Increasing The Lifetime of Wireless Sensor Networks using LEACH Protocol

"زيادة عمر شبكات الاستشعار اللاسلكية باستخدام LEACH بروتوكول"

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Dedication

To the memory of….

My mother

To the light of my life….

My parents

My sisters

Acknowledgement

I would like to express my sincere appreciation to Prof. Mohammed Alhamid and Dr. Maan Younus for their guidance, support and motivation throughout my Master's Thesis.

Also I'm particularly grateful to Dr. Radwan Abu Jassar, Dr. Maamoun Ahmed and Prof. Reyadh Naoum helping and encouraging my efforts during this research.

I owe more than thanks to my family members which includes my parents, my sisters and my relatives for their financial support and encouragement.

Finally, and most importantly, I would like to thank my father.

ABSTRACT

Energy efficient operation is a critical issue that has to be addressed with large scale wireless sensor networks deployments. Cluster based protocols are developed to tackle this problem, and the Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the best known protocols of this type. However, certain aspects of LEACH offer room for improvement, one such aspect is the arrangement of wireless sensor network with the fixed base station location.

In this thesis, we propose an algorithm that is based on LEACH protocol but uses a sleep mode of cluster head. This algorithm produces reasonable improvement over LEACH in a network area 500m x 500m. We also compare the proposed algorithm to another protocols that use DTx, LEACH, EEE-LEACH and SRDC-LEACH in term increase the lifetime.

For calculation, MATLAB environment is used, simulation results are provided to show the comparative effectiveness of different clustering algorithm on network lifetime, cluster head selection, and normal nodes in the network.

Finally, on the basis of the obtained results from the simulation, we compare the proposed algorithm with another algorithms based on LEACH protocol, the comparison results show that, the our algorithm has best lifetime.

الملخص

تعد عملية كفاءة الطاقة أمرا حاسما، في شبكات الاستشعار اللاسلكية. حيث تم تطوير عدة بروتوكولات للبحث في حلول لهذه المشكلة، ويعتبر برتوكول (LEACH) احد أفضل هذه البروتوكولات. حيث يكون الهدف الأساسي من بروتوكول (LEACH). إطالة عمر شبكات الاستشعار اللاسلكية من خلال تحسين استخدام الطاقة.

في هذه الرسالة، اقترحنا خوارزمية جديدة هي (SWIT-CH-LEACH) تستخدم برتوكول (LEACH) وتنويم رؤوس المجاميع، (SWIT-CH-LEACH) تعطي تحسنا ملحوظا على أداء (LEACH) في الشبكة. بعد ذلك قمنا بمقارنة الخوارزمية المقترحة مع برتوكولات أخرى قدمت حلول لإطالة عمر الشبكة. ولإجراء الحسابات اللازمة استخدما بيئة MATLAB.

نتائج المقارنة بينت أن الخوارزمية لمقترحة أعطت أفضل عمر لشبكات الاستشعار اللاسلكية.

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Abbreviations

ADCs : Analog to Digital Converters

BS : Base Station

CH : Cluster Head

CHs : Cluster Heads

CPU : Central Processing Unit

DTx : Direct Transmission Protocols

GPS : Global Positioning System

EEE : Energy Efficient Extended

HMRP : Hierarchy Based Multipath Routing Protocol

LEACH : Low Energy Adaptive Clustering Hierarchy

MRE : Maximum Residual Energy

MR : Multi-hop Routing

MCH : Master Cluster Heads

RSSI : Received Signal Strength Indicator.

NDEA : Node Degree and Energy-Aware

SHORT : Shortest Hop Routing Tree

SRDC : Scheduling Roles Dormant Cells

SWEET : Slotted Waiting Energy Efficient Time

SWIT-CH : Switching Cluster Head

TDMA : Time Division Multiple Access

TLHCLP : Three Levels Hierarchical Clustering LEACH Protocol

WSNs : Wireless Sensor Networks

WSN : Wireless Sensor Network

Chapter One

Introduction

1.1 Overview

In this chapter we review a brief background about the scope of the thesis, we give a review of wireless sensor networks, LEACH protocol. Then we gave an idea about our research problem and how it has been addressed, our own contribution, and the outline of the thesis chapters.

1.2 Wireless Sensor Networks

Wireless sensor networks (WSNs) may consist of several thousands of homogeneous or heterogeneous sensors (as shown in figure1.1) that share the need to organize the following:

1- Data collaboration or network data collection.

2- Sink routing.

3- Integration of sensors.

4- Processors.

5- Transceivers.

Remote sensing platforms are typically characterized by reduced processing capabilities, limited memory capacities, and fixed battery supplies (Brownfield, M. I., et al. 2006).

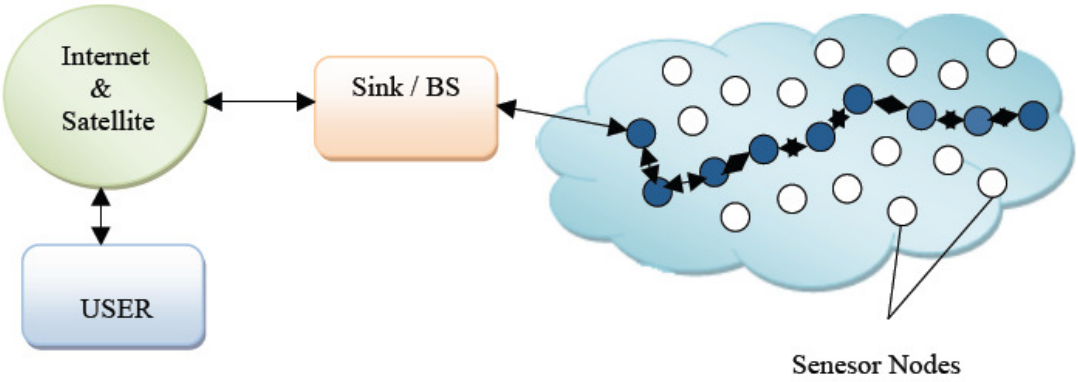
The wireless sensor network energy consumption falls into three categories: sensing, computing, and communicating (Sohrabi, k. et al.2000). Demonstrates that the communications costs dominate a wireless sensor network, sensor platform's power budget. The wireless sensor network must also be scalable to support extremely dense sensor fields.

