodes, hence the nodes die out almost at the same time. The characteristics of IMPROVED LEACH are very desirable as it is close to an ideal solution. Even when we change the number of cluster heads per round, IMPROVED LEACH proves to be more

robust and more stable than the probabilistic-based models. Overall, IMPROVED LEACH improves the lifetime of wireless sensor networks by an order of magnitude, which is significant when compared with LEACH, SEP and SEP-E. IMPROVED LEACH takes advantage of the local information i.e the residual energy of each node to optimize the energy consumption in both homogeneous and heterogeneous scenarios we have considered, regardless of the level of energy hierarchies in the network. Longer *persistant period* in proposed work justifies the load balancing in the network.

In our future work, we intend to adapt IMPROVED LEACH protocol to a real world application setting such as:

- In agricultural farmland for fertilizer spraying operations.
- Intrusion detection system (IDS).
- Detection of poisonous gas.

It is our hope that this method can provide more insight into optimizing WSN energy consumption in real-world scenarios.

ACKNOWLEDGMENT

Every success stands as a testimony not only to the hardship but also to hearts behind it. Likewise, the present work has been undertaken and completed with direct and indirect help from many people and I would like to acknowledge all of them for the same.

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