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Enhanced Wireless Sensor Network Protocol

Aditya Tandon[1], Kuldeep Bhardwaj[1], Hrithik Tyagi[1], Harsh Chaudhary[1], Nikita Nijhawan[2]

[1]BTECH CSE (BPIT)

[2]Assistant Professor CSE (BPIT)

***ABSTRACT*: Wireless Sensor Network (WSN) consists of spatially distributed independent sensors which check the physical or ecological surroundings and to considerately send the data collected by sensing environment via the network to a main place named as sink or base station. The sensor nodes in a WSN are constrained in terms of resources like energy, memory, computational speed etc. The in-network processing in WSN like data aggregation, information fusion, computation and transmission activities require the sensors to use their energy efficiently in order to extend their effective network life time. This project is an attempt to study the WSN under energy constraints and also possibly checking the future scope by extending the implementation of LEACH protocol over heterogeneous WSN and various ideas. The study will be achieved by reviewing the topology and the residual energy of the sensor nodes for election mechanism and comparing the leach protocol with the proposed efficient algorithm.**

***KEYWORDS:* Sensor networks; Energy-aware routing; routing protocols; Classification of protocols**

I. WIRELESS SENSOR NETWORK: AN INTRODUCTION

Wireless sensor network consist of huge number of nodes of small power and processing capability which are capable of calculate, report and analyze various variables like temperature, pressure etc. like physical variables which are correlated to surrounding environment. It can also monitor sound and pollutants with its sensing capability. These networks find a lot of areas for deployment which include battle field surveillance and various civilian application areas like industrial monitoring, traffic control and health monitoring etc. it is also used now a days in digital homes like projects to make houses and offices autonomous. It can also monitor ecological factors for environment and forest monitoring. It can detect intrusion, change in the events like presence by thermal change, and monitor the movement also in the deployed area. Data thus collected by the nodes is send to the special node called as sink or base station where the data is compiled to analyze that which respective action is to be taken respective to that particular situation.[1] So that useful information can be fetched or action could be taken.

Architecture

In the architecture we have a single command node called as sink which take control of all the sensor nodes deployed in the field. Wireless sensors are proficient in radio-based short-haul contact and are dependable for checking whether large event or action is present in the specified area. Many nodes combine to make sensor in a particular area or energy zone to make a cluster.

Many other factors like residual energy, overall energy, distance and stability etc can be taken to make any node cluster head among a group of nodes named cluster. Sensors receive data and give it to the gateway node which works on these reading to process them. Gateways can trail events or goals using values or data from wireless sensors in the clusters as estimated by the node in command. Since the sensor nodes can be contacted by gateway nodes the nodes are expected to carry more energy and save it for transmission. The report thus generated is passed to the sink and system level fusion is done over the collected values to perform the action in that present scenario.

Components

Wireless sensors are proficient in radio-based short-haul contact and are dependable for checking whether large event or action is present in the specified area. A WSN contains hundreds or thousands of these SNs. the command node reports generated through fusion of sensor readings, e.g. tracks of detected targets .These sensors have the ability to communicate either among each other or directly to an external Base-Station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Each individual node is comprised of one or more sensing devices, a processor, a communication unit, and a power supply. SNs are usually scattered in a sensor field, which is an area where the SNs are deployed. Sensor nodes can be categorized in two types these are:

Homogeneous nodes: When all the nodes deployed during the simulation considered having same energy coefficient then we call it homogeneous environment.

Heterogeneous nodes: When the nodes deployed are divided in different energy level approaches like two or three energy levels, it is called as heterogeneous environment. For example in our case we are taking normal energy nodes and advanced energy nodes.[7]

FEATURES Due to a lack of infrastructure, SNs need to cooperate with each other so as to maintain life and secure information. Each SN not only acts as a host, but also as a router for data forwarding. Each SN has limited power, memory storage, data processing capacity and radio transmission range [5]. Generally, a WSN has the following characteristics Ad hoc Deployment, Dynamic Network Topology, Energy Constrained Operation, Unattended Operation, Infrastructure-less, Shared Bandwidth and Large Scale of Deployment. [8]