There has been a long history for remote sensing as a means for humans to observe the physical world. For example, the telescope invented in the 16th century is simply a device for viewing distant objects. As with many technologies, the development of sensor networks has been largely driven by defense applications.

Applications for energy efficient wireless sensor network include homeland defense, sensing, military surveillance, and environmental sensing (Mainwaring , A. ,et al. 2002).

The wireless sensor network can be structured or unstructured (Maraiya, K., et al. 2011). A basic wireless sensor network requires very little infrastructure. In one such network, nodes can be deployed in an ad hoc fashion. The network is not attended after deployment and does monitoring and reporting on its own. However, the sensor network deployed to obtain data from the environment may require a large number

of sensor nodes, depending on the area to be covered. Due to large numbers of nodes the management of network becomes difficult, and complex structure is required. The structured wireless sensor network has planned deployment of sensor nodes, and this means that fewer nodes are required to cover the area compared to an unstructured network.



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gure1.1: General Overview of Wireless Sensor Networks (Behrouz, R. 2012).

1.3 Sensor Node Structure

A sensor node typically composed of four main components as shown in figure 1.2.

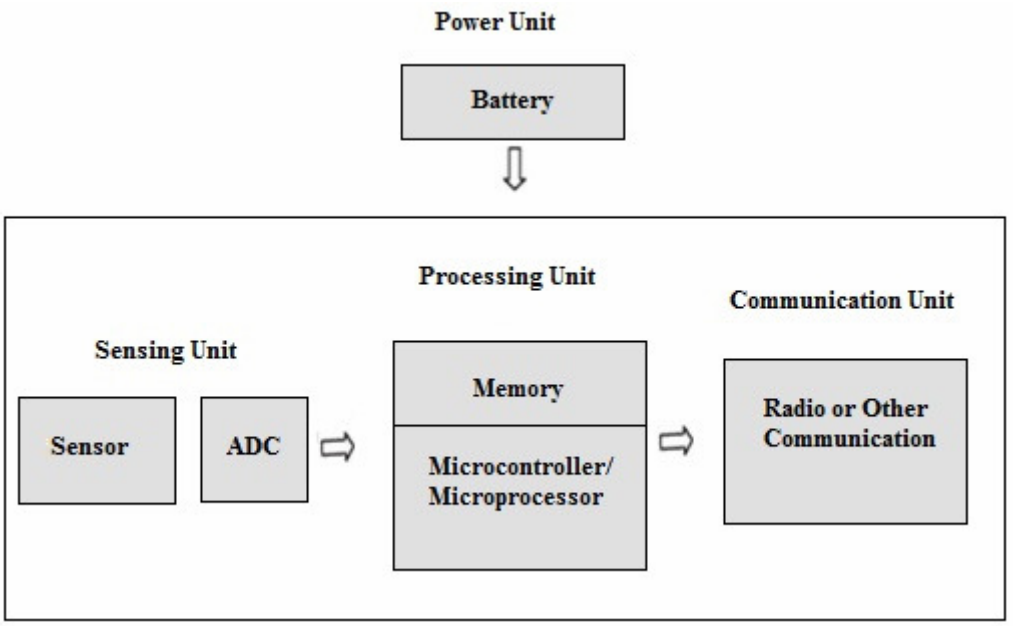

Figure1.2: Structure of Sensor Node (Chugh & Singh 2013).

1- Sensing Unit: The sensing unit usually consists of one or more sensors and analog to digital converters (ADCs). The sensors observe the physical phenomenon and generate analog signals based on the observed phenomenon. The ADCs convert the analog signals into digital signals, which are then fed to the processing unit.

2- Processing Unit: The processing unit usually consists of a microcontroller or microprocessor with memory, which provides intelligent control to the sensor node.

3- Communication Unit: The communication unit consists of a short range radio for performing data transmission and reception over a radio channel.

4- Power Unit: The power unit consists of a battery for supplying power to drive all other components in the system. In addition, a sensor node can

also be equipped with some other units, depending on specific applications (Habib, A.2008).

1.4 Protocol Stack

A streamlined protocol stack a WSN is compressed in figure (1.3)

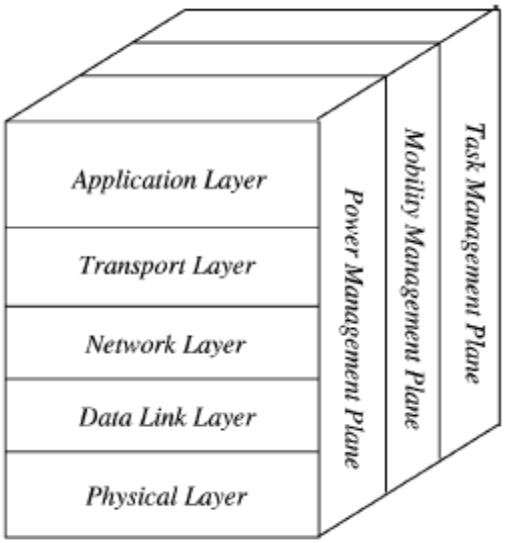

Figure 1.3: Architectural Layers of a WSN (Alkhatib & Baicher 2012).

1- Physical Layer : It can provide an interface to transmit a stream of bits over physical medium. Responsible for frequency selection, carrier frequency generation, signal detection, Modulation and data encryption.

2- Data link layer: The data link layer's function is data streams multiplexing, error control, frame detection and ensuring reliable connections.

3- Network layer: The network layer's function is to take care of addressing and forwarding packets.

4- Transport layer: Transport Layer Protocols are used to decrease congestion, packet losses and to increase reliability.

5- Application layer: Responsible for traffic management and provide software for different applications that translate the data in an understandable form or send queries to obtain certain information. Sensor networks deployed in various applications in different fields, for example military, medical, environment, agriculture fields.

1.5 Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network (as shown in figure 1.4). All the node in a network organize themselves into local cluster, with one node acting as the cluster head. All non-cluster head node transmit their data to the cluster head, while the CH node receive data from all the cluster member, perform signal processing functions on the data aggregation and transmit data to the remote base station. Therefore, being a cluster head node is much more energy intensive than being a non-

cluster head node. thus, when a cluster head node dies all the nods that belong to the cluster lose communication. The problem of LEACH protocol is balance the energy consumption, network energy consumption.

