OPTIMAL CLUSTERING AND ROUTING PROTOCOL IN WIRELESS SENSOR NETWORKS

A Minor Project Report

submitted in partial fulfilment of the requirements for the award of the degree

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Bachelor of Technology

in

COMPUTER SC. & ENGINEERING

BY

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CERTIFICATE

I hereby certify that the work which is being presented in the B.Tech. Minor Project Report entitled **"Optimal Clustering and Routing Protocol in Wireless Sensor Networks",** in partial fulfillment of the requirements for the award of the **Bachelor of Technology in Computer Sc. & Engineering** and submitted to the Department of Computer Sc. & Engineering of National Institute of Technology Raipur is an authentic record of my own work carried out during a period from July 2017 to December 2017 under the supervision of Ms.Veena Anand ,Assistant Professor, CSE Department.

The matter presented in this thesis has not been submitted by me for the award of any other degree elsewhere.

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ABSTRACT

The lifetime of a wireless sensor node refers to the duration after which the node's energy has ended. Since battery replacement in most applications of wireless sensor networks is not possible, so designing an energy efficient protocol in this networks is useful. Therefore many studies have been done to increase the network lifetime. So clustering is one of the techniques useful for partitioning the network into areas called clusters and authorizing energy waste issues (eg: data gathering , aggregating and routing to sink) to some nodes called cluster heads. In the project optimal clustering in multipath and multi-hop protocol has been proposed which aims to alleviate energy consumption and increase the network of wireless sensor network. This is proposed for a circular area surrounding a sink ,one hop communication between the sink is replaced by an optimal multi hop communications. The optimal number of clusters is computed and the energy consumption is optimized by partitioning the network into nearly the equal size of clusters. The simulation results have showed the increase in the network lifetime comparatively with other clustering techniques.

ACKNOWLEDGMENT

Before we get into the thick of things, I would like to add few words of appreciation for the people who have been a part of this project right from its inception. Doing this project is one the academic challenge I have faced and without the guidance and patience of the people who constantly supported , this task wouldn’t have been done. I owe my deepest gratitude to them.

It gives me an immense pleasure in presenting this project report on “Optimal clustering and Routing Protocol In Wireless Sensor Networks”. It has been my privilege to have a project guide who have assisted me from the commencement of this project. The success of this project is achieved only through the sheer hard work and determination put by me with the help of my project guide.

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I also feel warm hearted sense of obligation to my laboratory staff members and seniors who helped me in the collection of data and resource material and also in processing and drafting the manuscript. The project is dedicated to all those people who helped me while doing this project.

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CHAPTER-1
INTRODUCTION

In this chapter, we first provide an overview of Wireless Sensor Networks, then we focus on the Energy-efficient Routing Algorithms[1]. In addition, we describe the components of WSNs and an energy efficient routing protocol in Wireless Sensor networks.

1.1 Wireless sensor network

A Wireless Sensor Network or WSN [2] [3]is supposed to be made up of a large number of sensors and at least one base station. The sensors are autonomous small devices with several constraints like the battery power, computation capacity, communication range and memory. They also are supplied with transceivers to gather information from its environment and pass it on up to a certain base station, where the measured parameters can be stored and available for the end user. In most cases, the sensors forming these networks are deployed randomly and left unattended to and are expected to perform their mission properly and efficiently. As a result of this random deployment, the WSN[3] has usually varying degrees of node density along its area. Sensor networks are also energy constrained since the individual sensors, which the network is formed with, are extremely energy-constrained as well. The communication devices on these sensors are small and have limited power and range. Both the probably difference of node density among some regions of the network and the energy constraint of the sensor nodes cause nodes slowly die making the network less dense. Also it is quite common to deploy WSN[3] in harsh environment, what makes many sensors inoperable or faulty. For that reason, these networks need to be fault-tolerant so that the need for maintenance is minimized. Typically the network topology is continuously and dynamically changing, and it is actually not a desired solution to replenish it by infusing new sensors instead the depleted ones. A real and appropriate solution for this problem is to implement routing protocols that perform efficiently and utilizing the less amount of energy as possible for the communication among nodes.

The WSN consist of two main components:

1. Sensor Nodes, [4]and
2. Base Station [2][5](Central Gateway).

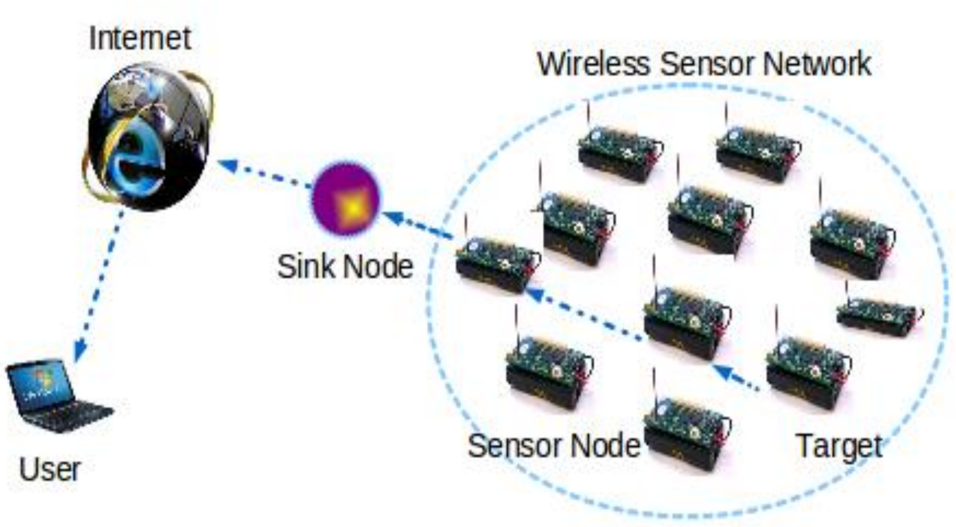

Figure 1.1 Wireless Sensor Network

1.1.1 Sensor nodes

Sensors nodes[6] are typically built of few sensors and a mote unit as shown in Fig.1.2. A Sensor is a device which senses the information and pass it on to mote. Sensors are typically used to measure the changes in physical environmental parameters like temperature, pressure, humidity, sound, vibration and changes in the health parameter of person e.g. blood pressure and heartbeat. MEMS based sensor have found good use in sensor nodes. A mote consists of processor, memory, battery, A/D converter for connecting to a sensor and a radio transceiver for forming an ad hoc network[7]. A mote and sensor together form a Sensor Node[8]. A sensor network is a wireless ad-hoc network of sensor nodes. Each sensor node can support a multi-hop routing algorithm and function as forwarder for relaying data packets to a base station.

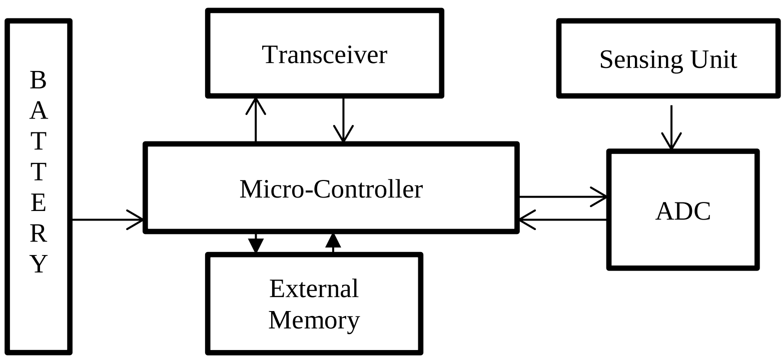

Figure 1.2 Block diagram of sensor node

1.1.2 Base Station

A base station [9] links the sensor network to another network. It consists of a processor, radio board, antenna and USB interface board. It is preprogrammed with low-power mesh networking software for communication with wireless sensor nodes. Deployment of the base station in a wireless sensor network is very important as all the sensor nodes handover their data to the base station for processing and decision making. Energy conservation, coverage of sensor nodes and reliability issues are taken care of during deployment of base station in sensor network[3]. Generally base stations are assumed static in nature but in some scenarios they are assumed to be mobile to collect the data from sensor nodes.