II. LEACH

LEACH [4] stands for Low Energy Adaptive Clustering Hierarchy Protocol. W.R. Heinzeolman proposed this protocol, which is based on cluster structure and hierarchical technology. Hierarchical protocols are defined to reduce energy consumption by aggregating data and reducing transmission to the base station. LEACH is a Self-organizing, adaptive clustering protocol that uses randomization to distribute energy load evenly. LEACH is a TDMA based MAC protocol in which a network is divided into several clusters. Within each cluster, 1 sensor node is elected as a Cluster Head (CH) while, all other nodes are Cluster Members (CM) as shown in figure 2. CH collects the data locally from all its CMs and transmits the aggregated data either directly or via multi-hop transmission to the base station. LEACH protocol provides a concept of rounds and each round contains two phases:

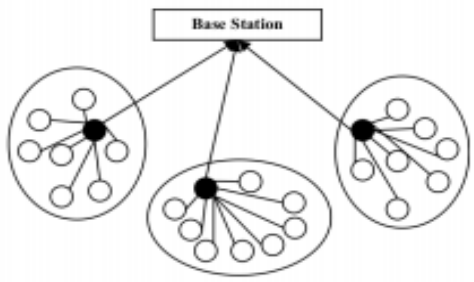

Fig.2 LEACH clusters

1. Cluster Set-up phase: Set-up phase is used to make cluster and select cluster head for each cluster by choosing the sensor node with maximum energy. Cluster heads are chosen randomly based on a set formula. Once a node is elected as a cluster head, it cannot become cluster head again until all other nodes of the cluster have become cluster head once. This helps in balancing energy consumption. 3 fundamental steps of this phase are

Cluster Head Advertisement: Each node that elected itself a CH for current round broadcasts advertisement message to rest of the nodes using same transmit energy.

Cluster Setup: Non-CH nodes keep their receivers on during this phase and decide which cluster to belong to by choosing the CH based on the received signal strength of the advertisement. They send join requests to the chosen CH. [9]

Creation of Transmission Schedule: CH creates a TDMA schedule telling each node when it can transmit. It allows the radios of each CM to be turned off during the time of non-transmission and thereby saving a lot of energy.

2. Steady phase: In this phase, the cluster nodes send their data to the CH. The CH then aggregates all the collected data and forwards this data to the base station either directly or via other CH along the static route defined in the source code. After certain pre-defined time, the network again goes back to the Set-up phase to ensure uniform energy dissipation. Figure-3 presents a flow diagram of the basic LEACH protocol. **Advantages** CH aggregates the whole data which leads to reduction in the traffic of entire network. A single hop routing from nodes to cluster head saves energy. It increases the lifetime of sensor nodes. LEACH is completely distributed as it does not need any control information from base station as well as no global knowledge of the network is required.

Limitations It does not give any idea about the number of cluster-heads. If a CH dies, the associated cluster will become useless as the data gathered by the cluster nodes will never reach the base station. Clusters are divided randomly, which results in uneven distribution of clusters (in terms of density, size and cluster head position). This can lead to an increase in the energy consumption.[2,6]

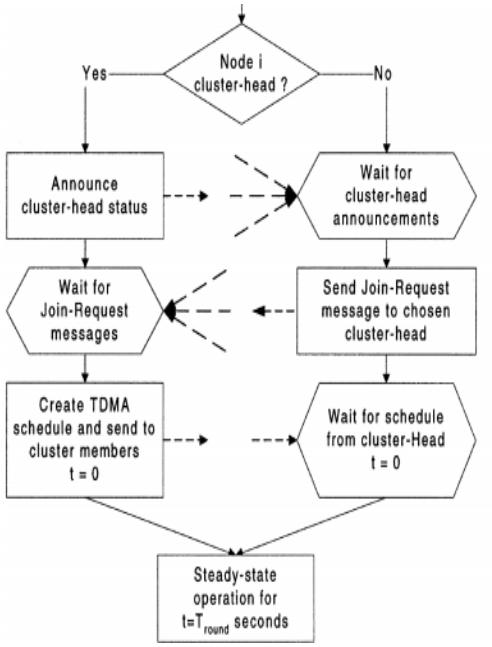

Figure 3: Flow Diagram of LEACH protocol

III. RELATED WORK ON LEACH

M-LEACH Multi-hop LEACH [5] allows sensor nodes to use multi-hop communication within the cluster in order to increase the energy efficiency of the protocol. Multi-hop communication can be used both within the cluster and from cluster head to base station as well.