LEACH minimize the communication energy that is dissipated by the cluster heads and the cluster members as much as 8 times when compared with direct transmission and minimum transmission energy routing (Heinzelman, W. R., et al .2000).

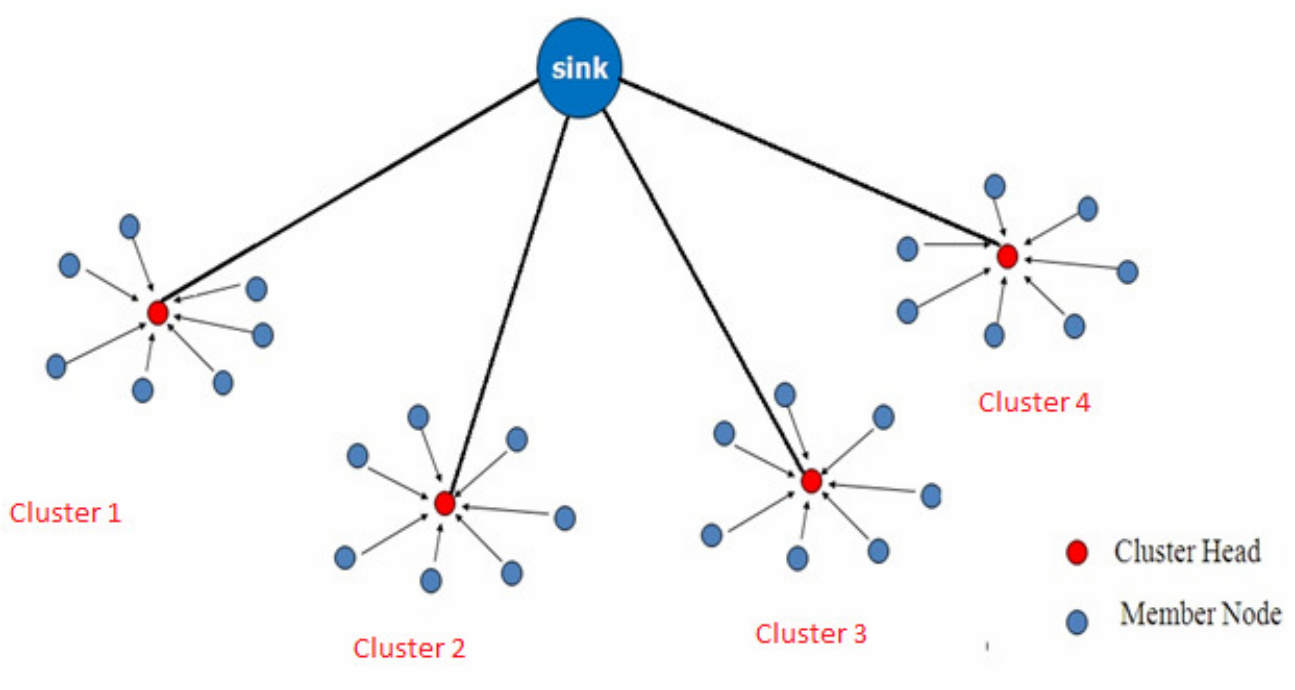

Figure 1.4: LEACH Protocol (Kumar, Y., et al . 2012).

1.6 The Problem Definition

All sensors will collect information and send to the base station which leads the energy consumption in the network. Especially when all the cluster heads effective, adjacent, collect the same information and send

to base station, the problem would be to cluster heads died quickly and which lead to energy consumption for wireless sensor networks.

1.7 Goal of Research

The goal of this research is to minimize the energy consumption and to increase the lifetime for wireless sensor networks using LEACH protocol.

1.8 Questions

This research will answer the following question

1- How can we design new algorithms to increase the lifetime for wireless sensor networks?

2- How can we identify methods that can be applied ?

3- How can we use the LEACH Protocol to develop a new algorithm?

1.9 Objectives

The main objectives of this thesis are:

1-To implement and simulate a wireless sensor networks using MATLAB simulator.

2-To implement a modified LEACH algorithm that solves the energy consumption problem in wireless sensor networks.

3-To compare and evaluate the performance of the LEACH and modified LEACH in term of network lifetime**.**

4-Develop a new technique to increase the lifetime for wireless sensor networks.

5-Using LEACH protocol to build a new algorithm to increase the lifetime of wireless sensor networks.

1.10 Motivation

Save the energy of cluster head to increase the lifetime of the WSN. In a LEACH protocol, cluster head sends query to all nodes in its cluster, aggregates data from all the nodes and report it to the base station. The cluster head spends more energy than other nodes in the networks, so its energy decreases sharply. The node that has less energy cannot become a cluster head. The goal is how to save energy a cluster head so that the network lifetime increases.

1.11Organization of The Thesis

In addition to this chapter, there are other four chapters in this thesis. Thus in this section we will describe briefly the contents of these chapters.

Chapter two provides a general description to increase lifetime of wireless sensor networks by mentioning its characteristics, benefits, types, and importance.

chapter three Presents the process of applying the (SWIT-CH-Algorithm).

Chapter four includes a description of the Structure and implementation of the proposed algorithm (Switching cluster heads LEACH Protocol).

Chapter five presented and discussed the conclusions of our research; the final results and how we used them to contribute to the studied domain are presented among the conclusions. Future work is suggested at the end of this chapter.

Chapter Two

Literature Review

2.1 Overview

This chapter gives a brief idea about the most related work in the literature that related to our study. We provide a background and literature review of the increasing lifetime for wireless sensor networks.

2.2 Literature Review

This part investigates of existing study and research which is relevant to our theme and present some background reading required to give context to our research.

(Kumar & Pal. 2013) The scope of this paper is the protocol assisted LEACH (A-LEACH) which achieves lessened and uniform distribution of dissipated energy by separating the tasks of routing and data aggregation. It introduces the concept of helper nodes which assist cluster heads for multi-hop routing. A new algorithm has been formulated to facilitate energy efficient multi-hop route setup for helper nodes to reach base station. The proposed protocol extends the lifetime of the network, minimizes overall energy dissipation in the network and distributes

dissipation among cluster heads, sensor nodes and helper nodes vis-à-vis LEACH. This is substantiated by simulation results. Helper nodes in assisted LEACH (A-LEACH) protocol has improved the lifetime of the network by distributing the minimized energy dissipation throughout the nodes. Theoretical analysis and simulation results substantiate this.

