Improvement of Survival time of WSN using Cluster Based TL-LEACH Protocol with BFO

A Dissertation Report Submitted

In partial fulfillment of the requirement for the

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Master of Technology in Electronics and Communication

By

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May - 2015

CERTIFICATE

This is to certify that the Thesis titled "**Improvement the survival time of the WSN using cluster based TL-LEACH with BFO"** that is being submitted by **MANOJ KUMAR** is in partial fulfillment of the requirements for the award of MASTER OF TECHNOLOGY DEGREE, is a record of confide work done under my guidance. The contents of this Thesis, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Date: Signature of the Advisor

Mr. Bhaktapriya Mohapatra

ACKNOWLEDGEMENT

I take this opportunity to express a deep sense of gratitude to **Mr. Bhaktapriya Mohapatra** for providing excellent guidance, inspiration and encouragement to go ahead throughout this Dissertation. It is because of his constant and general interest and assistance that supports me in the compilation of this Dissertation.

I would like to declare that this dissertation report is my own by made by following the guidelines of LPU. This is entirely the piece of work done on my own.

In the last, I would also like to thank my family and friends who have been a source of encouragement and inspiration throughout the duration of this dissertation.

Manoj Kumar

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DECLARATION

I hereby declare that the dissertation entitled " **Improvement the Survival time of Wireless Sensor Network using cluster based TL-LEACH with BFO**" submitted for the M.Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

Date:

Examiner 1 **Examiner II**

ABSTRACT

An energy efficient routing protocol is the major concern in wireless sensor network. In WSNs the sensor nodes are battery operated, so that WSN's rely on various resource constrained nodes with limited energy, range. So that it is necessary to concern the energy of battery so to extend the life of wireless sensor network (WSN). In WSN the sensor nodes are gathered the data at regular intervals and same is send to the BS (Base Station). So in this method need more energy but the battery is neither replaced nor recharged, so we are going for efficient routing protocol that is cluster protocol which is in the category of hierarchical routing protocol. LEACH (Low energy adaptive clustering hierarchical) is routing protocol in which we are deciding a cluster according to energy based of their nodes. In every cluster we are deciding the cluster head (CH) which is used to directly communicating with the base station (BS) instead of every node. We are deciding the cluster head according to the formula which is explained in chapters. After the LEACH we are going further some more efficient routing protocol that is Two – LEACH protocol. If the base station is far away from the cluster head and very difficult to communicate with the base station than we chose another cluster head that means in tree manner in which second cluster head gives the information to the first cluster head and after that it communicate with the base station directly, so that we can remove the far problem. So to increase the life time of WSN network we have to choose the cluster which has maximum energy and this is possible by the help of BFO (Bacteria Foraging Optimization). So in this Dissertation WSN network's life time is increased by 2TL-LEACH with BFO. As the bacteria are hungry of food so they go where the possibility of food is maximum and food is replaced here by energy. By the help of BFO we are able to select the cluster which has maximum energy and after that cluster head is selected as in LEACH using same formula. So that by using this process the life time of WSN network is increased.

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LIST OF ABBREVIATIONS

WSN	Wireless Sensor Network
LEACH	Low Energy Adaptive Clustering Hierarch
DD	Directed Diffusion
CH	Cluster Head
Non-CH	Non-cluster head
BS	Base Station
BFO	Bacteria foraging Optimization

CHAPTER 1
INTRODUTION

A wireless sensor network is an important part of all technologies now a day in technical world. Wireless sensor network is a network consisting several autonomous devices, using sensors to monitor the physical and environment condition. WSN (Wireless sensor network) have a gateway that provide a wireless connectivity back to the wired world and distributed nodes to provide a wireless connectivity. In many applications like disaster, security, field supervision and tracking WSN is used. WSN preferred as cheap, convenient and easy solution. We can find the location easily and gained the information by the help of sensors nodes.. But one of major drawback of WSN is limited energy available with each of the nodes. Hence, it is necessary to conserve energy so to extend the life time of a wireless sensor network (WSN) deployment. So, recent advancement in electronics technology enables designer to develop low cost, small size sensors and low power so to increase the life time of network. In wireless sensors network sensor nodes are able to monitor physical activity environment, compute and transmit this collected information to core network and these nodes (sensors) can communicate with each other and with Base station (BS) also.

There are different types of routing protocols are proposed for WSNs based on different-2 condition. These protocols can be classified as proactive, reactive and hybrid based on their model of function and type of target application. Proactive protocol it establishes the route before they actually needed. In this protocol node senses the environment then gather the information and then delivers the gathered information to the BS (base station) through predetermined route that's mean the route is known already. (Low Energy Adaptive Clustering Hierarchy) LEACH utilizes this type of protocol. In case of reactive protocol it finds the route only when they needed or only if required. TEEN (Threshold Sensitive Energy Efficient Network) is an example of reactive protocol. Hybrid protocol is the combination of both reactive and proactive concepts. It first evaluates all the routes and then improves the route at the time of routing.

Further depending on the participating style of nodes, the classification of routing protocol as direct communication, flat and clustering protocols. In direct communication nodes send their data directly to the base station (BS). This protocol applied in case of very large network. In case of

Flat protocols the responsibility of all the nodes are equal. In case if any node wants to transmit their data then it first search the valid route to the base station and then transmits the data. Clustering WSNs are divided into different cluster and each cluster having its own cluster head. All the nodes send their data to their cluster head (CH) and then cluster head aggregates the data and delivers the data to the BS (Base Station) directly for example TEEN.
More importantly, depending on the network structure routing protocols can be classified as Hierarchical method, Location based, and Data centric. For example LEACH. Data Centric protocols are query based protocol that is used for elimination of much more redundant transmission. In this protocol the BS send queries related to some particular area for information and then wait for the acknowledgement regarding that particular information. Since data is requested through queries, so each and every data has its own attributes with some specifications. SPIN the first data centric protocol.

The main challenge in wireless sensors network which is faced is the routing because of complexity in network. This is complex because dynamic nature of wireless sensor network, no conventional addressing scheme, limited battery life, and limited transmission ranges of sensor nodes. Sensors have limited battery and this battery cannot be replaced due to area of deployment. So, that the network life time depends on battery capacity of sensors. So, that a careful management of resources is needed to increase the life time of sensors in wireless sensor network. The quality of routing protocols depends upon the amount of data which is successfully received by BS (Base Station) from sensor nodes that are deployed in the network region. So to make the energy efficient of the wireless sensor network a number of routing protocols have been proposed. These protocols are characterized by hierarchical and location based routing protocols. Hierarchical routing protocol provides maximum energy efficiency for example LEACH (Low energy adaptive clustering routing hierarchical) protocol which is briefly explained later and extended version of LEACH also described.

Sensor: - It is the one of the most important part of Wireless Sensor Network. Sensors is the device that detects the events like temperature, touches or any physical activities and giving the corresponding output as an electrical and optical signal. A sensor node is composed of many parts, these are- sensing part, processor part, transmitter part, mobilizer, position finding systems. For example thermometer (mercury in glass) – As the temperature is increases is changes in liquid expansion which can be read on calibrated glass tube**.** There are many sensors according the need of output which we needed and selected the sensors according to that.

1.1 Understanding the WSN Communication with User

A wireless sensor network consists of three main components which are gateway, nodes, and software as well. The spatially distributed measurement nodes interface with sensors to monitor assets or their environment.

Gateways

In a WSN system, the gateway acts as the network coordinator in charge of node authentication. The gateway collects measurement data from distributed sensor nodes and bridges from a specific area, where you can collect data, analyze, and present your measurement data using a variety of software implementation. In wireless sensor network, you can use multiple gateways, each communicating on a different way, and no overlapping software-selectable wireless channel through it.

Measurement Nodes

Wireless sensor network measurement nodes direct sensor connectivity, reliable communication it is. Nodes are devices are battery-operated, offering up to an approximately two-three year lifetime.

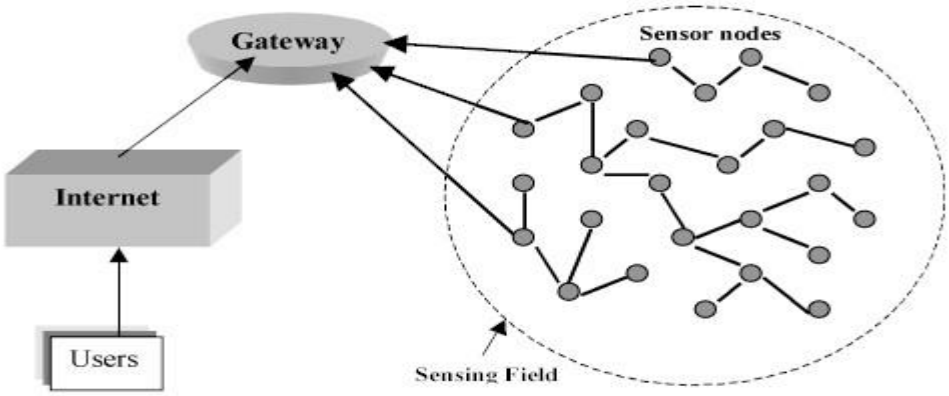

Figure 1:1 User Communicating with the WSN

1.2 Some Potential application

1. Environmental monitoring of soil, air.
2. Structural monitoring for building and bridges.
3. Industrial machine monitoring.
4. Tracking (Asset).
5. Cellular phone, GPS (Global positioning system).