Figure 1.3 Base Station Node

1.1.3 Radio Model

We have assumed the same radio model[10] which has been used in earlier works. For the radio hardware, the transmitter dissipates energy to run the transmitter radio electronics and power amplifier, and the receiver dissipates energy to run the receive radio electronics as shown in Fig.1.4. For the scenarios described in this project work, both the free space[11] (d2 power loss) and the multi path fading[12] (d4 power loss) channel models were used depending on the distance between the transmitter and the receiver. If the distance is less than a threshold, the free space (fs) model is used; otherwise, the multi path (mp) model is used.

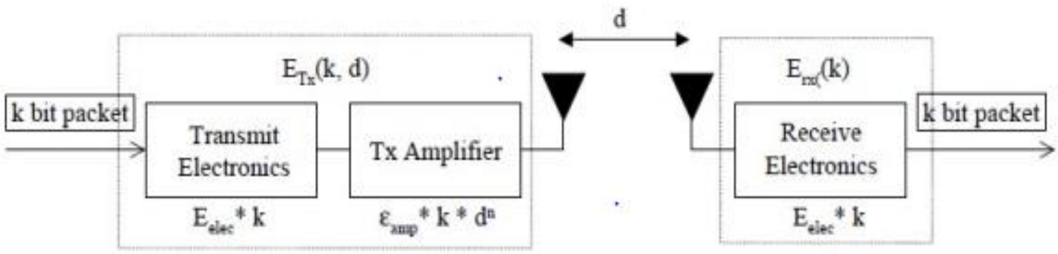

Figure 1.4 Radio Model[2]

1.2 Energy-efficient Routing Algorithms

Energy efficient routing algorithm[13] can be categorized as follows: data centric routing[14] algorithm, location based routing algorithm [5]and hierarchical routing algorithm [15]. Data centric routing algorithm uses meta data to find the route from source to destination before any actual data transmission to eliminate redundant data transmission Location based routing algorithm requires actual location information for every sensor node. Hierarchical routing algorithm[15] divides the network into clusters. Cluster head (CH) is elected in each cluster. CH[16] collects data from its members, aggregates the data and sends to sink. This approach is energy efficient but relatively complex than other approaches.

1.2.1 Data centric

Data centric protocols[14] are query based and they depend on the naming of the desired data, thus it eliminates much redundant transmissions. The BS [9]sends queries to a certain area for information and waits for reply from the nodes of that particular region. Since data is requested through queries, attribute based naming is required to specify the properties of the data. Depending on the query, sensors collect a particular data from the area of interest and this particular information is only required to transmit to the BS and thus reducing the number of transmissions. e.g. SPIN was the first data centric protocol.

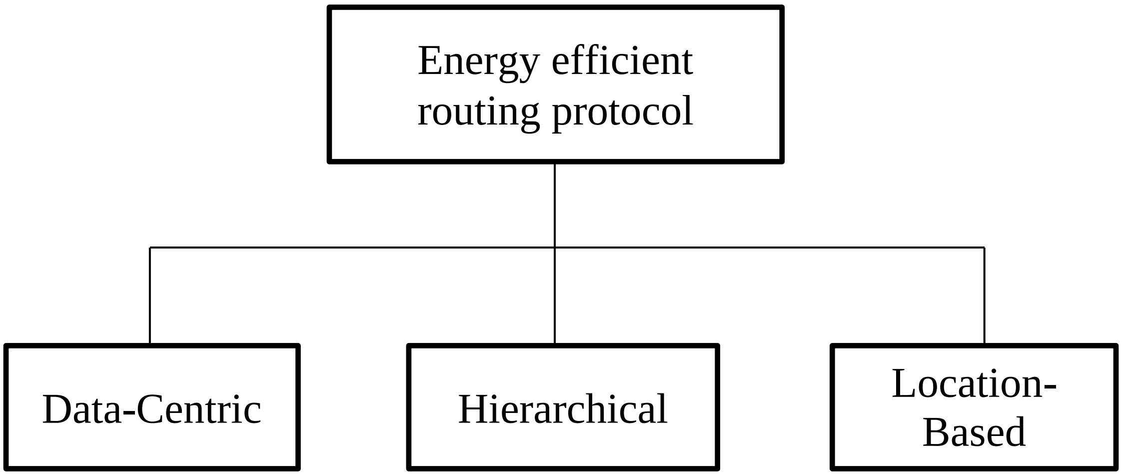

Figure 1.5 Classification of Routing In WSNs

1.2.2 Hierarchical

Hierarchical routing[15] is used to perform energy efficient routing[13], i.e., higher energy nodes can be used to process and send the information; low energy nodes are used to perform the sensing in the area of interest. e.g. LEACH[17], TEEN, APTEEN.

1.2.3 Location Based

Location based routing protocols need some location information of the sensor nodes. Location information can be obtained from GPS (Global Positioning System) signals, received radio signal strength, etc. Using location information, an optimal path can be formed without using coding techniques. e.g. Geographic and Energy-Aware Routing(GEAR).

1.3 Clustering[18]

In an appropriate network organization the data is organized and summed up by gathering and grouping the sensors. These groups are called clusters. In general, each cluster has a cluster-head which coordinates the data gathering[19] and aggregation process in a particular cluster. Clustering in WSNs guarantees basic performance achievement with a large number of sensor nodes. In other words, clustering improves the scalability of WSNs. Clustering in general minimizes the need for centralized control. The clustering protocols mainly focus on two aspects which involve the selection of the cluster head and then rotating this cluster head to balance the energy consumption of the sensor nodes in the network. These clustering algorithms do not take the location of the base station into consideration. Due to the heavy relay traffic the cluster heads[20] near to the base stations tend to die earlier than the cluster-heads which are located far from the base station. In order to avoid this problem, some unequal clustering algorithms have been proposed in the literature. In unequal clustering, the network is partitioned into clusters of different sizes where the clusters close to the base station are smaller than the clusters far from the base station.

Challenges in WSN [13]arise in the implementation of several services; there are so many controllable and uncontrollable parameters by which the implementation of wireless sensor network can be seriously affected such as energy conservation. As it is known, the valuable small size of a sensor node imposes a small battery with a limited available energy budget. When the wireless sensor network[12] replaced the single macro sensors, it gained an advantage in the extended range of sensing, fault tolerance, improved accuracy and lower cost than its predecessors. But as the number of nodes increases in the WSN, to increase the coverage range and accuracy, energy management becomes a major constraint since all these nodes are battery powered. And in that situation recharging or replacing of the battery is impossible.