(Aslam, M., et al. 2012) The main focus of his study is how to extend routing protocols work in order to increase the life time, and how quality routing protocol is improved for the wireless sensor network. In hierarchical routing protocols whole network is divided into multiple clusters. One node in each cluster play leading rule. Cluster head is the only node that can communicate to base station in clustering routing protocols. This significantly reduces the routing overhead of normal nodes because normal nodes have to transmit to cluster-head only.

(Vashist & Khurana.2013) The scope of this paper includes both the first and the second levels. The global problem of maximizing network lifetime under the joint clustering, routing, and coverage constraint. Two issues at hand:

1. Extra overhead of the network routing redundant messages.
2. Extra overhead of running redundant sensors.

Using clustering-or routing-based compression, duplicate observations are eliminated as they are routed towards the sink. Deactivating redundant sensors minimizes coverage overlap and waste. Reduce unnecessary cost

by disabling or turning off redundant sensors. Reduction from 12 to 7 active. Many papers address separately energy efficient routing, clustering, and area coverage and connectivity.

Many others address integrated problem of area coverage and network connectivity, but they do it in flat networks and don't reap the benefits the energy savings and ease of manageability of cluster-based networks.

(Soe, K. 2008) The system design and implementation architecture is proposed to increase sensor network lifetime for target tracking. The purpose of the system is to support the ability to track the position of moving targets in an energy efficient manner with low energy consumption for the sensing nodes in the network and to extend the life time of a sensor network.

(Ofrim & Săcăleanu. 2010) This article presented a very successful technique for reducing the energy consumption and increasing lifetime of wireless sensor networks. To evaluate the efficiency of the proposed "Adaptive Scheduling Algorithm" in term of network lifetime, a scenario containing network topology are built, synchronization techniques, energy model and management of data transmission and scheduling. For the same wireless sensor network model, the simulation results confirm an important increase in network lifetime in the case of applying the Adaptive Scheduling Algorithm compared to the network lifetime in the case of a Non-Adaptive Scheduling model.

(Yongtao, et al. 2006) The authors are analyzed the reasons why the uncertainty in LEACH degrades system life, and then present a distributed clustering algorithm based on an adaptive backoff strategy. LEACH due to its randomness, is not as load balancing as expected. To solve such problem they proposed a new distributed clustering algorithm, which not only uses an adaptive backoff strategy to realize load balance among sensor node, but also ensures that the elected cluster-heads are well distributed. Simulation results indicate that the propose of algorithm is efficiently to prolongs the system life.

(Wang, Y., et al. 2006) Several methods for transmitting data in randomly deployed sensor nodes have been proposed, including direct communication, flat, and clustering protocols. This work presents a Hierarchy-Based Multipath Routing Protocol (HMRP) for wireless sensor networks, based on the layered network, sensor nodes have multipath routes to the sink node through candidate parent nodes. The simulation results indicate that the proposed HMRP can increase the lifetime of sensor networks better than other clustering or tree-based protocols.

(Taneja & Bhalla. 2013) An energy efficient three level hierarchical clustering protocol (TLHCLP) for wireless sensor networks is proposed. The fundamental concept of this protocol is that there is a predefined radius around the base station (located at centre), some nodes are inside the radius and others are outside the radius. Cluster heads which are

outside the radius find the nearest cluster head which is inside the radius and send data to it. Then these inside cluster heads aggregate the data and send it to the base station. The proposed scheme is compared against LEACH protocol. Simulations have been conducted to evaluate these protocols and favorable results are obtained. This results show that TLHCLP improves network lifetime by an order of magnitude compared with LEACH.

(Luan, W., et al. 2012) The authors analyze LEACH (Low-Energy Adaptive clustering Hierarchy), a clustering based protocol and its limitations, and introduce a new weight defined by combining node degree and residual energy. They proposed an improved algorithm based on the weight. Simulation results show that the improved algorithm NDEA (Node Degree and Energy-Aware routing protocol) can optimize clustering and balance network load. Furthermore, it can greatly improve the network lifetime.

(Dakshayini, et al. 2013) The main purpose of this work is to propose an energy aware routing algorithm by assuming that nodes in a network are equipped with global positioning system (GPS). Initially the nodes are deployed randomly, and after deployment all the sensor nodes inform the location information to the base station before the set-up phase and steady state phase. After the location information is collected in the base station, the network coverage area A is divided into groups A1, A2, A3, etc. The

groups are created based on the location of the node and cluster head election probability p. The groups creation is done by the BS and does not guzzle too much energy. In each group a CH is selected randomly for each round, therefore the elected cluster heads are distributed uniformly in the network. Then each CH sends identity message to the group member nodes before starting the steady state phase. In steady state phase, all the CHs receive and aggregate the data from group member nodes as in LEACH but instead of directly sending the data to the base station. Therefore CH reduces the radio communication distance. In the proposed LEACH the residual energy remains up to 460 rounds when compared to LEACH which remains only for 193 rounds because the modified LEACH distributes the energy equally among all nodes compared to LEACH. In the modified LEACH, the first node dies in 240 rounds and in LEACH the first node dead at 102 rounds.

(Farooq, M. et al. 2010) This paper, deals with a Multi-hop Routing with Low Energy Adaptive Clustering Hierarchy (MR-LEACH) protocol. In order to prolong the lifetime of wireless sensor network. MR-LEACH partitions the network into different layers of clusters. Cluster heads in each layer collaborates with the adjacent layers to transmit sensor's data to the base station. Ordinary sensor nodes join cluster heads based on the Received Signal Strength Indicator (RSSI). The transmission of nodes is controlled by a Base Station (BS) that defines the Time Division Multiple

Access (TDMA) schedule for each cluster-head. BS selects the upper layers cluster heads to act as super cluster heads for lower layer cluster heads. Thus, MR-LEACH follows multi-hop routing from cluster-heads to a base station to conserve energy, unlike the LEACH protocol. Performance evaluation has shown that MR-LEACH achieves significant improvement in the LEACH protocol and provides energy efficient routing for WSN.