6. Satellite Television.
7. Remote garage door openers.
8. Cordless computer peripherals.

1.3 Elements of WSNs

There are several technical components that wireless sensor network node is contains- include radio, microcontroller, analog circuit, and sensor interface. Battery consideration is the second technology for WSN system. For long life requirement we must consider the size and weight of batteries make them a common choice because of low cost and wide availability**.**

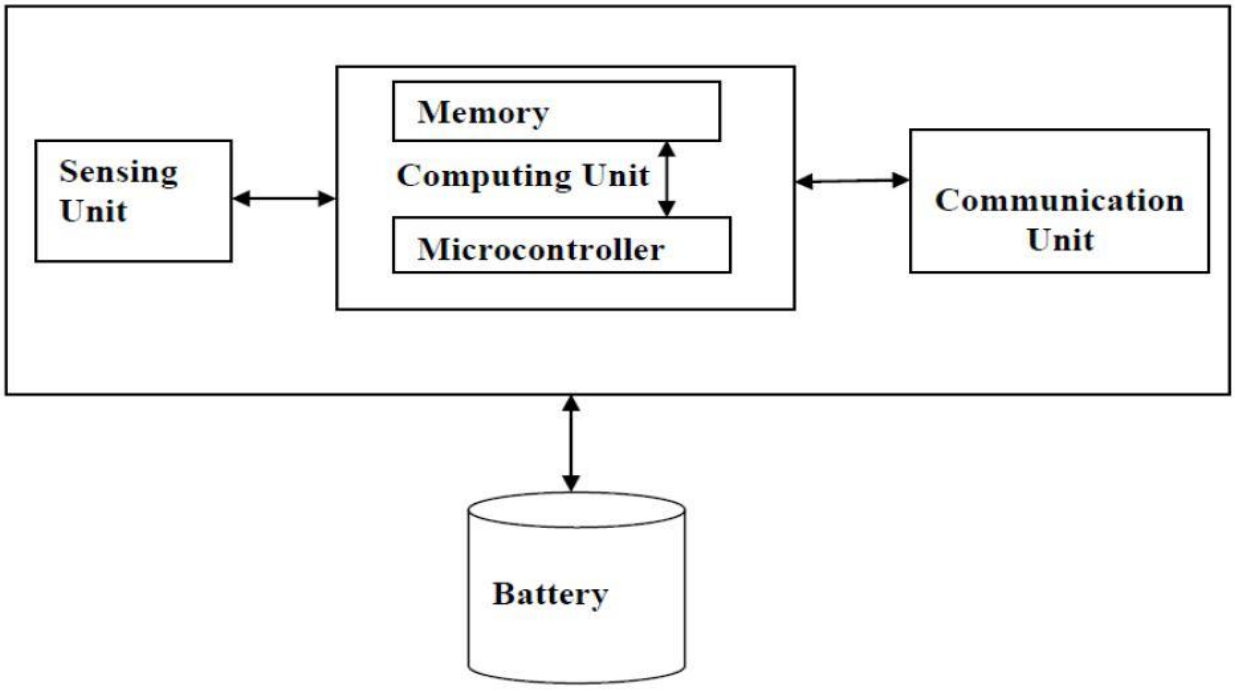

Figure 1.2 Architecture of WSN

1.4 Network Characteristic

Battery powered nodes– Nodes are generally powered by battery and they are placed in physical environment, where change and recharge of battery is difficult.

Serve energy – They are highly energy limited because of battery operated and storage capabilities**.**

Unreliable Sensor node –They (Sensor node) can be physically damaged or failures because of its deployment in harsh or changing in environment.

Application specific – They can be usually designed and deployed for a specific application.

Frequent topology change – network topology must be changes due to node failures, damage, addition, and channel fading.

1.5 Network Design objectives

Low node cost – Sensor node can't be reused because human interfaces is not possible, so that reducing cost of sensor node is an important task.

Low power consumption –As we know that Sensor nodes are powered by battery only so it is very difficult or impossible to charge or recharge their batteries as. If we reduces the power consumption of sensor nodes than we can directly increase the life time of WSN network.

Reliability – The network must provide error control and correction mechanism to ensure the reliable data delivery.

Adaptability – If changes the topology than it must be adaptive in nature. For example if a node is fail any condition, join or move.

Channel utilization – As we know that the network have limited bandwidth resources in nature, communication protocol designed for sensor node should efficiently make use of the bandwidth to improve channel utilization so that we can increase the life time of WSN network.

Quality of Service – It should be good.

1.6 Network design challenges and routing issues

Sensor location – The challenge that we have to faces the design of routing protocols is to manage the location of the sensor. We can use GPS to learn about their location which is effectively used in present.

Limited energy capacity*:* Sensor nodes are battery powered as we know, they have limited energy capacity so to increase the life time of WSN network we have to consume more energy.

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1.7 WSNs Topologies

Wireless sensor network nodes are typically organized in three types of network topologies.

Star topology – Each node is directly connected to a main gateway.

Cluster tree – Each node is connected in a tree manner, each node is connected to a node higher in the tree and then to the gateway and data is routed from the lowest node to the gateway. That's why we are using cluster tree to increase the reliability.

Mesh Network – The future of mesh network is that to connect the multiple nodes in the system and pass data through the most reliable path available.

1.8 Routing protocols in WSN

Location-based Protocols

In location-based protocols, sensor nodes are addressed by their means of their locations. This protocol is totally based on location. The energy consumption so to increase the life this method is used earlier.

Hierarchical Protocols

Many research projects in the last few years have explored hierarchical clustering in WSN. Hierarchical routing protocols provide maximum energy efficiency. So, that a number of hierarchical routing protocols has been proposed to gain the maximum life time of WSN network. In hierarchical routing protocols, whole network is deviled into multiple clusters as tree. A node is selected as a cluster head.

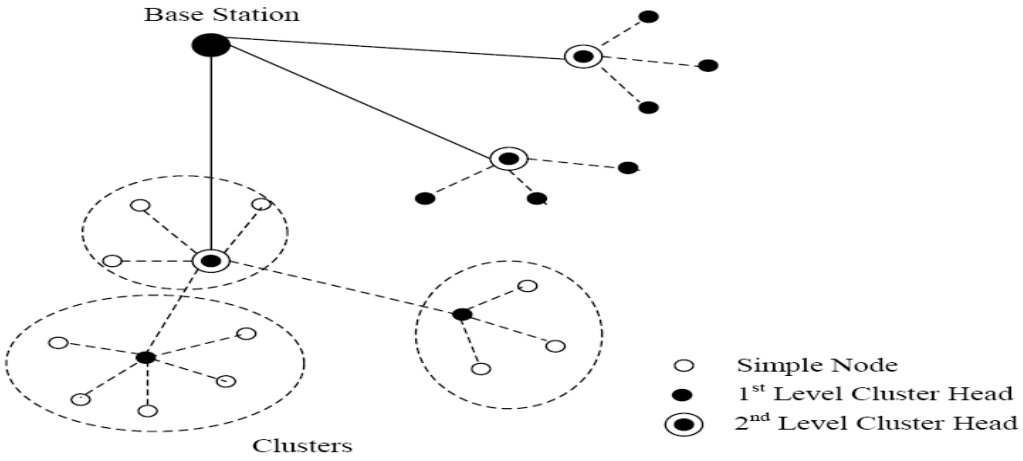


Figure 1.3 Hierarchical Approaches

As shown in Figure 1.3, a hierarchical approach breaks the network into clustered layer or tree.

1.9 LEACH (Low Energy Adaptive Clustering Hierarchical)

LEACH is considered as a basic energy efficient hierarchical routing protocol. LEACH is one of the first hierarchical routing protocols which are used in wireless sensor network (WSN). And it is used because of increase the life time of a network. 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) rather than each sensor nodes. LEACH

divides the network into several cluster of sensors as name indicates, LEACH is divided into rounds having two basis phases each namely

(i) Setup phase to organize the network of WSN into clusters based

(ii) Steady-state phase for the data aggregation, compression of data, and transmission data.

Basic communication hierarchy of LEACH is shown in Figure 1.4. LEACH reduces the energy by using following steps using following features.

1. Reducing the number of transmission by using CH (Cluster Head).
2. LEACH routing protocol makes WSN (Wireless sensor network) scalable and robust.
3. So, that when the data from the nodes of cluster is received to CH then it aggregate and compresses the data and transmits the data.
4. To increase more efficient routing protocols for WSN's we further use 2-LEACH, Multi-hop LEACH and many more as our requirement.