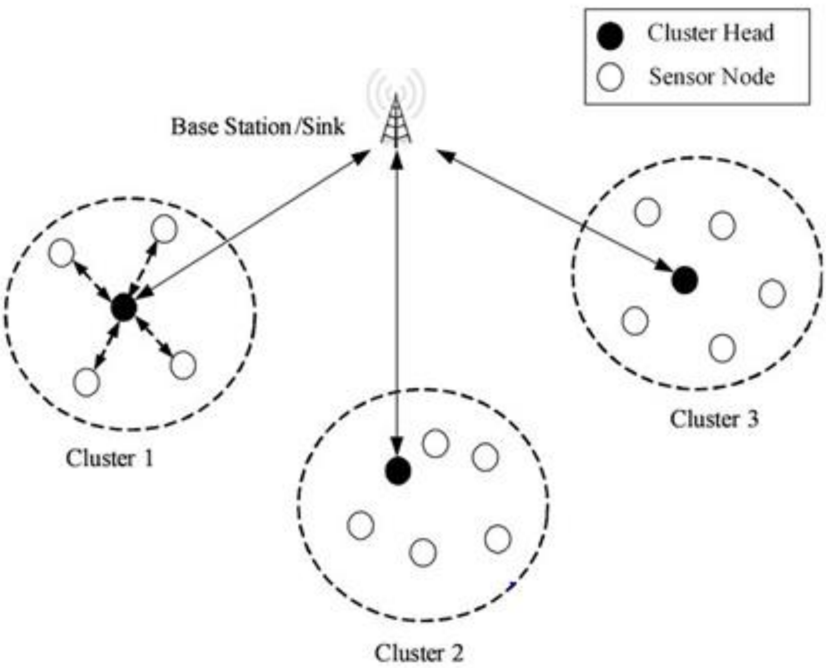

Figure 1.6 Clustering

1.3.1 Heterogeneous and Homogenous Clustering[21]:

Clustered sensor networks can be classified into two broad types; homogeneous and heterogeneous sensor networks. In homogeneous networks all the sensor nodes are identical in terms of battery energy and hardware complexity. With purely static clustering (cluster heads once elected, serve for the entire lifetime of the network) in a homogeneous network, it is evident that the cluster head nodes will be over-loaded with the long range transmissions to the remote base station, and the extra processing necessary for data aggregation[19] and protocol co-ordination. As a result the cluster head nodes expire before other nodes. However it is desirable to ensure that all the nodes run out of their battery at about the same time, so that very little residual energy is wasted when the system expires. One way to ensure this is to rotate the role of a cluster head randomly and periodically over all the nodes as proposed in LEACH[17][22]. However the downside of using a homogeneous network and role rotation is that all the nodes should be capable of acting as cluster heads, and therefore should possess the necessary hardware capabilities.

On the other hand, in a heterogeneous sensor network, two or more different types of nodes with different battery energy and functionality are used. The motivation being that the more complex hardware and the extra battery energy can be embedded in few cluster head nodes, thereby reducing the hardware cost of the rest of the network. However fixing the cluster head nodes means that role rotation is no longer possible. When the sensor nodes use single hopping to reach the cluster head, the nodes that are farthest from the cluster heads always spend more energy than the nodes that are closer to the cluster heads. On the other hand when nodes use multi-hopping to reach the cluster head, the nodes that are closest to the cluster head have the highest energy burden due to relaying. Consequently there always exists a non-uniform energy[1] drainage pattern in the network. Thus there are two desirable characteristics of a sensor network, viz. lower hardware cost, and uniform energy drainage. While heterogeneous networks achieve the former, the homogeneous networks achieve the latter. However both features cannot be incorporated in the same network. The objective of this paper is to compare homogeneous and heterogeneous sensor networks from the point of view of the overall network cost by taking into account the above energy-hardware trade-of. Thus most of the current clustering algorithms are homogeneous schemes, such as LEACH, PEGASIS, and HEED. The LEACH protocol handles the dissipation of the energy by rotation of the cluster heads among other clusters and timely formation and dissolution of the clusters.

CHAPTER -2

LITERATURE REVIEW

2.1 Introduction

Key issue in wireless sensor networks is maximizing the network lifetime and the amount of data transferred successfully during the network lifetime. In sensor networks, the data transport model is such that a base station, typically is located at the boundary of or beyond the field from where the sensors sense/measure data.

2.2 Understanding the protocol

2.2.1 Low Energy Adaptive Clustering Hierarchy(LEACH)

LEACH [23]is the first and most popular energy-efficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption. In LEACH, the clustering task is rotated among the nodes, based on duration. Direct communication is used by each cluster head (CH) to forward the data to the base station (BS). It uses clusters to prolong the life of the wireless sensor network. LEACH is based on an aggregation (or fusion) technique that combines or aggregates the original data into a smaller size of data that carry only meaningful information to all individual sensors. LEACH divides the a network into several cluster of sensors, which are constructed by using localized coordination and control not only to reduce the amount of data that are transmitted to the sink, but also to make routing and data dissemination more scalable and robust. LEACH uses a randomize rotation of high energy CH position rather than selecting in static manner, to give a chance to all sensors to act as CHs and avoid the battery depletion of an individual sensor and dying quickly. The operation of LEACH is divided into rounds having two phases each namely

(i) a setup phase [16]to organize the network into clusters, CH advertisement, and transmission schedule creation and

(ii) a steady-state phase[23] for data aggregation, compression, and transmission to the sink. LEACH is completely distributed and requires no global knowledge of network.

It reduces energy consumption by (a) Minimizing the communication cost between sensors and their cluster heads. (b) Turning off non-head nodes as much as possible. LEACH uses single-hop[21] routing where each node can transmit directly to the cluster head and the sink. Therefore, it is not applicable to networks deployed in large regions. Furthermore, the idea of dynamic clustering [18]brings extra overhead, e.g. head changes, advertisements etc., which may diminish the gain in energy consumption. While LEACH helps the sensors within their cluster dissipate their energy slowly, the CHs consume a larger amount of energy when they are located farther away from the sink. Also, LEACH clustering terminates in a finite number of iterations, but does not guarantee good CH distribution and assumes uniform energy consumption for CHs.

2.2.2 Optimal clustering and routing in WSN

OCRSN routing protocol was developed by inducing the features of energy aware routing and multi-hop intra cluster routing[21]. The operation of the OCRSN protocol is broken up into rounds where each round begins with a set-up phase, when the clusters are organized, followed by a steady- state phase, when data transfers to the base station occur. The below flow chart describes the overview of the protocol initially the user has to give the input which is in the form of number of nodes.

For the nodes generated, their positions are randomly assigned and displayed. Once the nodes are deployed, every node uses the neighbor discovery algorithm to discover its neighbor nodes. Using the cluster head selection algorithm cluster heads are selected among the nodes. These cluster heads broadcasts the advertisement message to all its neighboring nodes and thus clusters are formed with a fixed bound size. Each node in the cluster maintains routing table in which routing information of the nodes are updated. DRAND (distributed randomized time slot assignment algorithm) method is used, it allows several nodes to share the same frequency channel by dividing the signal into different time slots. The cluster head aggregates the data from all the nodes in the cluster and this aggregated data is transmitted to the base station[9].

CHAPTER -3
OUR APPROACH

3.1 Implementation

3.1.1 Leach

W. Heinzelman, introduced a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH)[24]. LEACH arranges the nodes in the network into small clusters and chooses one of them as the cluster-head. Node first senses its target and then sends the relevant information to its cluster-head. Then the cluster head aggregates and compresses the information received from all the nodes and sends it to the base station. The nodes chosen as the cluster head drain out more energy as compared to the other nodes as it is required to send data to the base station which may be far located. Hence LEACH uses random rotation of the nodes required to be the cluster-heads to evenly distribute energy consumption in the network. After a number of simulations by the author, it was found that only 5 percent of the total number of nodes needs to act as the cluster-heads. TDMA[25]/CDMA[11] MAC is used to reduce inter-cluster and intra-cluster collisions. This protocol is used were a constant monitoring by the sensor nodes are required as data collection is centralized (at the base station) and is performed periodically.

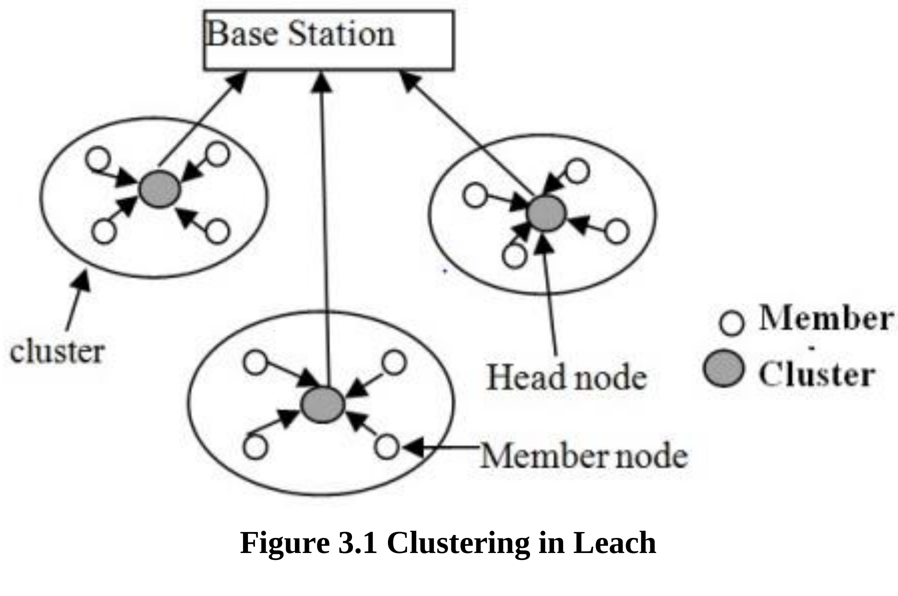

Figure 3.1 Clustering in Leach

LEACH operations can be divided into two phases:-

1. Setup phase

2. Steady phase

In the setup phase, the clusters are formed and a cluster-head is chosen for each cluster. While in the steady phase, data is sensed and sent to the central base station. The steady phase is longer than the setup phase. This is done in order to minimize the overhead cost.