(Bakaraniya & Mehta. 2013) A modified algorithm for Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is proposed. The modified protocol called "Kmedoids-LEACH protocol (K-LEACH) for clustered WSN" is aimed at prolonging the lifetime of the sensor networks by balancing the energy consumption of the nodes. The proposed protocol uses the kmedoids clustering algorithm for uniform clustering and Euclidean distance and maximum Residual Energy (MRE) is used to select the cluster head (CH). The performance of K-LEACH with that of the LEACH protocol is compared using simulations. Simulation result shows that K-LEACH improves the network lifetime over LEACH.

(Fang, S., et al. 2007) In this work overhead fully distributed clustering algorithm is proposed to decompose wireless sensor networks, where nodes are initialized with either equivalent or different energy capacities, into a two-tier clustered hierarchical structure. Energy rich nodes are assured to act as cluster heads (CH), and CHs are dispersed

evenly over the network. The purpose if the energy distribution is known in advance, Slotted Waiting Energy-Efficient Time (SWEET) prioritizes energy rich nodes in the CH competition. A CH utilizes a local transmission range to recruit its members and drive undermining CH contenders away from its cluster radius, so that cluster size can be restricted and CHs are less likely to huddle. A CH candidate running Slotted Waiting period Energy-Efficient Time Driven clustering algorithm (SWEET) simply waits and listens to other neighbors, until it has to become a CH, so the overheads during the clustering process are cut out. Though SWEET is an overhead-free method, it performs even better than some representative clustering schemes in extending system lifetime and enlarging network data capacity.

(Banerjee, T., et al. 2008) This paper proposed a scheme for improvement of network lifetime and delay by employing a connected group of mobile cluster heads in a wireless sensor network. As data sensing is triggered by an event, the sensors relaying the aggregated data to the base station run out of energy at a much faster rate than sensors in other parts of the network. This gives rise to an unequal distribution of residual energy in the network, making the nodes with lower remaining energy level to die much faster than others. To distribute the remaining energy more evenly in the network, some energy rich nodes are designated as cluster heads which move in a controlled manner toward locations rich

in energy and data. The propose is to reduces the transmission energy required by the static sensors to send data and thus increases the overall lifetime of the network. Along with transmission energy, time taken for transmitting data to the BS is also reduced as the CHs follow a connectivity strategy to always maintain a connected path to the BS. Simulation shows that lifetime of the network can be increased by 42% over existing scheme by making the CHs always move towards a stable equilibrium point, a point where the total residual energy of the network and data are concentrated. The connectivity algorithm also provides 40% improvement in the transmission delay as compared to existing schemes.

(Yang, Y., et al .2006) A new routing scheme proposed called Shortest Hop Routing Tree (SHORT), to achieve those design objectives through effectively generating simultaneous communication pairs and identifying the shortest hop (closest neighbor) for packet relay, and analyze a new tree-structure routing scheme also called shortest hop touting tree (SHORT), which can ensure the best "energy × delay" performance while, at the same time, achieve a good balance among other performance metrics such as energy efficiency and throughput. The paper contains many homogeneous sensor nodes, which are randomly deployed in an area of interest; and a base station, which has continuous power supply and is located far away from the sensing area. For the sake of comparison with

previous works to follow the similar assumptions for system modeling are chosen.

(Gupta, A., et al.2013) Present propose an algorithm which is modified version of LEACH and using MATLAB simulator are proposed. They evaluated the performance of improved protocol in terms of network lifetime, number of dead nodes, and number of alive nodes in comparison with existing protocol. The authors simulated LEACH CC and it is proved that LEACH-CC performs better than LEACH by 1.12 times the lifetime of network even when 80% nodes die. LEACH-CC can be improved even further when the size of the network increases.

PROTOCOL	HOP COUNT	CH SELECTION	ADVANTAGES	DISADVANTAGES
LEACH-A	Single hop	Residual Energy Level	Heterogeneous energy protocol is proposed for the purpose of decreasing the node's failure	Consumes much energy to transmit data to Base Station
LEACH-F	Single hop	Random	No need of re-clustering cluster members.	1)Node mobility cannot be handled. 2)Less energy saving.
LEACH-L	Multi hop	Based on distance	All nodes in the sensor are homogeneous and energy constrained.	It demands each sensor node to record its own location information and the information of candidate routing CH increasing the storage
LEACH-TL	Multi hop	Based on distance	New level of hierarchy used to transmit Information to Base Station (BS) over two different levels	Extra overhead for electing secondary CHs and cluster formation.
LEACH-S	Single hop	Residual Energy Level	Base station selects the cluster head with the help of improved central control algorithm.	If there's a change in the sun status, the solar nodes need to send a "change status" to itself, these decreases its energy level

Table 2.1 Comparision Between Leach Protocols

Our proposal is based on existence literature of clustering structure proposed by LEACH protocol.

Chapter Three

Methods For Increasing Lifetime Of WSNs

3.1 Overview

In this chapter we gave the most well known methods for WSNs, that extend the lifetime of the network. In this work we propose an algorithm, SWIT-CH-LEACH, the tasks of switching and distribution of roles dormant cluster heads of wireless sensor network to curb excessive consumption of energy consumed duplication and unhelpful tasks. SWIT-CH-LEACH algorithm was proposed to achieve equitable distribution of energy consumption for cluster heads on the network.

3.2 Introduction

When a sensor detects activities or unusual behaviors, it generates report messages and delivers them to the interested user. The user thus receives its information from multiple sensing sources. These users usually lose a lot of energy in dealing with such data or in re-broadcasting to higher levels or other users. To reduce the high-energy consumption we proposed the (SWIT-CH) algorithm functions to facilitate the process of

sending reports from terminal nodes to the interested users or re-broadcasting them to a higher level of the network, the user can be the cluster head, neighbor node (Ranganathan & Nygard 2010). The challenge to build a wireless sensor network in the area geographically far apart and rugged is related to the energy consumption (Akkaya & Younis 2005). In the past few years, the problem of energy took the attention of many researchers in the field of wireless sensor networks.