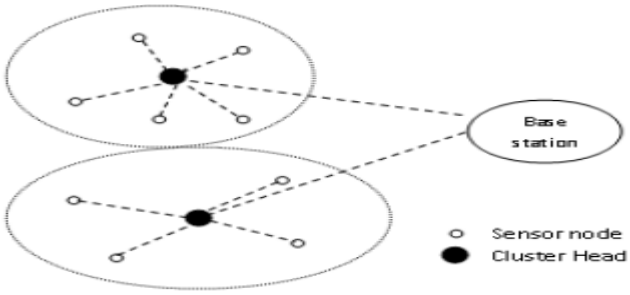


Figure 1.4: Clustering in LEACH Protocol

LEACH is a clustered and it is self– organised algorithm that minimizes energy consumption in WSN. It is composed by fixed length time periods and phases with set up phase and steady state phases. In the beginning of that phase, sensor nodes decide a random number between 0 and 1 to be able to compare with the threshold level which we are assume earlier, if the chosen number is lower than the threshold value, than the sensor node is decide as the new cluster head (CH). After that the cluster head inform the network that they are the new cluster haeds and process is so on.

During the set-up phase in LEACH, each sensor node tries to select itself as a cluster head according to probability method. For selecting the CH, every sensor node generates a random number between 0 and 1 as we are taking threshold level. If the number is less than the threshold T (n), the sensor node selects itself as a cluster head for current round in that cluster; the threshold is presented as follows:

$$T(n) = \frac{P}{1 - P * \left[r \bmod \left(\frac{1}{p} \right) \right]}, n \epsilon G$$

0, otherwise

Where the represents the percentage of cluster heads in the sensor network, and the r is the current number of round in the network, *G* is a set of nodes which have not been selected as cluster heads in the running rounds of cluster. In fact, T (n) can be seen that it is the average probability of the excess nodes being the cluster head in the round *r* in cluster.

Report Outline

Chapter 1 containing the introduction part which gives overview of WSN technology and different protocol used in it. And we have focused the power management technics for increase the life time of WSN network.

Chapter 2 containing included the Research Papers or Literature Review.

Chapter 3 in this chapter we are studies about Problem Formulation, Objective and Motivation of work.

Chapter 4 it included the implementation of Advance LEACH protocol with BFO.

Chapter 5 it included Simulation Results and Discussion.

Chapter 2
LITERATURE REVIEW

2. Extended Version of LEACH

2.1 LEACH – Mobile Protocol

As we already study that the energy of the network is the battery power of the nodes. And the battery power of nodes should not be wasted. For only this reason we are managing the network load and provide equal load sharing. Mobility is the new network facility proposed for cluster based network in WSN. Mobile – LEACH the network is constantly reconstructed according to the mobility changes in the network. LEACH – Mobile protocol should know if the node has the communicating ability with a definite CH (Cluster head). That's why in this case; the node broadcasts a cluster joint request message to be able to find a new cluster. When it receives a cluster joint acknowledgment message from a new cluster that means it is in a new cluster head. Each time slot, cluster head transmits a request message to the nodes which are not cluster head in the network.

2.2Multi-hop-LEACH

This is another type of protocol which is also used for energy efficient for wireless sensor network. The working of multi-hop LEACH is similar to LEACH protocol. It is mostly preferred when the cluster head and base station (BS) become too far to each other, because of the ever growing network covering area. So that the main aim of this protocol is to protect the ever-decreasing network performance as stable as possible. So network performance depends on the changing energy consumption of the nodes according to their distance from the BS. So that the data packet travels over multiple nodes to reach its destination. The figure of multi-hop LEACH is shown in Figure 2.1.

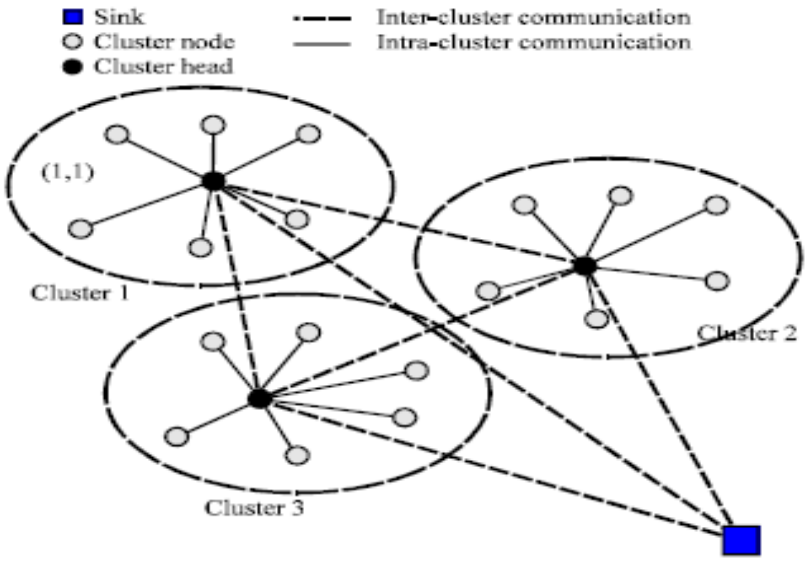


Figure 2.1: Multi – hop LEACH Protocol

2.3 Two-Level LEACH Protocol

In the two-level LEACH protocol the same procedure is used as we are using in LEACH protocol. In order to increase the life time of wireless sensor network, it is needed to reduce the number of nodes communicating to the BS (Base Station) directly. So that only very few cluster head can be in close proximity to the base station. The distant cluster head need to increase their power levels, so as to reach the base station. The cluster head is elected during the setup phase of LEACH. Another level of cluster head among the first level cluster head is introduced. So that one among the first level cluster head's is elected as the second level cluster head and this second level CH communicates to the BS (Base Station) directly. It is also called a two-level structure consist of leaf nodes, first level cluster head's and second level cluster head's. The first level cluster head's gather data from their respective cluster nodes, members, aggregate and transmit the same data to the respective second level cluster head's, which also send this whole data and information to the BS (Base station) in WSN.

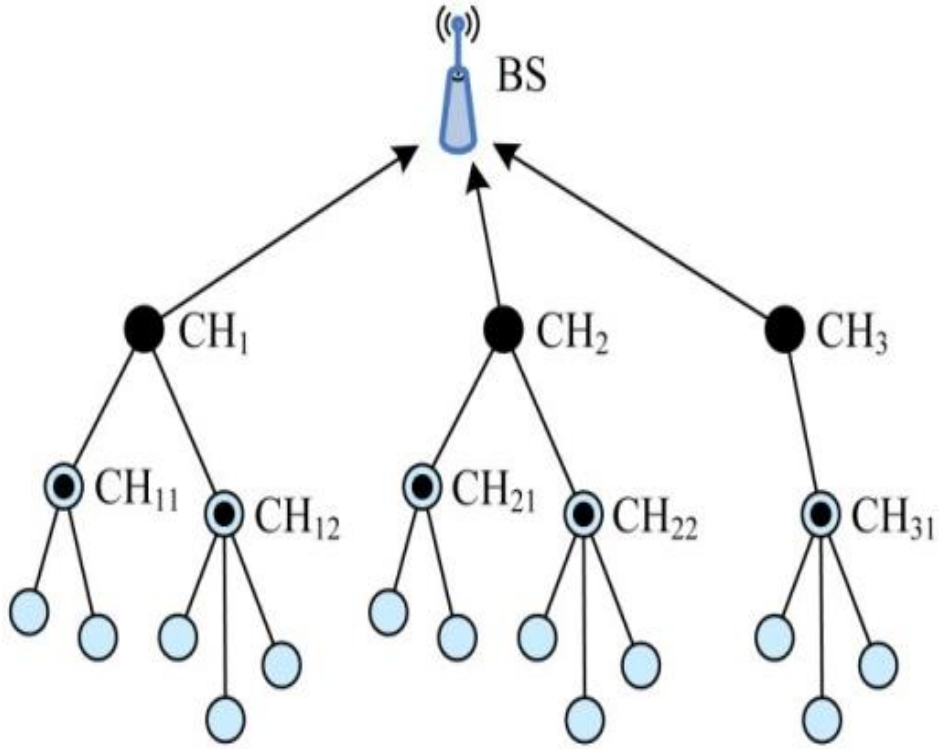


Figure 2.2: Two Level LEACH Protocols

2.5 TL-LEACH (Three Levels LEACH)

To reduce the nodes which communicate directly with the base station could save unnecessary power dissipation; hence the lifetime of the network could be prolonged. . Here in reselect another *N'* p (N'* stands for the number of the level cluster-heads and *N'=N*p,* while *p* is the percentage of level2 cluster-heads) nodes as the cluster-heads to send data to the base station. This information from other cluster heads will be fused in these *N'*p* nodes and then be transmitted to the base station. Thus a 3-level structure constitutes of leaf nodes, level1 cluster-heads and the other one level 2 cluster-heads, as shown in figure 2.3