1. Setup phase :- During the setup phase, a predetermined fraction of nodes, p, choose themselves as cluster-heads. This is done according to a threshold value, T(n). The threshold value depends upon the desired percentage to become a cluster-head- p, the current round r, and the set of nodes that have not become the cluster-head in the last 1/p rounds, which is denoted by G. The formulae is as follows :

T(n) = p/1-p[r mod(1/p)],If n E G,

T(n) = 0 otherwise ……….(1)

Every node wanting to be the cluster-head chooses a value, between 0 and 1. If this random number is less than the threshold value, T(n), then the node becomes the cluster-head for the current round. Then each elected CH broadcasts an advertisement message to the rest of the nodes in the network to invite them to join their clusters. Based upon the strength of the advertisement signal, the non-cluster head nodes decide to join the clusters. The non-cluster head[21] nodes then informs their respective cluster heads that they will be under their cluster by sending an acknowledgement message. After receiving the acknowledgement message, depending upon the number of nodes under their cluster and the type of information required by the system (in which the WSN is setup), the cluster-heads creates a TDMA schedule and assigns each node a time slot in which it can transmit the sensed data. The TDMA [25]schedule is broadcasted to all the cluster-members. If the size of any cluster becomes too large, the cluster head may choose another cluster- head for its cluster. The cluster-head chosen for the current round cannot again become the cluster-head until all the other nodes in the network haven't become the cluster-head.

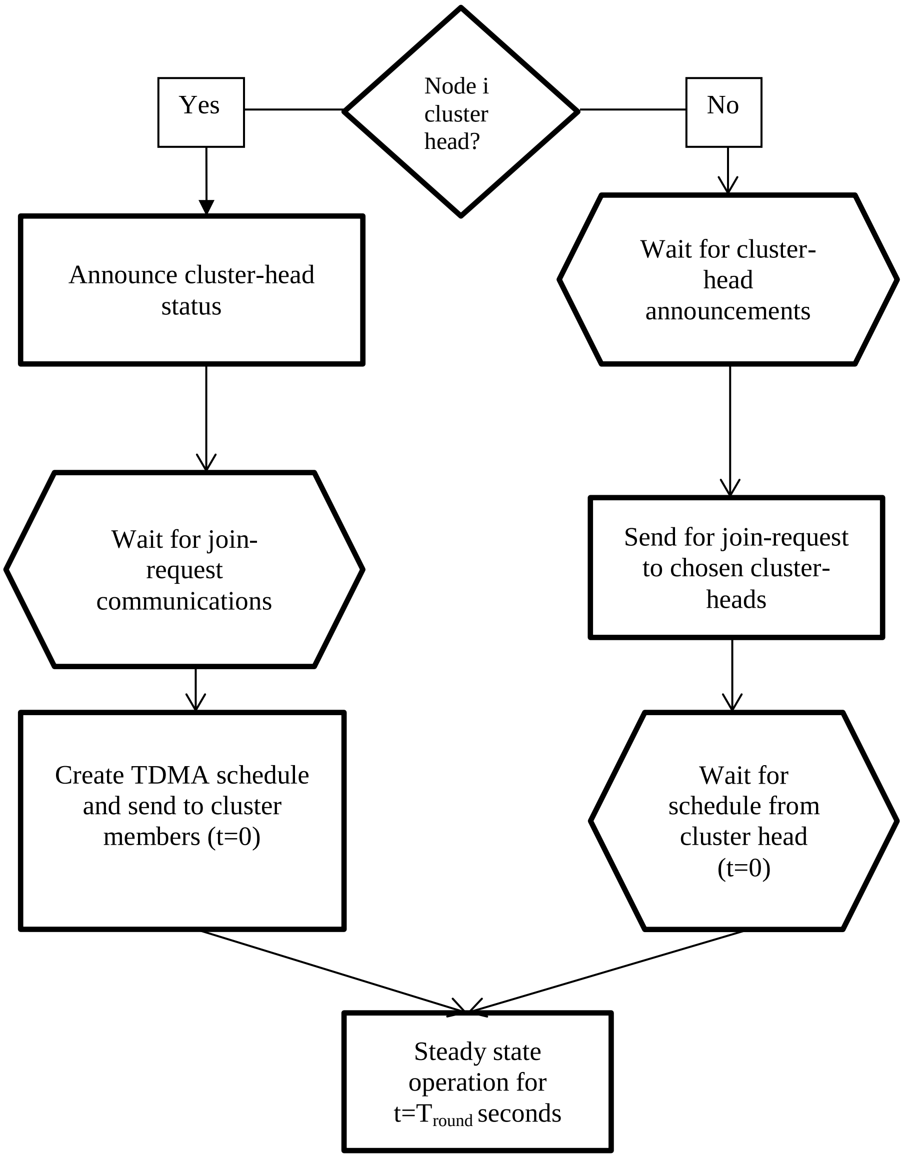

Figure 3.2 Flow chart for setup phase of Leach

2. Steady phase :- During the steady phase[16], the sensor nodes i.e. the non-cluster head nodes starts sensing data and sends it to their cluster-head according to the TDMA schedule. The cluster-head node, after receiving data from all the member nodes, aggregates it and then sends it to the base-station. After a certain time, which is determined a priori, the network again goes back into the setup phase and new cluster-heads are chosen. Each cluster communicates using different CDMA codes in order to reduce interference from nodes belonging to other clusters.

Assumptions

LEACH[24] protocol takes into a number of assumptions which may create a lot of problems in the real-time systems. A few of these assumptions are as follows:

• All nodes can transmit with enough power to reach the base station if needed.

• Each node has computational power to support different MAC protocols.

• Nodes always have data to send.

• Nodes located close to each other have correlated data.

• All nodes begin with the same amount of energy capacity in each election round, assuming that being a CH consumes approximately the same amount of energy for each node.

3.1.2 OCRSN

Algorithm operation LEACH could be divided into several rounds. Each round starts with a setup phase and finishes with steady state phase. In the setup phase clusters are organized and in steady state information is transmitted to base station. Setup phase First off, each sensor determines whether it wants to be cluster head or not considering its residual energy and number of times it is selected as cluster head. The decision is made based on a random number between zero and one. Afterwards, if selected number is less than threshold that node will be cluster head in a new round. This trust threshold is derived from following equation:

$$\mathbf{T(n) : T(n)= p/1\text{-}p \times(r \bmod (p\text{-}1))} \qquad \ldots\ldots\ldots(2)$$

Where p is probability for cluster heads (selected by cluster), r is current round and 1/p is a set of nodes which were selected as cluster heads in previous round. At the first stage all nodes might be cluster heads with p probability. When a node is selected as cluster head it cannot be a cluster head for next 1/p rounds. As the probability of being cluster head is lower for some nodes, with this method all nodes could be selected as cluster head. When the cluster head is determined it announces its position by broadcasting[25] advertisement message (ADV). This message includes a small message consisting of node ID and a header as announcement message. All nodes store received messages for next rounds. Each node selects its corresponding cluster head with respect to power of received signal. If at the end of procedure one node does not select its cluster head, one cluster head is randomly selected as its cluster head. Each node transmits a membership request message to its cluster head. In all stages of this phase, radio hardware of cluster heads must be on.

Cluster head[16] receives messages of its members. In LEACH algorithm, cluster heads operate as local control centers for coordination of data transfer in their cluster. Based on number of nodes a cluster head designs a schedule using TDMA method and transmits it to member nodes.