Routing protocols are divided into many categories like structure based routing protocols and operation based routing protocols. All these sub layers like flat routing, location based, multi path based, query based, negotiation based comes under the classes like hierarchical based routing, data centric routing and network flow Quality-of-Service based routing protocols (Nandgave, 2012).

3.3 Direct Transmission Protocols (DTx)

The direct transmission protocols consists of only base station and normal sensor nodes. The sensor nodes work as senders and base station serves as the destination node to all the other sensor nodes in the network. The sensor nodes transmit their data to the base station and the base station received all data. The sensor nodes and base station is directly communicated without any intermediate communicator. The nodes only remain active during the data transmission to the base station. Since the

nodes do not spend energy when receiving the messages from the other nodes, they will spend the minimum data on listening the channel and, then, they will spend their battery capacity on sending messages to the base station (Sharma & Shaw 2012). If a sensor node transmits data directly to the base station, the energy loss incurred depends on the location of the sensor nodes relative to the base station. As a result, the direct transmission protocol's complexity can be ignored, but it is the least energy efficient protocol in most cases (Rajendran, V., et al2006).

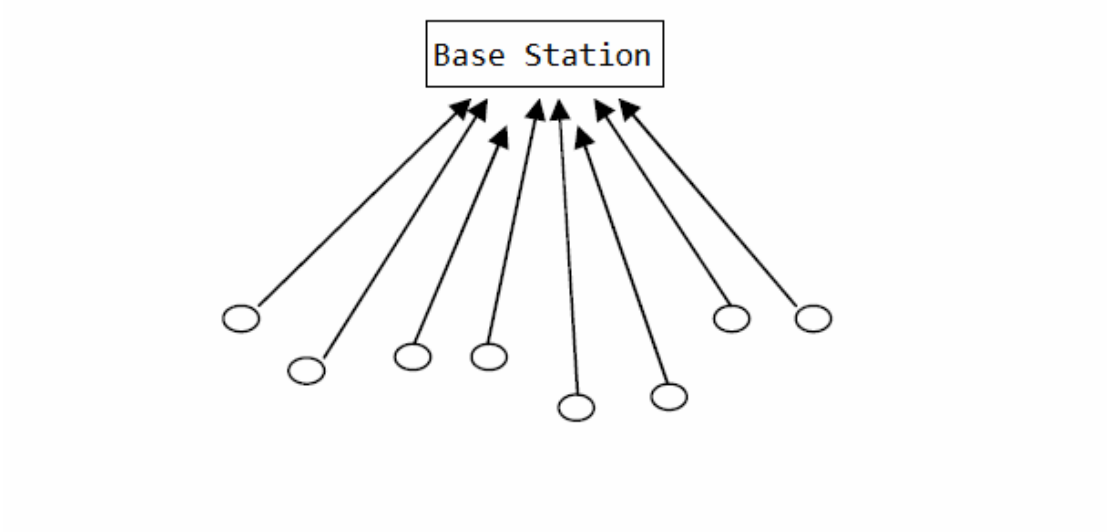

Figure 3.1: Architecture of Direct Transmission Protocol (Sharma & Shaw 2012)

3.4 LEACH Algorithm

(Heinzelman, W. R., et al .2000) Suggested a new adaptive clustering algorithm using distributed algorithm for the nodes that organize themselves into clusters shown in figure (3.2). The main concept of LEACH is to create clusters of sensor nodes based on the strength of the received signals and use the cluster heads as routers to the base station. Since data communication to the base station is the primary source of the energy consumption, the roles of the cluster heads rotate among the sensor nodes. This idea treat the problem of the present of the cluster head during the network lifetime (Rohbanian, M. R., et al. 2013). The operation of LEACH is divided into rounds in which each round contain two phases

1- Setup phase.

2- Steady state phase.

In the setup phase, the clusters are arranged and cluster-heads are chosen. In the first round, each node selects a random number between 0 and 1 and compares it to the threshold T(n) given in (3.1) and if the number is less than a threshold, the node becomes a cluster head.

$$T(n) = \frac{P}{1 - P * (r \bmod \frac{1}{P})} \; if n \in G, \;\; 0 \;\; otherwise \qquad (3.1)$$

Where *p* is the desired percentage of cluster heads, *r* is the current round, and *G* is the set of nodes that have not been cluster heads in the last *1/p*

rounds. In each round, selected cluster-heads broadcast an advertisement message to all the nodes in the network, informing their new status. After receiving this message, each of the non-cluster-head nodes can determine to which cluster they belong to based on the strength of the received signal. Then, according to the number of nodes in a given cluster, that cluster's cluster-head generates a TDMA (Time Division Multiple Access) schedule, and broadcasts a transmission time window to its CHs.

TDMA is a scheme where all concerned earth stations use the same carrier frequency and bandwidth with time sharing, non-overlapping intervals (Icev, S. D. 2011).

In the steady state phase (Zhang, & Zheng, 2014) (Mehndiratta, & Manju,2013). Nodes in each cluster can begin sensing the information and transmitting sensed information to their own cluster-head throughout the distributed transmission time. The cluster-head node conducts the data fusion, aggregating, compressing and then sending the aggregated data to the base station. Since the BS is usually far from the field, communicating to the base station will consume a lot of the cluster-heads energy (Thakkar, & Kotecha ,2012). When the designated transmission time is over, the steady state phase finishes and the network retreats into the setup stage and begins an alternate round, starting with choice of new cluster-heads.

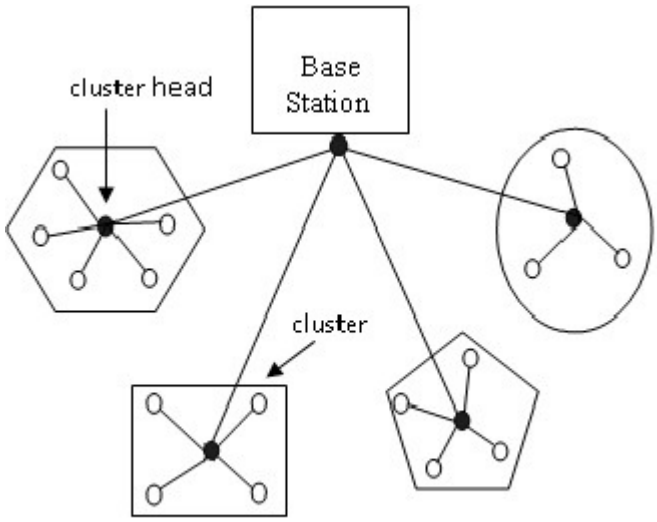

Figure 3.2: LEACH Protocol (Bakaraniya & Mehta 2013)

3.5 LEACH-SRDC

(Abdullah, M. Y., et al .2009) Proposed the tasks Scheduling and distribution energy management mechanism of Roles Dormant Cells (SRDC) to curb excessive consumption of energy consumed in the performance of duplicates task and unhelpful. Experimental results verify that the proposed of existing protocol LEACH with SRDC approach establishes a low energy communication structure and led to increase in wireless sensor networks lifetimes.