LEACH-C LEACH-centralized [6] is an attempt to distribute clusters throughout the entire sensor field. As a result of dispersing clusters throughout the network, LEACH-C protocol records better performance compared to LEACH. The base station receives information about residual node energy and node positions at the set-up phase of each round. With the received data, average residual energy for all nodes is calculated and all nodes with energy less than this average are excluded in selection of cluster heads.

LEACH-F LEACH with Fixed clusters (LEACH-F) is based on clusters that are formed once and then fixed. The Next Node position then rotates among the nodes within the cluster. The advantage with this is that, once the clusters are formed, there is no set-up overhead at the beginning of each round. To decide clusters, LEACH-F uses the same centralized cluster formation algorithm as LEACH-C. The fixed clusters in LEACH-F do not allow new nodes to be added to the system and do not adjust their behavior based on nodes dying. Furthermore, LEACH-F does not handle node mobility.

V-LEACH Vice Cluster Head LEACH [7] overcomes the fact that once the cluster head dies, the entire cluster fails to send its data to the base station. It includes CH and a vice-CH which is the node that will become a CH of the cluster in case the CH dies.

E-LEACH Energy-LEACH protocol improves the CH selection procedure. It makes residual energy of node as the main metric which decides whether the nodes turn into CH or not after the first round. Same as LEACH protocol, E-LEACH is divided into rounds, in the first round, every node has the same probability to turn into CH, that mean nodes are randomly selected as CHs, in the next rounds, the residual energy of each node is different after one round communication and taken into account for the selection of the CHs. That mean nodes have more energy will become a CHs rather than nodes with less energy.[5,6]

IV. OUR PROPOSAL

We will be working on improving the LEACH protocol for heterogeneous WSNs. Heterogeneous WSN consists of sensor nodes with different ability, such as different computing power and sensing range. Compared to homogeneous WSN, deployment and topology control are more complex in heterogeneous WSN. The main problem with LEACH protocol lies in the random selection of cluster heads. There exists a probability that the cluster heads formed are unbalanced and may remain in one part of the network making some part of network unreachable. In this work we will try to improve the network life. We will exploit the topology and residual energy of nodes in heterogeneous WSN to improve on the LEACH protocol and make it more efficient. We first divide our nodes into 2 classes-

Advance sensor nodes These are the nodes with residual energy greater than the average residual energy of the network.

Normal sensor nodes These nodes have residual energy below the average residual energy of the network. Let us now dig into how we set up the topology to enhance the energy of WSN.

Topology Modification: Sensor nodes may be deployed randomly or in a structured manner. The network may have a uniform or non-uniform node density. Nodes in the network can be of the same type to form a homogeneous network, or have various capabilities to form a heterogeneous network. Topology control in homogeneous network with uniform structure is simple because of the apriori knowledge about the relative location and capability of other nodes in the network. Without this apriori knowledge, topology control is more challenging in post-deployment configurations and more complex protocols are needed to collaborate the work among nodes. In our proposed work, the area far away from the base station will get more advance nodes as compared to the area near the base station.

Improved Election Criteria: The Set-up phase of LEACH protocol is responsible for the election mechanism for choosing cluster-heads for each round. We will modify these election criteria to incorporate additional information about both the initial and residual energy of each sensor node in the network. The decision of becoming a cluster-head for the current round will depend on the percentage of cluster-heads in the network, as well as the number of times a node has been used as a cluster-head before. In addition to this, The

probability of getting selected as a Cluster-head will be different for advance nodes and normal nodes. We will have an additional energy coefficient attached to the probability of advance nodes to give them a higher probability of becoming a cluster-head. Let Pnormal be the probability of a normal node becoming the cluster head, Padvance be the probability of an advance node becoming the cluster head, Psimple be the probability of a node of becoming cluster head as per naive leach protocol, 'a' be the additional energy factor and m the fraction of nodes, then we make the decision of electing cluster-head as per the formula:

Once the clusters are formed and the respective cluster-heads are chosen as per our improved method, Phase-2 of the native LEACH protocol executes as it is.