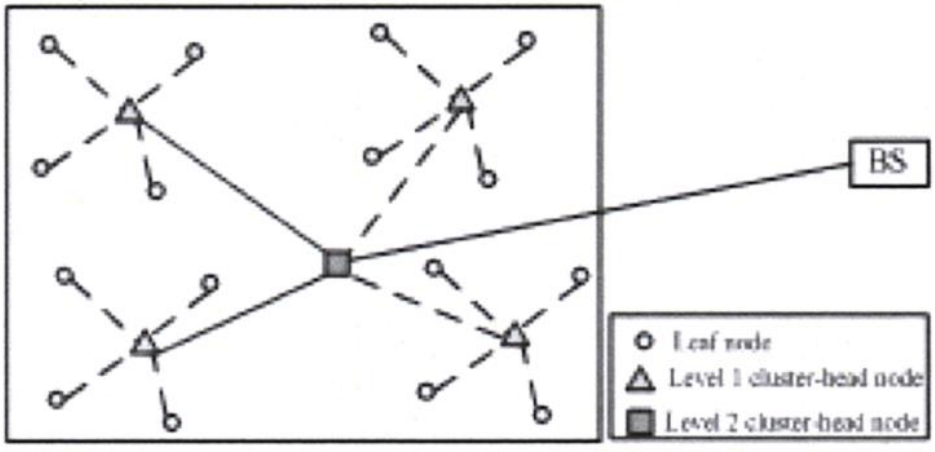


Figure 2:3 TL-LEACHES

As we can read from Figure 2:3 that cluster-heads of level1 gather information from their cluster members, so that it is fuse it and transmit it to level2 cluster-heads, that will fuse this information again and send it to the base station finally. In this structure, it is the cluster heads of level2 which communicate with the base station and so that since much more power consumed in these head nodes, nodes should be power balance strategy in the whole network. In this model, we select another $N'*p$ cluster-heads form $N*p$ level1 cluster-heads whose remaining power is among the range of top $N'*p$.

1. STUDY AND IMPROVEMENT ON LEACH PROTOCOL IN WSNs, by Beibei Wang, Chong Shen, Jing Li.

   In this paper we are studies and analyze the clustering mechanism in LEACH routing protocol in wireless sensor network. LEACH is the first cluster based protocol in wireless sensor network, but problem in LEACH protocol is that is that it depends on the time period to re – establish new cluster among the network. And the new cluster is chosen without considering the difference of energy consumption between the various clusters. And this problem can be removed by a cluster head who decide whether to select a new cluster head, based on their energy consumption. Thus, those clusters with fewer loads can avoid the energy consumption by selecting the cluster head frequently. So we that we can improve the life time of WSNs (wireless sensor networks). We have to make the more number of nodes alive. An improved LEACH is better than LEACH as shown in result graph because the maximum number of nodes is alive.

2. CLUSTER – BASEDPROTOCOL STRUCTURE IN WSNs, Pinar Kirci, HakimaChaouchi, AnisLaouiti, Deparment of Computer Engineering, Istanbul University, Turkey.

   An efficient routing protocol is the major concern in wireless sensors networks (WSNs). In this paper we are also design the energy efficient routing protocol. For energy efficient reason, LEACH protocol and improved version are presented. In this paper we are study about the LEACH – Mobile and Multi-hop LEACH and then compared according to their result and their energy usages and packet transmission

rates. The comparison of the two, Mobile – LEACH and Multi – hop LEACH gives essential results about the energy consumption and the network life.

3. Survey of Extended LEACH – Based Clustering Routing Protocols for Wireless Sensor Networks, M.Aslam, N.Javaid, U.Nazir, A.Bibi, Department of Electrical Engineering, Institute of Information Technology, Islamabad, Pakistan.

   In this paper we studies about the energy efficient hierarchical routing protocol. Because, an energy efficient routing protocol is the major concern in wireless sensor networks. In this paper we are study about the LEACH protocols and their benefits. Main focus of our study is how these extended protocols work in order to increase the life time of WSNs (wireless sensor networks), and quality routing protocol are improved for WSNs. After finding the improved protocol compare with the extended versions of LEACH. So it compares the features and performance in the hierarchical routing protocols. In this paper we also study about the M – LEACH and Multi – hop LEACH, after that compare the result of both technique.

4. Energy Efficient Routing Protocol for WSN's, Ravi Kishore Kodali and Professor Narasimha Sharma, Department of Electronics and communication Engineering, National Institute of Technology, Warangal.

   In this paper the energy efficient of wireless sensor nodes is the main concern. As we know that the sensor nodes are the limited energy or power so there are wastes of energy because every node is communicating to the base station so to save the power we are using hierarchical routing protocol called LEACH. In this we are choosing the many clusters and in every cluster there will be a cluster head which is directly communicating to the BS (Base Station). By forming clusters of nodes in the WSN, the measured data from the nodes can be aggregated and the aggregated value can be send towards the BS instead of sending every measurement value and thereby reducing energy consumed by the nodes. And they further work in two – level LEACH protocol and direct diffusion routing protocol both are in hierarchical routing protocol categories.

5. Cluster size optimization in sensor networks with decentralized cluster-based protocols, NavidAmini, AlirezaVahdatpour, WenyaoXu, Mario Gerla, MajidSarrafzadeh, Computer Science Department, University of California, Los Angeles, United States.

   Network life time and energy efficient are viewed as the dominating consideration in designing cluster – based communication protocol for wireless sensor networks (WSNs).

   This paper provides the optimal cluster size that minimizes the total energy in such network. So, that the all sensors communicate data through their elected cluster heads to the base station and this method is called the LEACH. So, in this paper we are working in three LEACH protocol to eliminate the problem for far location of sensor nodes to the cluster head to increase the energy efficiency of wireless sensor network.

6. A cluster-based routing protocol for wireless sensor networks with nonuniform node distribution JiguoYua,∗, YingyingQia, GuanghuiWangb, XinGua.

   Due to no uniform node distribution, the energy consumption among the nodes is more unbalanced in cluster – based wireless sensor networks (WSNs). In this paper, the cluster - based routing protocols for wireless sensor networks with no uniform node distribution is proposed, which includes an energy aware clustering algorithm (EACA). And a cluster based routing algorithm. EACA gives the competition range to construct cluster of even sizes. And the same time the cluster choses the cluster head to increase the energy efficiency of wireless sensor network.

7. Hierarchical Routing Protocol to Improve Efficiency of WSNs Yong- Zhen Li et al.,(2013) Ai-Li Zhang et al.,(2013)and Yu-Zhu Liang ,(2013)

   Itexplained theinadequacy of LEACH that each node is regularly repeated several times designated as cluster head and the cluster head is also changes continuously so consume some energy, so the authors propose a hierarchical-routing improved

algorithm based on Leach algorithm(Leach-R). For selection of cluster heads, the authors give the simplified version of leach by simplifying the formula of threshold which is used for selection of cluster heads. It gives the better results as compared to existence Leach selection. The proposed algorithm is known as cluster head reappointment routing algorithm.Simulation result shows that leach-R in terms of the network lifetime and energy consumption in large scale networks gives better results as compared to Leach-M.

8. Improve the Life time through LEACH hierarchical Protocol by Tripti Singh et al.,(2013)[9],Neha Gupta et al.,(2013) and Jasmine Minj al.,(2013)

Gives the description that using Hierarchical routing whose topology is cluster based is very auspicious approach for improving throughput. Deployment of nodes in WSN is random in nature which is very tough job to watch over an inaccessible area. Their main objective is to improve network lifetime and reliability of the network with better throughput. So in order to fulfill their objective they use LEACH as one of the prominent Hierarchical routing protocol in WSN. The authors proposed the static clustering with dynamic selection of cluster heads. It is very good technique to restrict the random selection of cluster heads as compare of random selection.

CHAPTER 3
PROBLEM FORMATION, OBJECTIVE AND MOTIVATION

3.1 Problem Formulation

Wireless Sensor Networks (WSN) consists of a numerous number of small low-powered nodes with sensing and wireless capabilities. These devices are known as sensors. These devices sense the physical quantity from the surrounding environment then gathered the information and then send to the BS (Base Station). As these all the devices are battery operated so there energy are limited if they directly send there sense information to the BS (Base Station) then the lifetime of the node become very short so that it will be no more capable of sensing and after a short time the sensor node get die. So for eliminating this problem clustering concept is used which is helpful in overcoming this problem. The biggest challenge of the WSN is energy. Energy needs to be minimized as all the sensors are operates on limited battery power and also for longer duration. So the primary design objective of the WSN is to efficiently use the energy of the sensor nodes and prolong the survival lifetime of the entire network. So in order to fulfill the WSN objective various routing protocols are designed which plays a vital role in prolonging the lifetime of the network along with reduction of the energy consumption among the nodes during the transmission of information from source node to sink. And there is one more problem in LEACH that is randomly selecting the cluster, so there is probability of selecting the cluster which has less energy. So to overcome this problem BFO (Bacteria Foraging Optimization) is used that helps in selecting the cluster head which has maximum energy overall and after that select the cluster head (CH) out of them.

3.2 OBJECTIVES

1. Study different clustering techniques in WSN
2. To propose a new energy efficient clustering algorithm using 2-tier Leach with BFO i.e. Bacterial Foraging optimization in WSN that lengthens the lifetime of wireless sensor networks.
3. Analyze the simulation results of the new proposed algorithm and evaluate the performance
4. Compare the result of proposed technique with the existing techniques and analyze the result.