The problems of wastage energy in wireless sensor networks resulting from duplication tasks and functions for nodes in the same area coverage and re-send duplicate messages. Energy wasted when exploit certain part of the network where die half of the nodes, which in turn leads to the suspension of the entire network. To reduce the high-energy

consumption they proposed the scheduling system functions to facilitate the process of sending reports from terminal nodes to the interested users or re-broadcasting them to a higher level of the network. However, little effort has been made for the optimal cluster head distribution, which is an important factor for communication energy efficiency. Thus, a distributed cluster heads selection approach should be exploited to form reasonable clusters so that the cluster heads can perform more energy-efficient forwarding tasks. Through this feature this proposal is a practical and important addition to the LEACH protocol.

The distribution of roles dormant cells will enable them to distribute roles where oblige nodes that serve the same purpose as other neighboring nodes to shift to dormant cells for a period of time dependent on the time and energy consumed by the active node. The distribution of functions and tasks during the first phase of the deployment of the network, which can be defined as the objective of this network, expanded network will be dividing into subgroups that is called cluster.

3.6 EEE-LEACH Protocol

(Sharma & Sharma 2012) Suggested Energy Efficient Extended LEACH (EEE LEACH). Consider a new technique that is using multilevel clustering to increase energy efficiency by decreasing its radio communication distance. This multilevel clustering approach since its

having a single layer of clusters formation between the nodes and base station like LEACH, it contain two layers of clusters formation (Sharma & Shaw 2012). In the first layer CHs are formed where the normal nodes transmit their own data to their respective CH and by using the fuse mechanism the CHs aggregate the received data. Again in the second layer Master Cluster Heads (MCH) are formed. After the formation of MCHs, the CHs search the nearest MCHs by calculating the distance between them and transmit their aggregate data to the respective MCHs. In the similar way, the MCHs received data from their nearest CHs, aggregate all received data, transformed them into a compress format and forward them to the base station. The number of CHs and MCHs are initially decided by using a predetermined fractional value i.e. p (election probability value) for CHs and pm (election probability value) for MCHs. In EEE LEACH, the numbers of MCHs are kept less than the number of CHs to minimize the overall communication distance between the nodes and base station. EEE LEACH protocol performs better network life-time and is more energy-efficient than LEACH protocol.

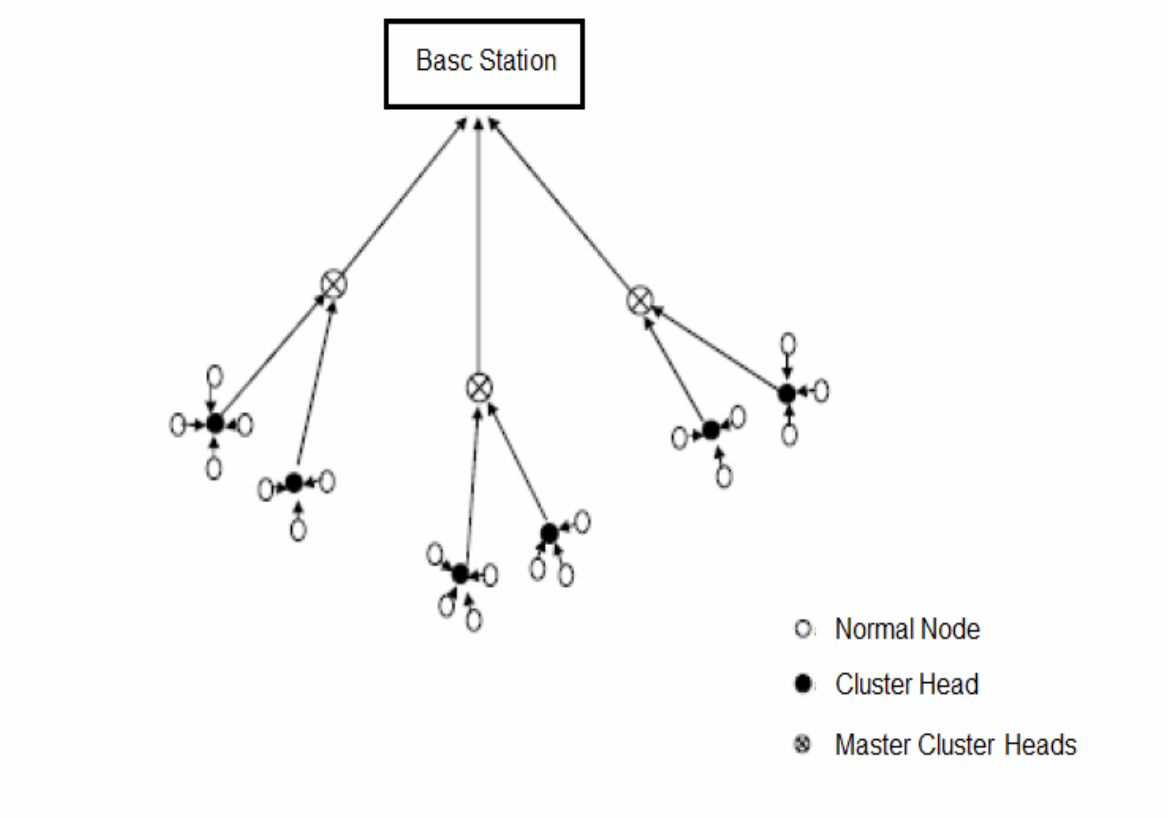

Figure 3.3: Architecture of EEE LEACH Protocol (Sharma & Shaw 2012)

3.7 Proposed Model Switching Cluster Heads in LEACH (SWIT-CH-LEACH)

Wireless sensor nodes have the functions of data acquisition, processing and reporting. The related sensing, computation and communication operations will lead to energy depletion. Out of all the energy consumption sources in WSNs, wireless communication is the largest portion (Chhetri, A. S.,et al. 2005).