V. SIMULATION RESULT

The life time of network is related to the number of alive nodes, number of dead nodes, the rate of packet transmission and the duration for which Variable Values for proposed protocol cluster of nodes is formed in network. The System which is proposed here gives good output in all parameters. We have taken all these values and found that there are less dead nodes and more alive nodes in the proposed system. Also, the rate of packet transmission is enhanced and due to more alive nodes, the cluster formation process is ensured for a long time which tends to increase the life time of the wireless sensor network. Our Modified system output shows improvement in four areas.

• There is less number of dead nodes. • Number of alive nodes is enhanced. • Packet transmission to base station occurs frequently. • Even in the last round, clustering process is going take place.

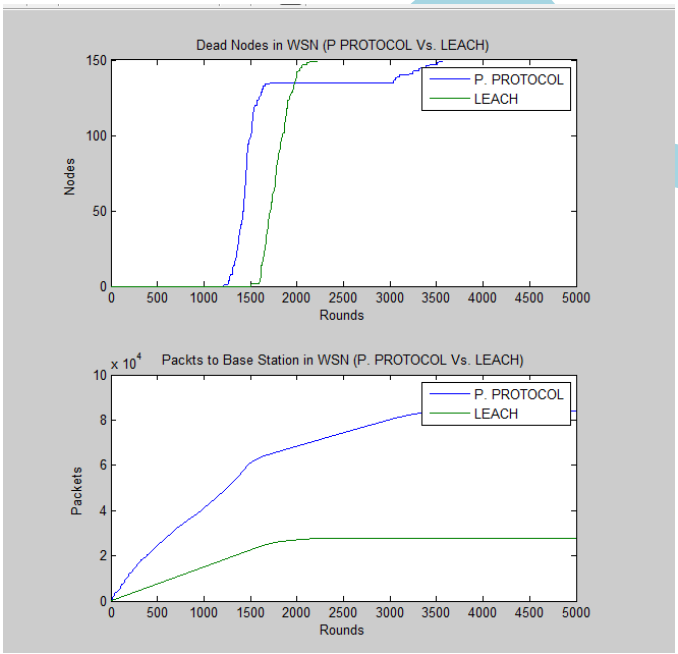

Figure 5 presents the result graphs from our MATLAB simulation which benchmarks the performance of our proposed algorithm against the LEACH algorithm. From the analysis we found that taking scenario i.e. LEACH V/S proposed protocol that the LEACH protocol persists for nearly 2280(approx.) number of rounds whereas our protocol persists till 3830(approx.) rounds. This proves that out protocol outperforms the LEACH protocol.

VI. FUTURE SCOPE

Various directions in which further research work can be carried out are following:

1. We can change the parameters on which election of the heterogeneous nodes network is carried out. For example, as in some other protocol like ISEP a combination of average and residual energy is taken. 2. We can extend the heterogeneity of nodes by having three levels like normal node, intermediate node and advanced for deployment in our multi-level energy transmission.
3. We can change direction of our study to GPS EQUIPPED sensor nodes which are capable of location based sensing and apply our concept to that specific domain.
4. Multi-hop concept between cluster head nodes away from sink can be paired with multiple transmission level and heterogeneous network.

VII. CONCLUSION

The basic LEACH protocol fails to take full advantage of the extra energy provided by the heterogeneous nodes. The stability period of LEACH is very short and nodes die at a steady rate. This is because LEACH treats all the nodes without discrimination. Our protocol takes initial energy and residual energy into account at the same time. The results show increase in the number of rounds of stability period than LEACH. Interestingly, the number of alive nodes and the packets delivered are more in our protocol. This means that our protocol is more efficient than LEACH. In addition to this, while the LEACH protocol persists for only around 3830 number of rounds, our proposed protocol survives for approximately 2280 rounds which benchmarks the efficiency of our protocol in terms of network longevity.

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