3.3 MOTIVATION OF WORK

WSN (Wireless sensor network) is formed by wireless sensor node which relies exclusively on battery power which is very much limited and we can't replace the battery as human interference is not possible. So we must increase the life time of the network by efficiently utilizing the available power. For that we have to make the cluster and after making the cluster we have to choose the cluster head using the formula and calculation in such a way that it would provide the maximum life time of WSN network.

Chapter 4

Implementation of Advanced LEACH Protocol with BFO

4.1 Two-Level LEACH Protocol

In the TL- LEACH protocol the same procedure is used as we are using in LEACH protocol. In order to increase the life time of wireless sensor network, it is needed to reduce the number of nodes communicating to the BS (Base Station) directly. So very few cluster head can be in close proximity to the base station in WSN network. The distant cluster head need to increase their power levels, so as to reach the base station. The cluster head is elected during the setup phase of LEACH. Another level of cluster head among the first level cluster head is introduced. So that one among the first level cluster head's is elected as the second level cluster head and this second level CH communicates to the BS (Base Station) directly. It is also called a two-level structure consist of leaf nodes, first level cluster head's and second level cluster head's. The first level cluster head's gather data from their respective cluster nodes, members, aggregate and transmit the same data to the respective second level cluster head's, which also send this whole data to the BS (Base station) hence the life time of WSN network can be increased.

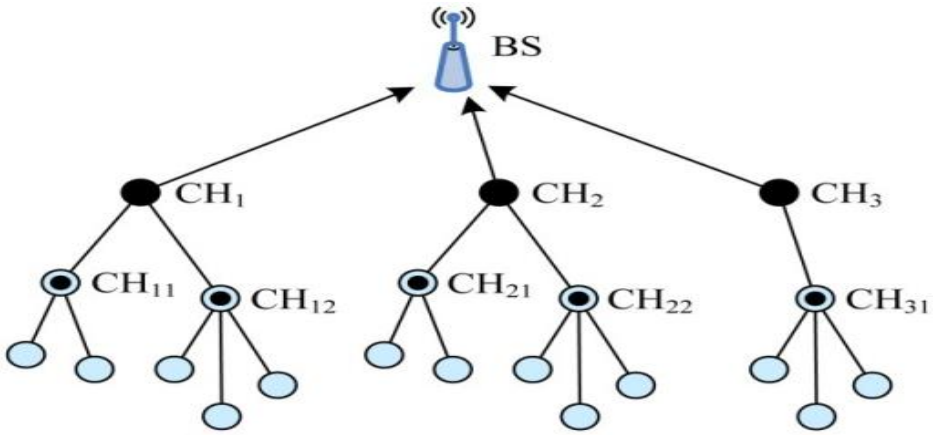
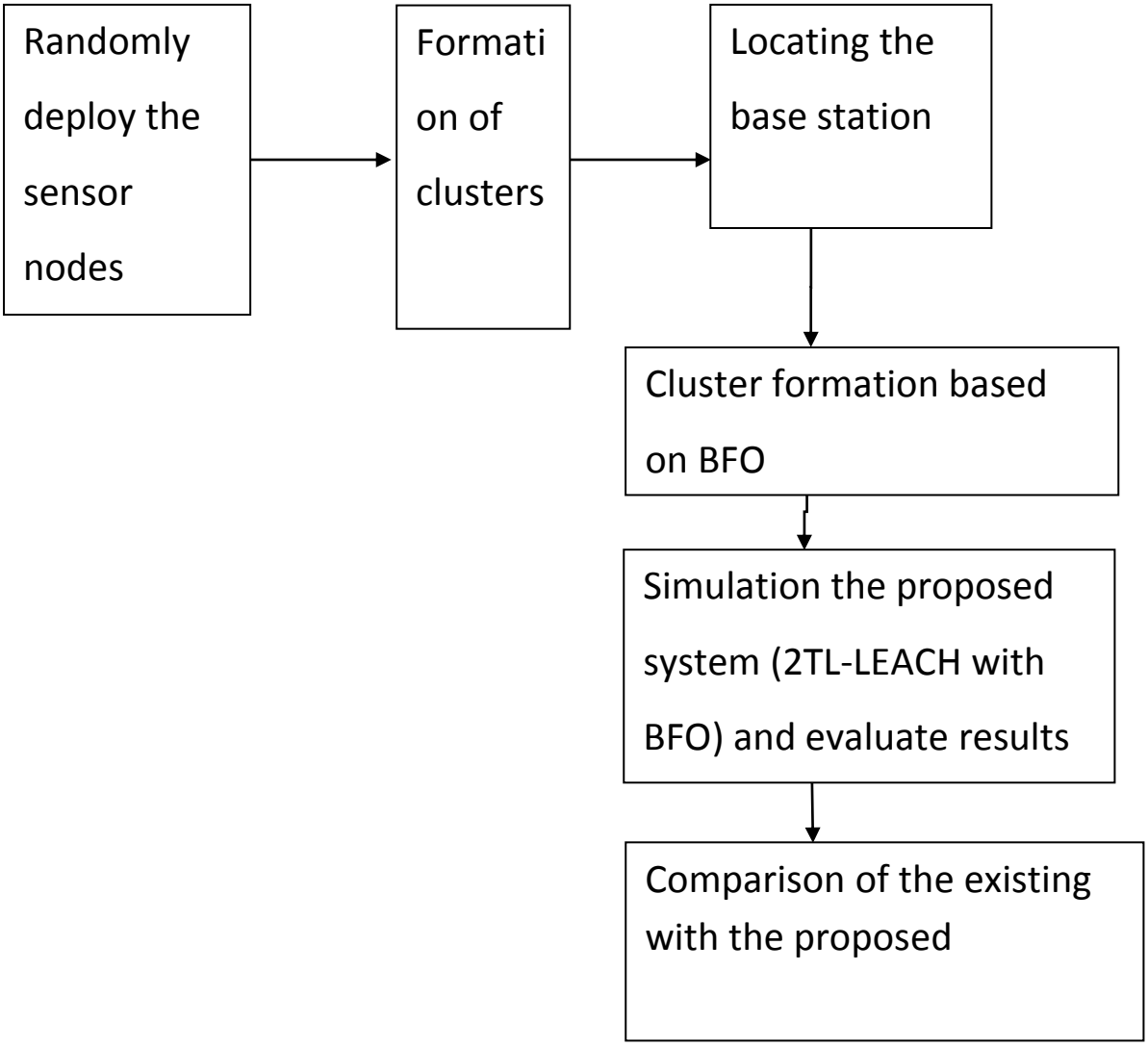


Figure 4.1: Two Level LEACH Protocols

4.2 Diagram of Proposed Work



4.2 Block diagram of proposed work

As we know that in WSN there are many nodes which are connected to the BS (Base Station) and every node is battery operated. So, that the routing is a main challenge which is faced by WSN because of complexity. WSN is limited battery life, computational overhead, no conventional addressing scheme. The Sensor has limited battery and this battery cannot be replaced, therefore, network's lifetime depends upon battery capacity of node.

4.2.1 Formation of Cluster

In WSN there are many sensor nodes which are communicating to the base station so traffic is more and waste of energy also to eliminate this factor we choose the cluster which is group of sensor nodes, so there are many cluster in network and now we have to choose the cluster head among them.

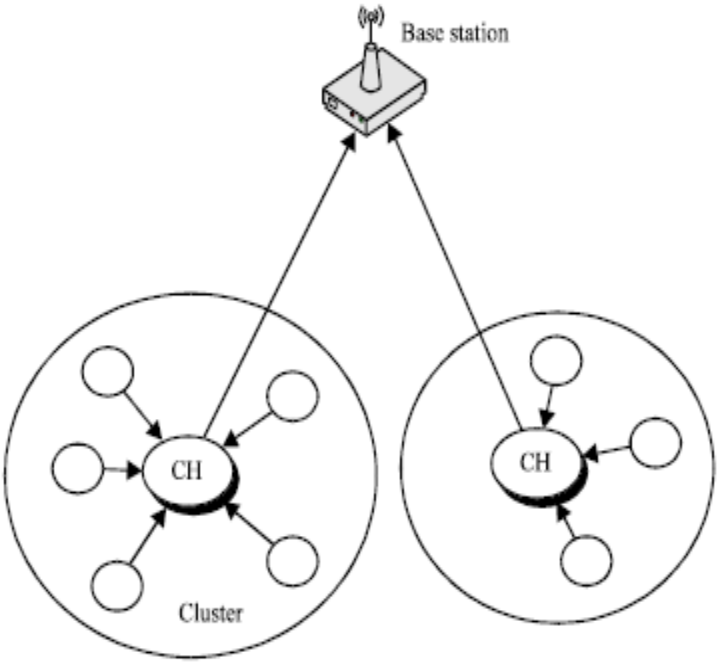


Figure 4.3: Formation of Cluster in WSN

After selecting the cluster we have to select the cluster head (CH) using the formula which is already mention earlier. Now the cluster head is communicating with the base station so that we can save the power and improve the life time of wireless sensor network.

4.2.2 Locating the Base Station

Now the base station is located and the information and control mechanism is handling by base station only through the cluster head which is taken by the help of BFO (Bacterial Foraging Optimization) which is gathering all information from the node and communicate with the base station.