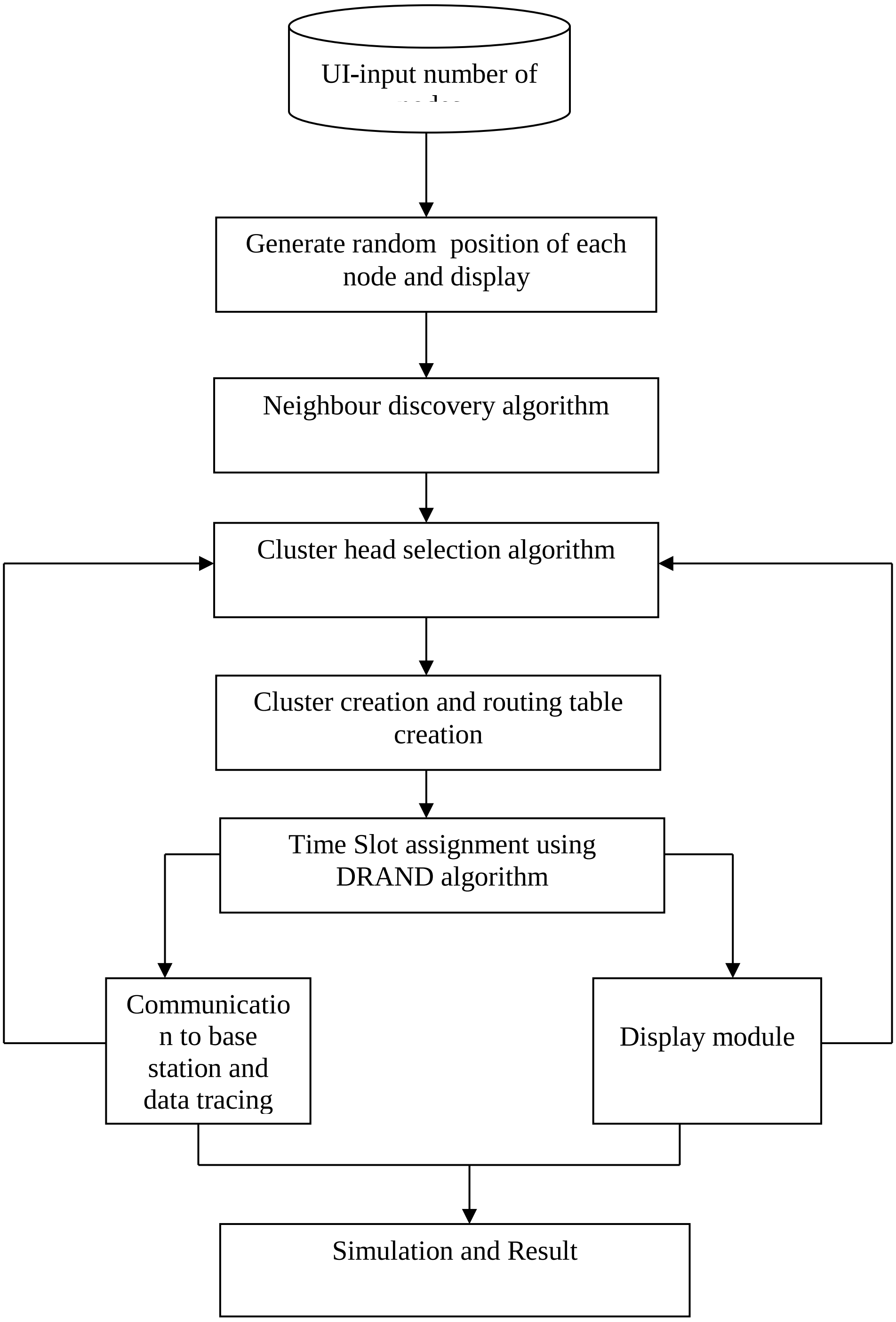

Figure 3.3 OCRSN Flow chart

3.1.3 Setup Phase

Initially, after the node deployment the neighbor discovery takes place. This can be done using many methods like: k-of-n approach, ping, beacon messaging. After the neighbor discovery, when cluster are being created, each node decides whether or not to become a cluster-head for the current round. This decision method is similar to the one used in LEACH. The setup phase operates in the following sequence:

1. CH (Cluster Head) Selection [16]
2. Cluster Formation

In LEACH, nodes take autonomous decisions to form clusters by using a distributed algorithm without any centralized control. Here no long-distance communication with the base station is required and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, no global communication is needed to set up the clusters. The cluster formation algorithm should be designed such that nodes are cluster-heads approximately the same number of time, assuming all the nodes start with the same amount of energy. Finally, the cluster-head nodes should be spread throughout the network, as this will minimize the distance the non-cluster-head nodes need to send their data. A sensor node chooses a random number, r, between 0 and 1.

Let a threshold value be

$$\mathbf{T(n) : T(n)= p/1\text{-}p \times(r \bmod (p\text{-}1)) \qquad \ldots\ldots\ldots(3)}$$

If this random number is less than a threshold value, T(n), the node becomes a cluster-head for the current round. The threshold value is calculated based on the above given equation that incorporates the desired percentage to become a cluster head, the current round, and the set of nodes that have not been selected as a cluster head in the last (1/P) rounds, p is cluster head probability. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). This message is a small message containing the node's ID and a header that distinguishes this message as an announcement message. Each non-cluster-head node determines to which cluster it belongs by choosing the cluster-head that requires the minimum communication energy, based on the received signal strength of the advertisement from each cluster-head. After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits a join-request message back to the chosen cluster-head. The cluster-heads in LEACH act as local control centers to co-ordinate the data transmissions[15] in their cluster . The cluster-head node sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non cluster-head node to be turned off at all times except during their transmit time, thus minimizing the energy dissipated by the individual.

3.1.4 Data Transmission Phase[15]

Once the clusters are created, the sensor nodes are allotted timeslots to send the data. Assuming nodes always have data to send, they transmit it at their allotted time interval. When a node receives data from one its neighbors, it aggregates it with its own data. While forwarding the aggregated data, it has to choose an optimal path from its routing table entries. It uses a heuristic function to make this decision and the heuristic function is given by,

$$\mathbf{h = K (E_{avg} / h_{min} * t) \ldots\ldots..(4)}$$

where K is a constant, E_{avg} is average energy of the current path, h_{min} is minimum hop count in current path, t = traffic in the current path. The path with highest heuristic value is chosen. If this path's E_{min}> threshold, it is chosen. Else the path with the next highest heuristic value is chosen, where

$$\mathbf{E_{min} = E_{avg} / const \ldots\ldots\ldots(5)}$$

The constant may be any integer value like 10. If no node in the routing table has E_{min} greater than threshold energy, it picks the node with highest minimum energy.

3.1.5 Periodic Updates

The information about the paths and routing table[20] entries at each node becomes stale after a little while. The heuristic values calculated based on the stale information often leads to wrong decisions. Hence the nodes are to be supplied with fresh information periodically. This will increase the accuracy and timeliness of the heuristic function. During the operation of each round, the necessary information is exchanged at regular intervals. The interval of periodic updates is chosen wisely such that the node does not base its decisions on the stale information and at the same time, the periodic update does not overload the network operation.

CHAPTER 4
SIMULATION

4.1 Introduction

Today, most of the research is done to develop ultra-low powered WSN which is only possible only if the overall network lifetime increases, energy consumption [16]decreases and the network run with high stability and reliability. To achieve this, many algorithms have been implemented. They are called energy-efficient algorithms. These algorithms in their basic form have already been implemented on various network protocols including LEACH, AODV, TEEN etc. However, these algorithms need further research for increase in network lifetime, energy efficiency etc. So OCRSN is one of the energy efficient protocol designed to increase the network lifetime.