4.2.3 Cluster Formation Based On BFO (Bacteria Foraging Optimization)

Bacterial Foraging Optimization (BFO)is a population-based optimization algorithm. In recent technical areas, bacterial foraging behavior has provided rich source of solution in many engineering applications and computational model in technical world. BFO has been applied for solving practical engineering problems like in Science optimal control, harmonics estimation channel equalization. BFO has been used for cluster head selection to provide improved energy efficiency in routing.

4.3 Bacteria Foraging Optimization

As the bacteria are hungry of the food same concept is apply here in selection of cluster so it chose the most energy cluster as bacteria in the search of food. The process of natural selection tends to eliminate animals with poor foraging strategies and favor the propagation of genes of those animals that have successful foraging techniques, that's why they are more likely to enjoy reproductive success. In many generations, poor foraging strategies are either eliminated or shaped into good ones or healthy one. This activity of foraging led the researchers to use it as optimization process or in selection process. The Escherichia Coli or E. coli bacteria this is present in our intestines which undergo a foraging strategy. So the control system of these bacteria that dictates how foraging should proceed can be subdivided into four sections namely,

1.Chemo- taxis - This process simulates the movement of an *E.coli*cell which present in our body through tumbling and swimming via flagella (part of body). So that Biologically an *E.coli*bacterium can move in two different ways. These can swim for a period of time in the same direction or it may tumble, alternate between these two modes of operation for the entire lifetime in our body.

$$\theta^i(j+1,k,l) = C(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}}$$

2.Swarming - An interesting group behavior has been observed for several motile species of bacteria including *E.coli*and *S. typhimurium*. A group of *E.coli*cells arrange themselves in a traveling ring by moving up the nutrient gradient when placed amidst a semisolid matrix with a single nutrient chemo-effecter. So the cells when stimulated by a high level of *succinate*,

release an attractant *aspertate*, which helps them to aggregate into groups of cell and thus move as concentric patterns (symmetric pattern) of swarms with high bacterial density. The cell-to-cell signalling in *E. coli* swarm and tumble.

$$jcc(\theta, p(j,k,l) = \sum jcc(\theta, \theta i(j,k,l))$$

$$\sum[-dattrac \tan t \exp(-wattrac \tan t \sum(\theta m - \theta^i m)\text{^}2) + \sum[hrepellant \exp(-wrepellant \sum(\theta m - \theta^i$$

3. Reproduction - Size the least healthy bacteria eventually dies while each of the healthier bacteria (those yielding lower value of the objective function as in chemo taxis) asexually split into two bacteria, are placed in the same location. This keeps the swarm constant. That's mean healthier bacteria reproduce another bacteria and then split in to two bacteria.

Elimination and dispersal - In elimination and dispersal the gradual or sudden changes in the local environment due to some reason where a bacterium population lives may occur due to many reason for example significant local rise of temperature may kill a group of bacteria that are currently in a region with a high concentration of nutrient gradients.So, thebacteria which have less power is eliminated automatically and the process is going on so that only healthy bacteria is survives.

4.4 Bacterial Foraging Optimization Algorithm

The algorithm that models bacterial population Initializations of chemo- taxis, swarming, reproduction, elimination, and dispersal is given here initially $j=k=l=0$ which is necessary. The algorithm, updates to the θi automatically result in updates to P number of sensor nodes in WSN. The dead node which is present in WSN is eliminated automatically and new node is formed.The procedure of BFO is as follows.

Chapter 5

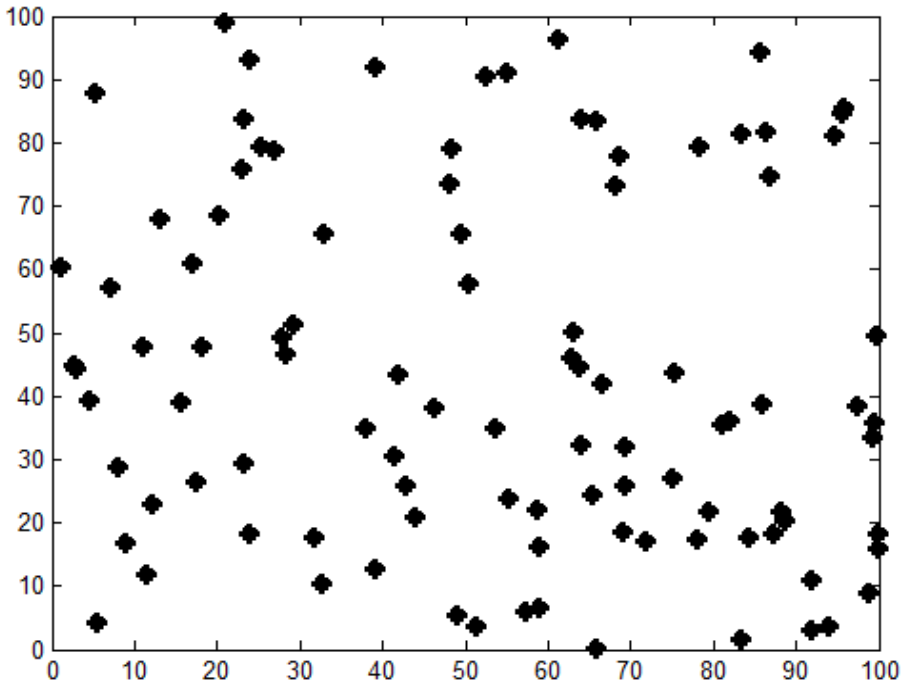
SIMULATION RESULTS AND DISCUSSIONS

5.1 Implementation of LEACH Protocol

The parameter taken for LEACH Protocol

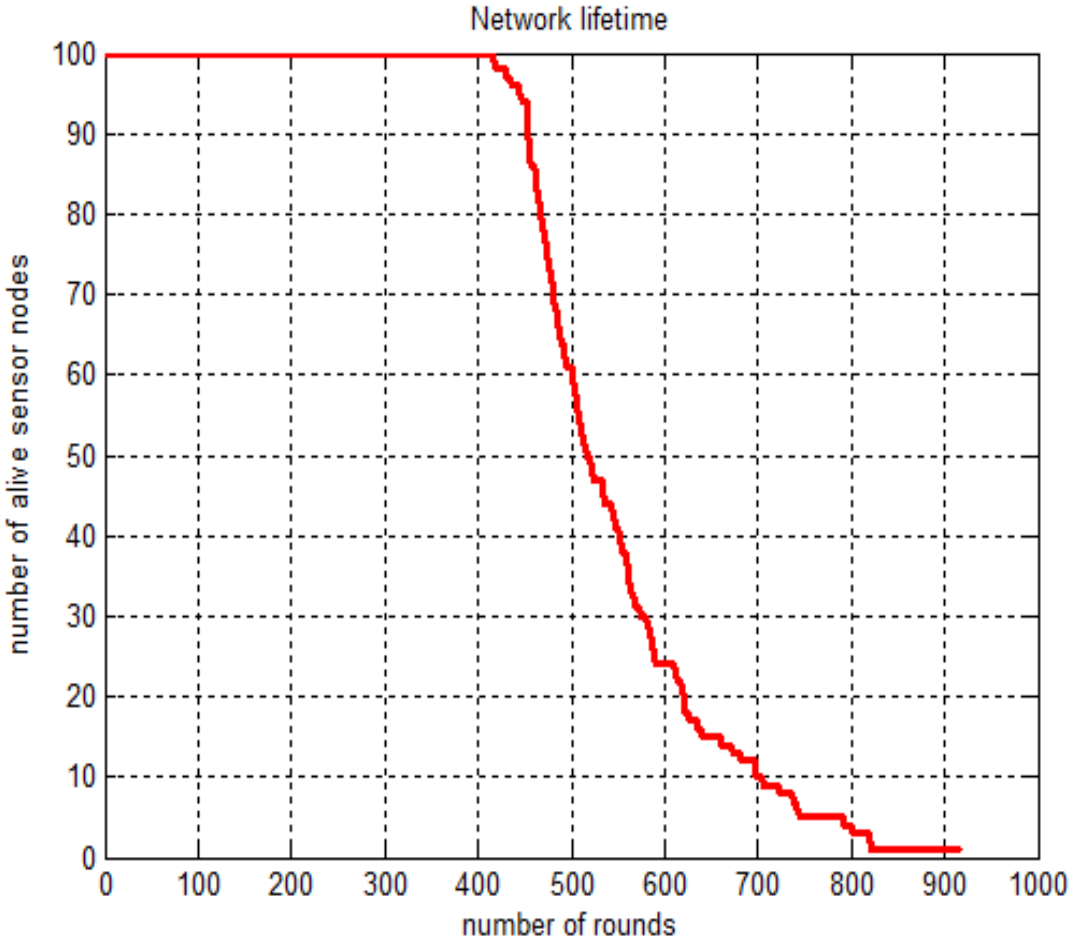
- Number of nodes, n=100;
- Packetlength=6400 bits;
- Control packet length=200 bits;
- Initial energy=0.5J;
- Radio energy dissipation model i.e. transmit energy=50 nJ/bit, receive energy=50 nJ/bit;
- Transmit amplifier types, Efs=10 pJ/bit/m^2, Eamp=0.0013 pJ/bit/m^4;
- Data aggregation energy, EDA=5 nJ/bit/signal;

Deployment of Sensor Nodes



5.1 A WSN with 100 sensor nodes

Where x axis are breath in meter and y axis is the length (m)



5.2 (i) Alive nodes in WSN

Figure 5.2 (i)illustrate the graph that indicates the statistics of alive nodes with different number of rounds. In figure 5.2 (i) using LEACH protocol all the nodes are alive till 410 rounds that means the WSN network is working properly till 410 and then start dying thereafter. All the nodes are completely die after 920 rounds. After 410 rounds the performance of the network starts degrading and therefore all the nodes completely die after 920 rounds.

By Changing the Parameter

Figure 5.2(ii) illustrates that all the nodes are alive till 600 rounds and then start dying thereafter. In this figure we change only the packet length and control packet length parameters and keeping all other parameters same we get this graph better as compared to the above graph. In this all the nodes are live till 600 rounds so the node lifetime increases by 200 rounds

approx. by changing the two parameters. After 600 rounds the performance of the network starts getting depleted and after 1150 rounds approx. all the nodes get die. The parameters are as follows:

- Number of nodes, n=100;
- Packet length=4000 bits;
- Control packet length=500 bits;
- Initial energy=0.5J;
- Radio energy dissipation model i.e. transmit energy=50 nJ/bit, receive energy=50 nJ/bit;
- Transmit amplifier types, Efs=10 pJ/bit/m^2, Eamp=0.0013 pJ/bit/m^4;
- Data aggregation energy, EDA=5 nJ/bit/signal;

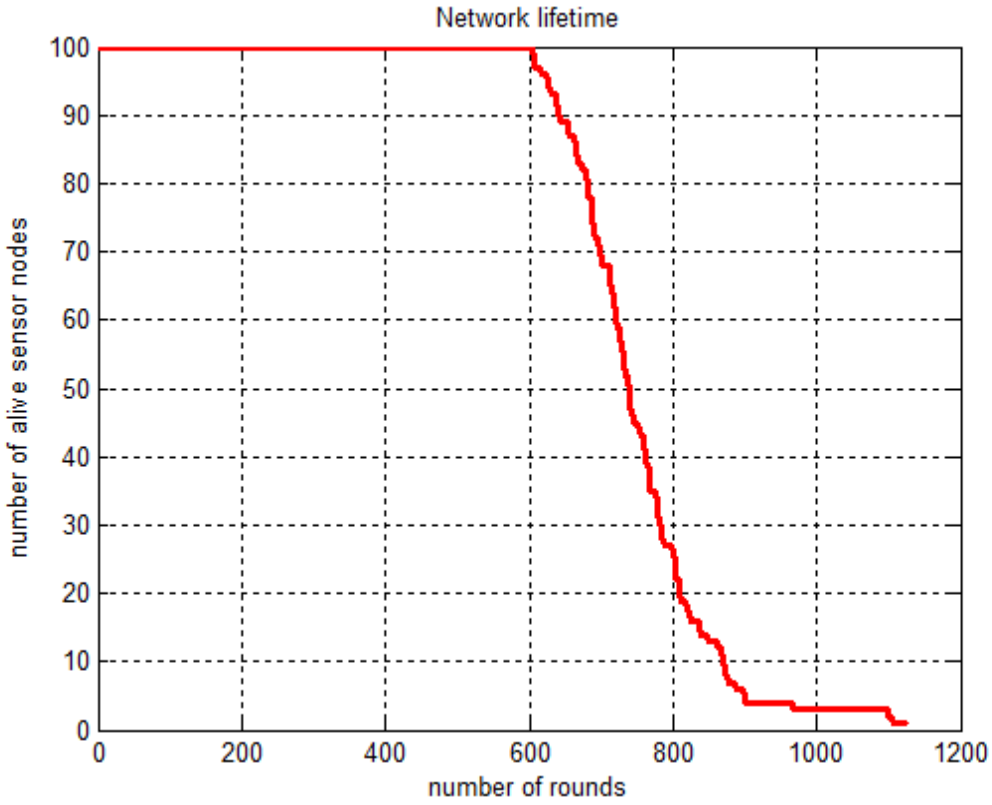


Figure 5.2(ii): Total numbers of alive nodes in WSN using leach protocol using different parameters

5.2 Implementation LEACH with BFO

Parameter to be taken for LEACH with BFO

Ne(number of elimination dispersal event) =20;

Nr (number of reproduction steps) =20;

Nc (number of chemotactic) =20;

Np (total number of bacteria in the population) =20;

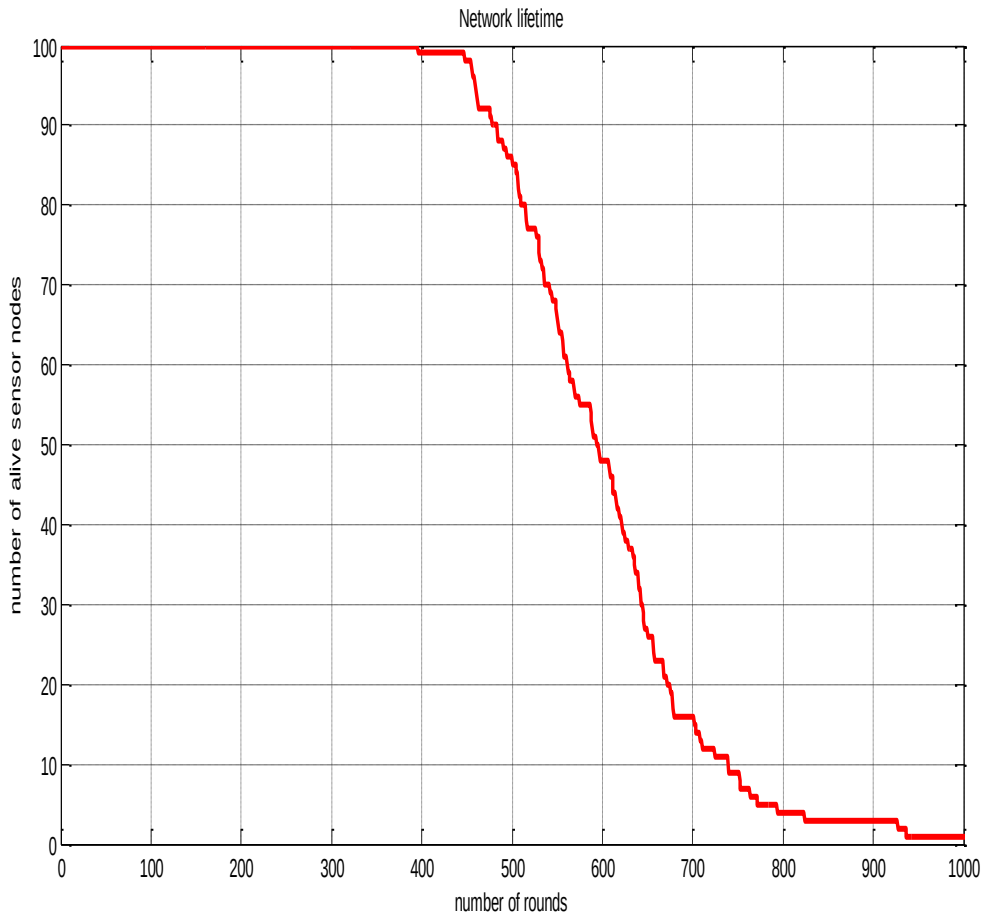
Ns (swimming length) =10;

Eo=0.64;

D (dimension of the search space) =5;

C1 (size of the step taken in the random direction) =0.01;