4.2 MATLAB Environment

The simulation[13] is carried out using Custom Built Iterative Based Simulator in MATLAB 8.2.0.701 (R2017a) which simulates the sending, receiving, dropping and data forwarding etc. MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB product, technical computing problems can be solved faster than with traditional programming languages, such as C, C++ and Fortran. It is used in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis. Add-on toolboxes (collections of special purpose MATLAB functions, available separately) extend the MATLAB environment to solve particular classes of problems in these application areas. MATLAB provides a number of features for documentary work. MATLAB code can be integrated with other languages and applications, and gives out various new algorithms and applications. It’s features include:

1. High-level language for technical computing
2. Development environment for managing code, files, and data
3. Interactive tools for iterative exploration, design, and problem solving
4. Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration

5. 2-D and 3-D graphics functions for visualizing data

6. Tools for building custom graphical user interface.

4.3 Network parameters and assumption

Both LEACH [22] and OCRSN are simulated using MATLAB. The parameters taken into consideration while evaluating OCRSN and LEACH are as follows.

- Round Number vs Number of Dead Nodes (with variation of probability)
- Round Number vs Average Energy of Each node (with variation of probability)
- Round Number vs Number of Dead Nodes (with variation of number of nodes)
- Round Number vs Average Energy of Each node (With variation of number of nodes)

To simplify the simulation of these protocols few assumptions are made. They are as follows:

1. Initial energy of nodes is same.
2. Nodes are static
3. Nodes are assumed to have a limited transmission range after which a another equation for energy dissipation is used
4. Homogeneous distribution of nodes.
5. Nodes always have to send the data.

Network Parameters

Parameter	Value
Simulation Area	100×100
Channel type	Wireless channel
Base station Location	(150,50)
Energy Model	Battery
Transmission amplifier E_{fs}	10*0.000000000001
Transmission amplifier E_{mp}	0.0013*0.000000000001
Data aggregation Energy	5*0.000000001
Transmission Energy E_{Tx}	50*0.000000001
Receiving Energy E_{Rx}	50*0.000000001

CHAPTER - 5

RESULT

5.1 Simulation of protocols at 0.2 probability

The below set of results represent the simulation of both LEACH and OCRSN protocols at 0.2 probability that is the percentage of total nodes which can become cluster head is 2% of the total number of node.