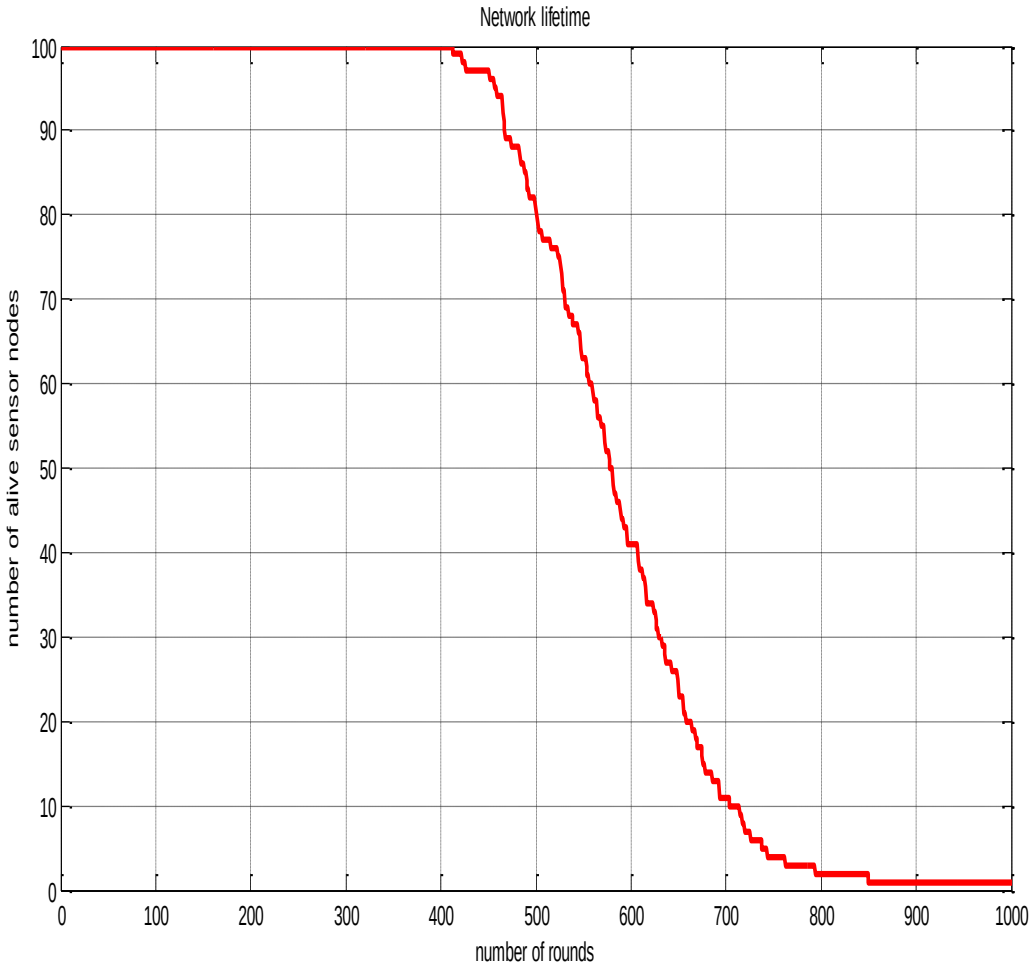
Ped (elimination dispersion probability) =0.9



5.3 Alive nodes in WSN

Figure 5.3: illustrates the graph that indicates the statistics of alive nodes with different number of rounds. In figure 5.3 using LEACH protocol all the nodes are alive till 420 rounds that means the WSN network is working properly till 420 and then start dying thereafter. All the nodes are completely die after 930 rounds

5.3 Implementation of TL- LEACH with BFO

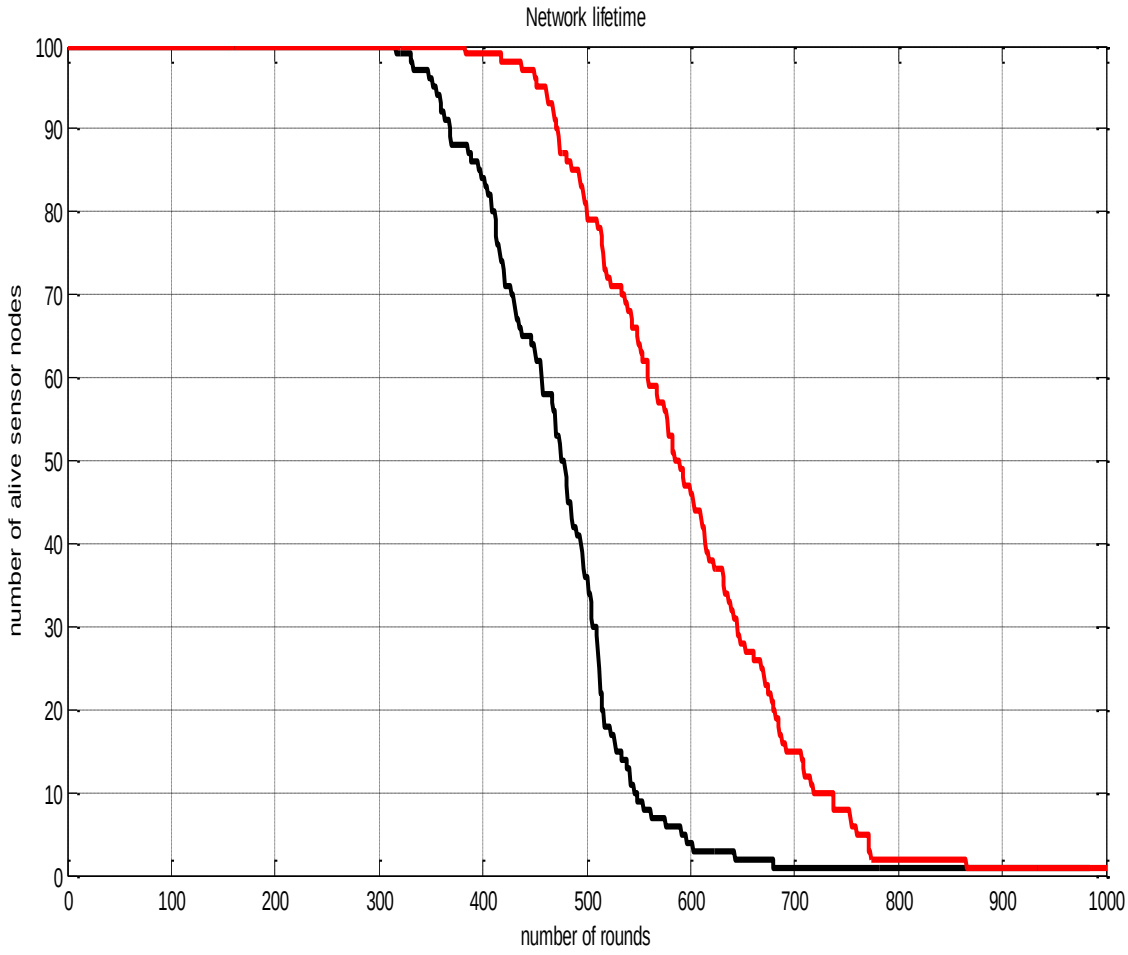


5.4 Alive nodes in WSN

Figure 5.4: illustrates the graph that indicates the statistics of alive nodes with different number of rounds. In figure 5.4 using LEACH protocol all the nodes are alive till 420 rounds that means the WSN network is working properly till 420 and then start dying thereafter. All the nodes are completely die after 1000 rounds. So that by using the TL-LEACH with BFO we can

increase the life time of WSN (wireless sensor network) network. And so, that this method is useful in WSN technique.

5.4 Comparison between LEACH and TL-LEACH with BFO



5.5 Alive nodes in WSN

Figure 5.5: illustrates the comparison between LEACH and TL-LEACH with BFO and so we can achieve the better life time of wireless sensor network. As shown in figure 5.2 LEACH the alive node start dying after 410 and completely dies after 920 round while in figure 5.5 the drastically changes is shown. The alive nodes start dying after 420 round and completely die

after 1000 round, so there are comprehensive changes in alive nodes and because of that the lifetime of WSN (Wireless Sensor Network) network can be increased.

Chapter 6
CONCLUSION

Conclusion 6.1

In recent years, WSN are being widely used in monitoring various physical phenomena. It (WSN) can be applied virtually in any environment which calls for monitoring before taking an appropriate method. There are many application of WSN for example in areas in disaster management, environment monitoring. WSN (wireless sensor node) have the sensor nodes which is used to collect the data and send the aggregated data to the Base Station but the nodes are the power limited and limited range also so there are less consumption of energy and the nodes neither be recharge nor replaced as the human interference is not possible, so that to make the WSN more efficient LEACH is used. Our study based as LEACH protocol is based on the random selection of cluster heads which is the main drawback of the leach As our study reveals as LEACH protocol is based on the random selection of cluster. It is because in some case might be the node selected as a cluster head has very low energy so the nodes that become the members of that cluster head cluster has to suffer a lot and it may restrict their communication with the Base Station. In LEACH the cluster is selected based on their energy of different-2 nodes and after that select the cluster head (CH) using formula. That's why the cluster head gathered data from all nodes in that cluster and communicate with the base station directly to increase the life time of wireless sensor network. BFO (Bacteria Foraging Optimization) is the technique which is used to select the cluster in WSN, it select the node which have the maximum energy as it means and eliminate the poor elements (nodes) and the same time new nodes are formed.

6.2 Scope of the Work

1. Using the 2 – LEACH with BFO (Bacterial Foraging optimization) we can increase the lifetime of the WSN network. WSN is one of the evolving technologies, so which sensor nodes are able to monitor the physical environment. And these sensors can communicate with each other and also with external base station. As the sensor has limited battery and this battery cannot be replaced because of deployment of sensor nodes in the areas is full of

risk so that the human intervention is impossible. A sensor node can only be equipped with a limited energy supply, and the replenishment of energy might be impossible, so the energy factor influences the system lifetime directly**.**

2. In LEACH each node is decide their cluster head and the cluster head directly communicating with the Base Station (BS) rather than the each node communicate with the base station.
3. Monitoring and control of Indurtrial appliances, in military of Surveillance, Forest fire detection, Agriculture and ocean for monitoring fish, medical-monitoring of peoples location and heath care as well.
4. To provide efficient energy harvesting techniques
5. To provide more secure way of data transmission for military mainly.

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