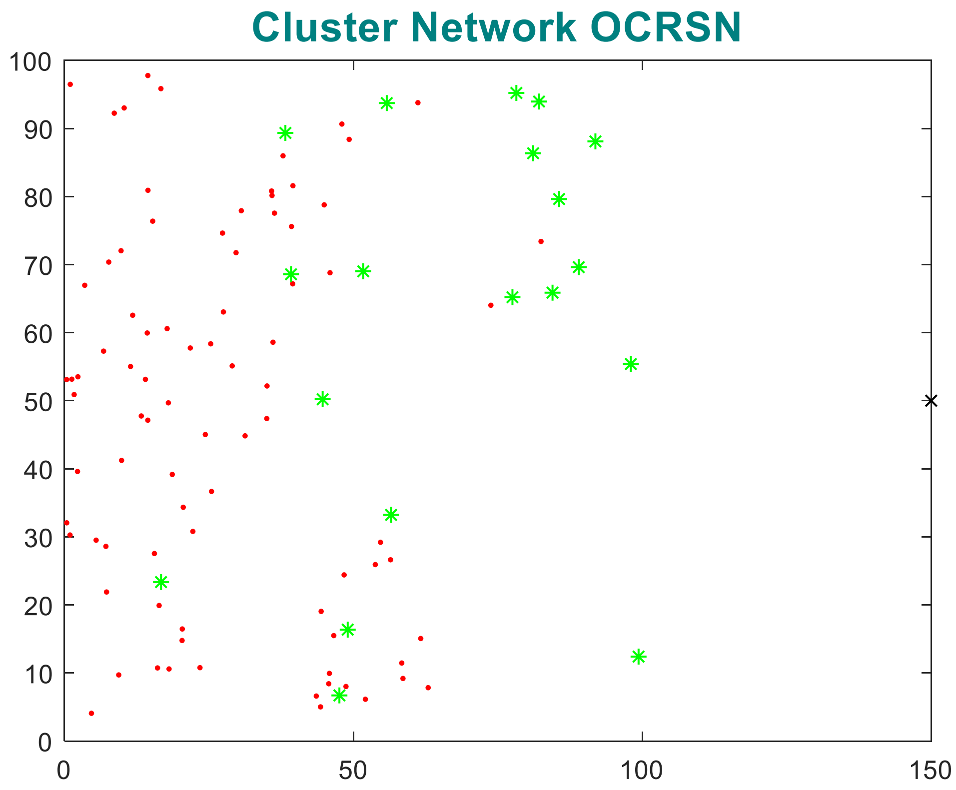

Figure 5.1 Cluster network of OCRSN for 200 nodes

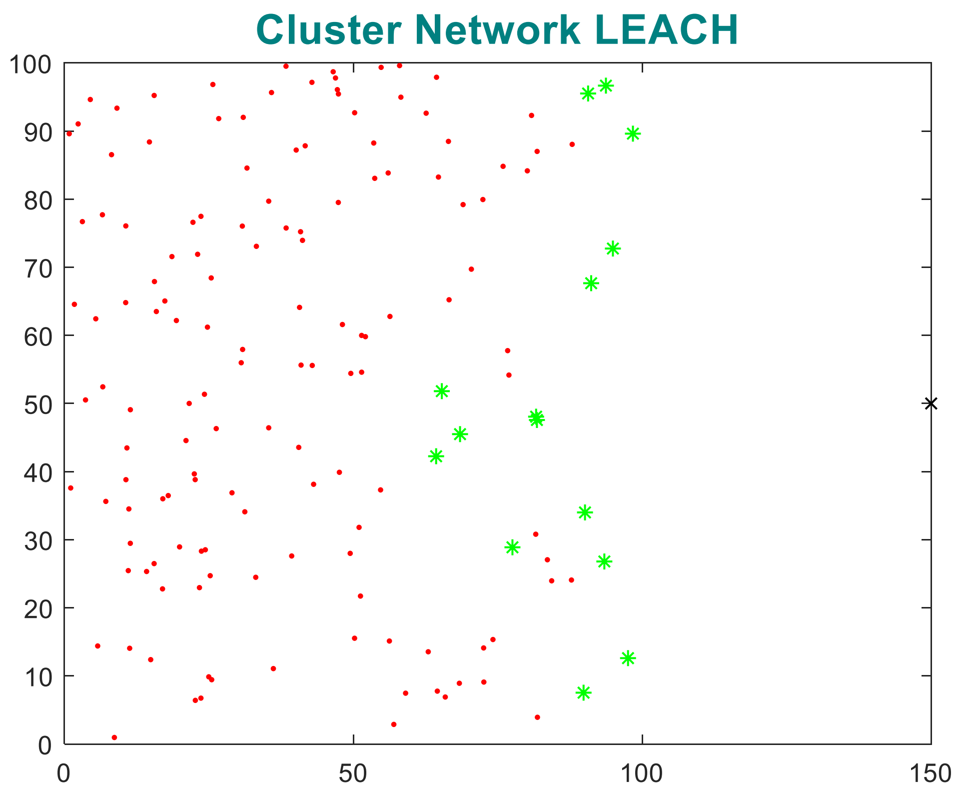

Figure 5.2 Cluster network of LEACH for 200 nodes

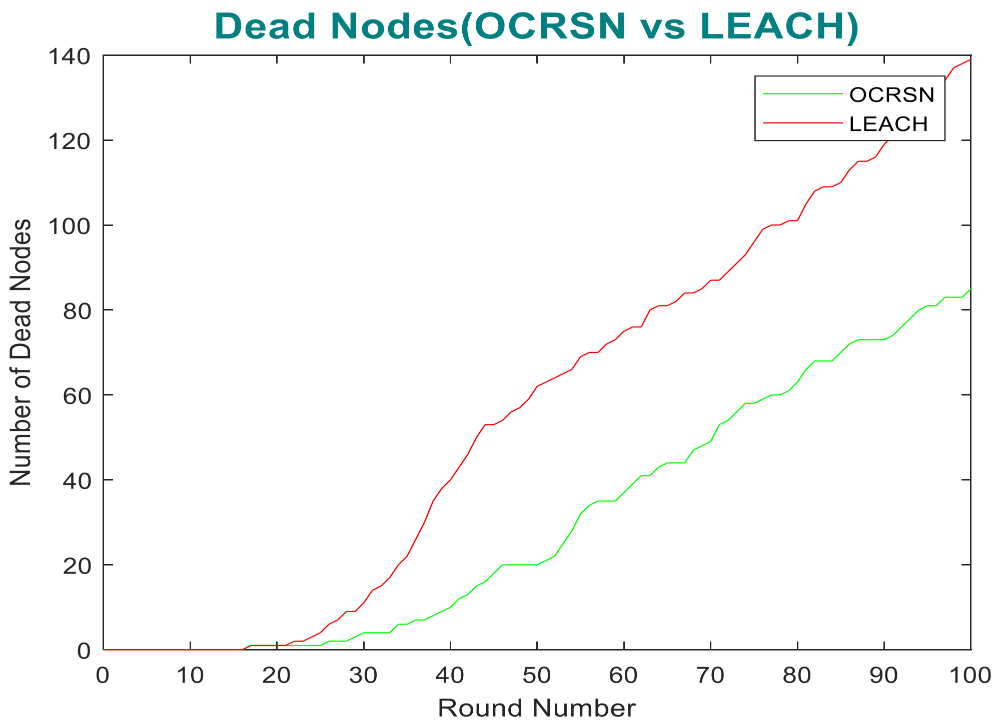

Figure 5.3 Comparison of dead nodes for 100 rounds for 200 nodes in LEACH and OCRSN

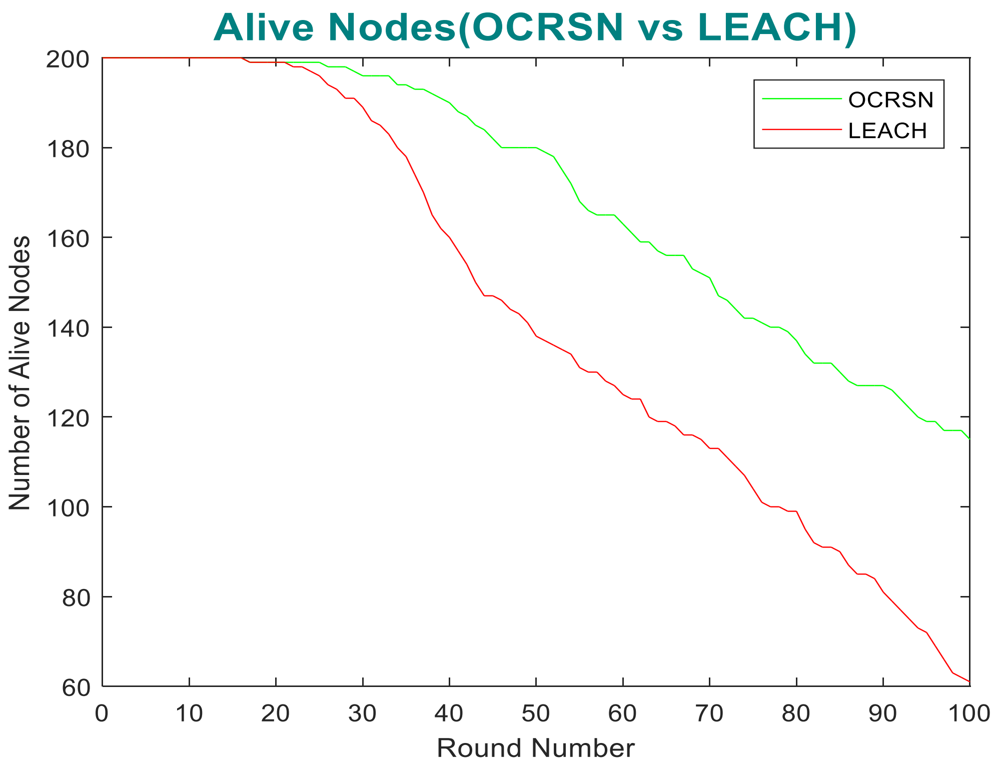

Figure 5.4 Comparison of Alive nodes for 100 rounds for 200 nodes in LEACH and OCRSN

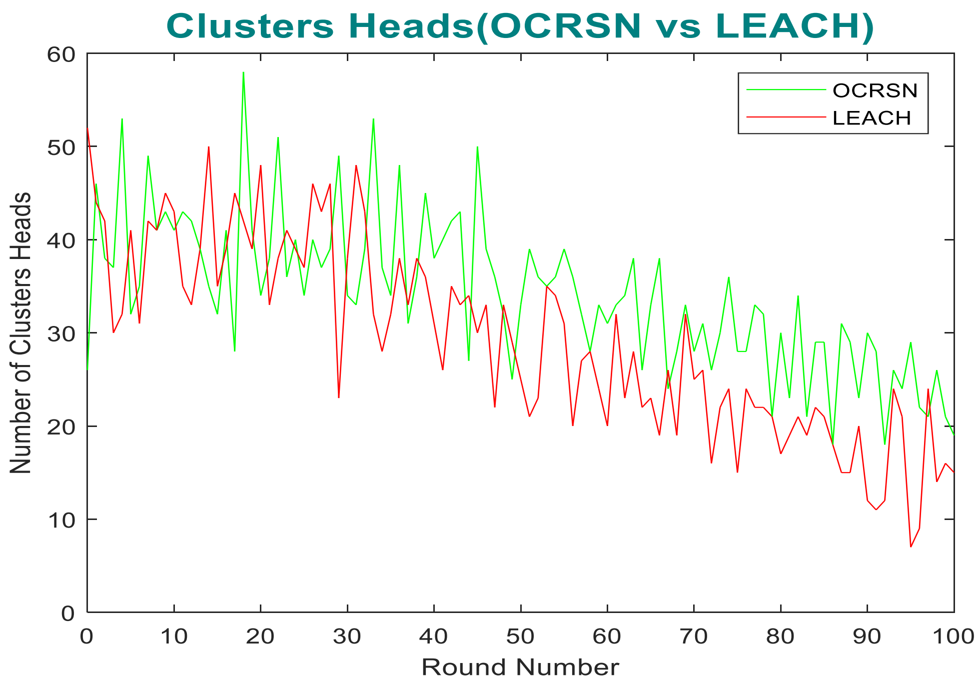

Figure 5.5 Comparison of Cluster Heads for 100 rounds for 200 nodes between LEACH and OCRSN

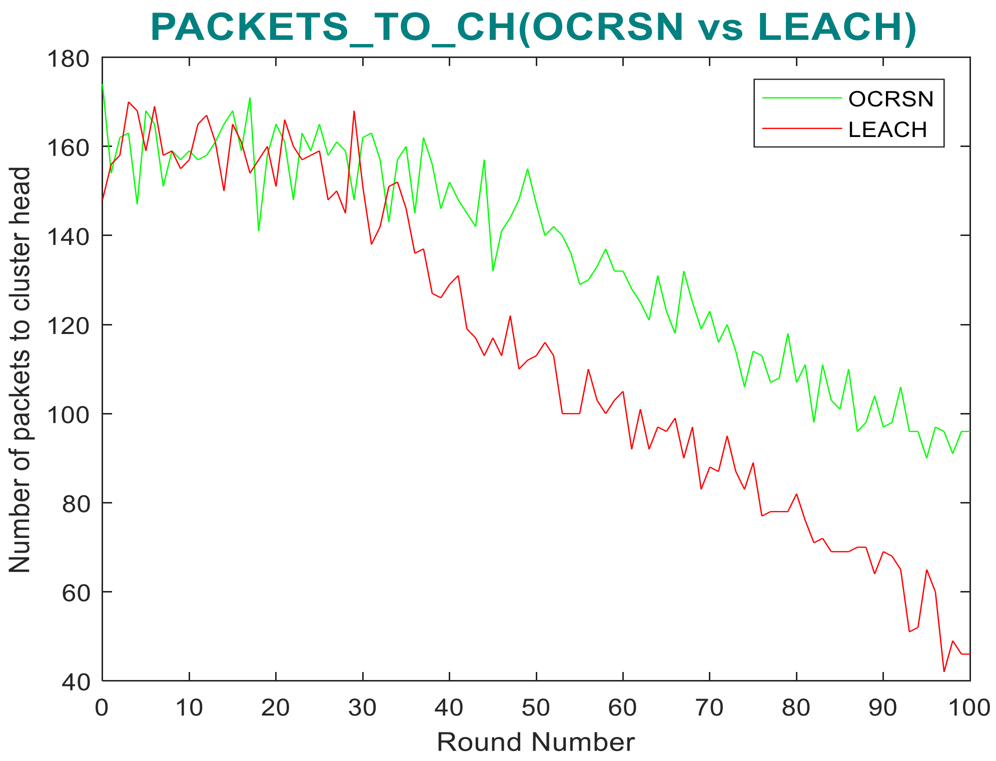

Figure 5.6 Comparison of Number of packets sent to Cluster Head for 100 rounds for 200 nodes between LEACH and OCRSN

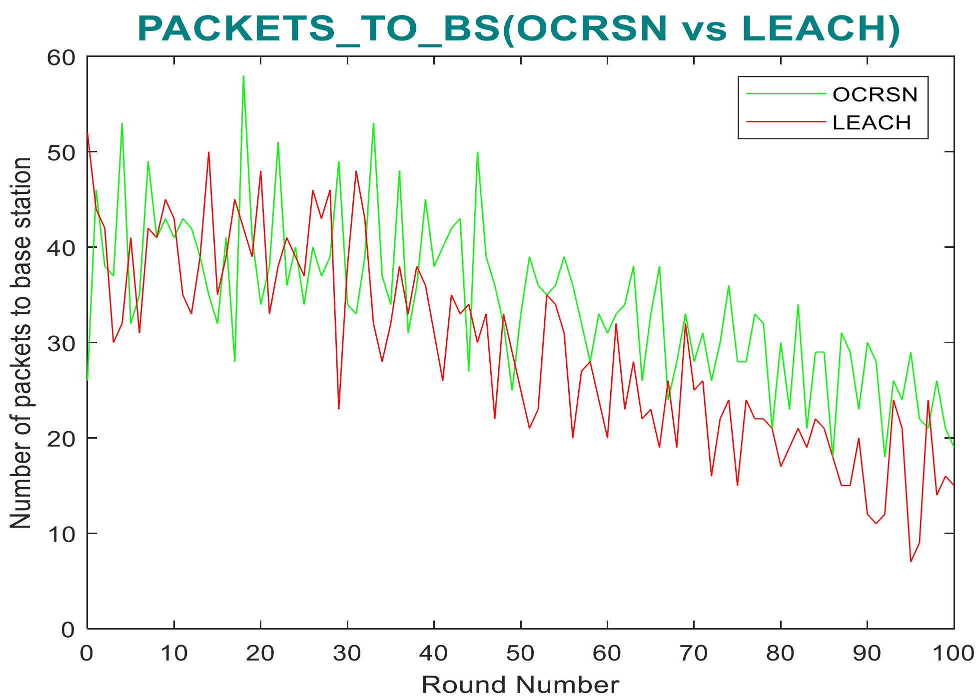

Figure 5.7 Comparison of number of packets sent to base station for 100 rounds for 200 nodes between LEACH and OCRSN

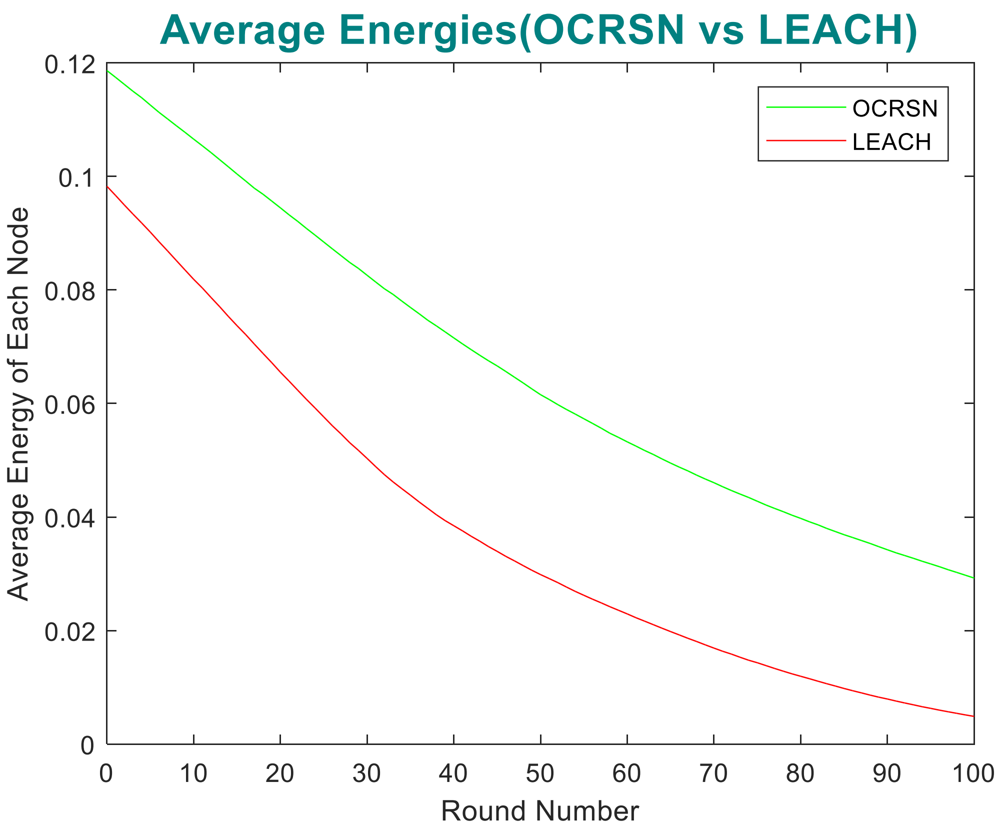

Figure 5.8 Average Energy of each node

CHAPTER- 6

CONCLUSION

6.1 Conclusion

Wireless Sensor Networks are usually spread over large areas are recently finding applications in many fields. In this regard, there is a requirement of methods which can manage the WSN’s in a better way. Wireless Sensor Networks are powered by the limited capacity of batteries. The main challenge in the design of protocols for Wireless Sensor Network is energy efficiency due to the limited amount of energy in the sensor nodes. The ultimate motive behind any routing protocol is to be as energy efficient as possible to keep the network running for a longer period of time. In this paper we have presented clustering as a means to overcome this difficulty of energy efficiency. Detailed description about the working of two protocols, namely LEACH and OCRSN are presented. We have also presented the details about the simulation and the results of it. From the brief analyses of the simulation we have come to a conclusion that LEACH can be preferred in cases of smaller networks where the total number of nodes is less than fifty where it performs slightly better than OCRSN and OCRSN can be chosen in larger networks and also when the heuristic probability of Cluster Head selection is more.

Advantages:

1) It increases the network life time.
2) It is used to outrage the battery replacement problem in nodes.
3) Average energy of the nodes get preserved.
4) Number of alive nodes is comparatively larger.
5) Data transmission rate is higher.

Besides these advantages LEACH suffers from many drawbacks such as:

1. Extra overhead to do dynamic clustering.
2. Cluster head selection is randomly that doesn’t take into account energy consumption
3. LEACH is not able to cover large area.
4. Cluster heads are not uniformly distributed

6.2 Future Work

Designing Efficient Energy Routing Protocol is the fundamental requirement for WSNs, because after some round sensor nodes are dead. The Number of rounds depends upon the power of individual sensor which is measured in joule/node. So by varying the transmission energy of the nodes we can vary the rounds . So, now we have a necessity to design energy efficient routing protocol which helps to keep sensor alive for a long time or for long rounds. In this project we have studied various energy efficient routing protocols and we can compare the efficiency of OCRSN with other protocols like SEP and HEED.

CHAPTER-7

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