3.7.1 SWIT-CH-LEACH Expanded

This section is introducing a new algorithm called (SWIT-CH-LEACH) to achieve the equitable distribution energy consumption of wireless sensor networks. It have many of steps as shown in the figure 3.4

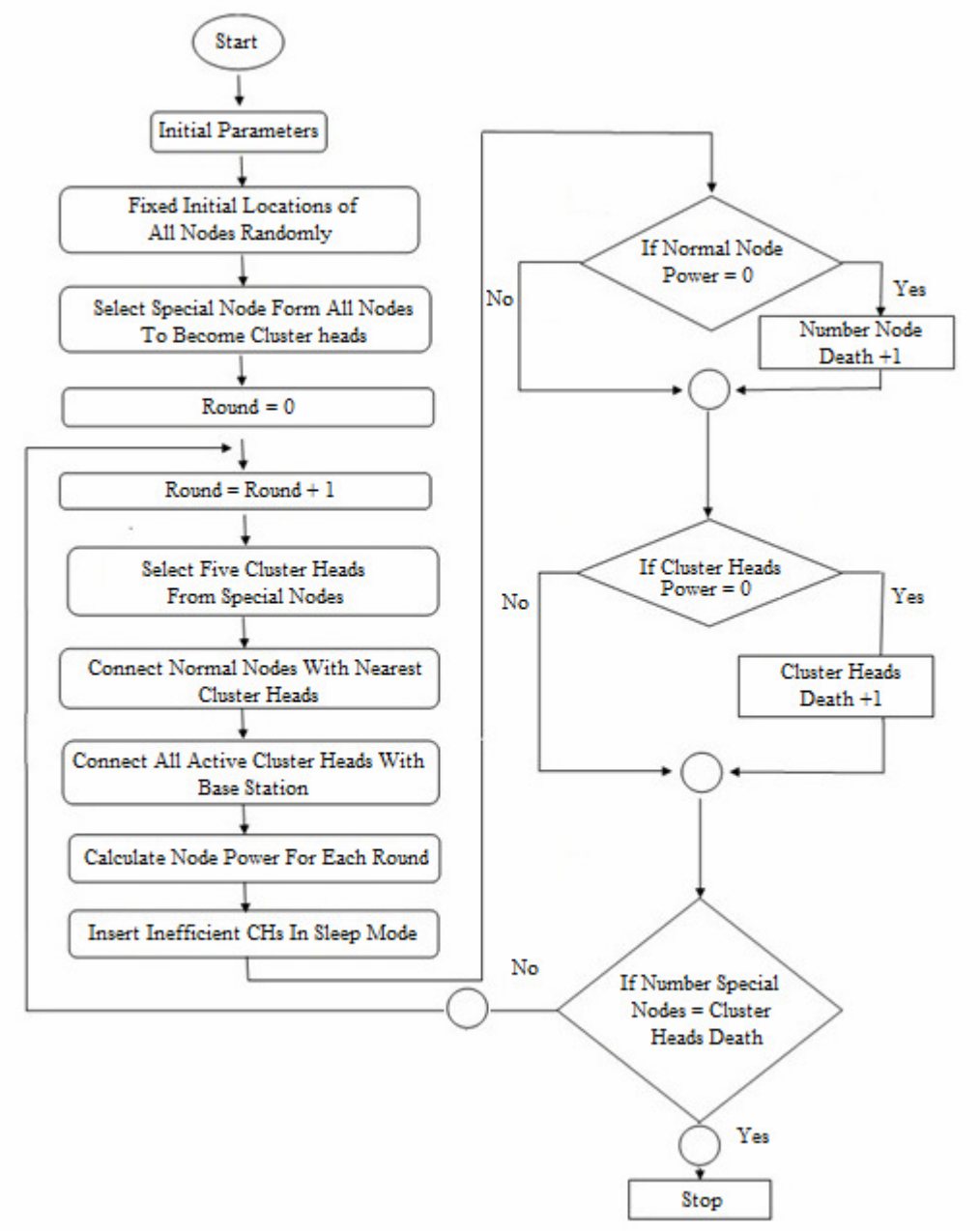

Figure 3.4: Structure of SWIT-CH-LEACH

The SWIT-CH Algorithm is starting be called the initial parameters, power of normal node 2J, Special Node 3J, environment size 500m x 500m, number of node 100, number of cluster head 20, active cluster head 5, sleep cluster head 15, Special Node Ratio 20%, the first job fix the location node randomly, then select the most powerful node as a working cluster head after that will select the active cluster heads and put the rest special node in sleep mode. For each round will be calculate the node power, by find firstly power used in its round then update the all node of power, all the previous operations will repeat until the most of the cluster heads are diad.

3.7.2 Dijkstra's algorithm

Conceived by computer scientist Edsger Dijkstra in 1956 and published in 1959, is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing and as a subroutine in other graph algorithms. For a given source vertex (node) in the graph, the algorithm finds the path with lowest cost (i.e. the shortest path) between that vertex and every other vertex. Because in LEACH Protocol is depended on Single-hop. Applying Dijkstra-type algorithm on Leach protocol, can determine a shortest distance between the two nodes then all compare the each result

(distance). So Euclidean plane, if $p = (p_1, p_2)$ and $q = (q_1, q_2)$ then the distance is given by

$$\mathbf{d(p,q)} = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2}.$$

Where *d* (in meters) is the transmission distance (Skiena, S. 1990).

3.7.3 Cluster Structure of WSNs

Explain how the composition of 100 nodes as shown in figure (3.5). In figure (3.6) represents beginning of the formation five cluster heads, figure (3.7) which consists of several cluster head (20 cluster heads, 5 active, 15 sleep) contiguous communicate with each other, and the method of selecting the cluster heads, which has the largest power energy of cluster heads.

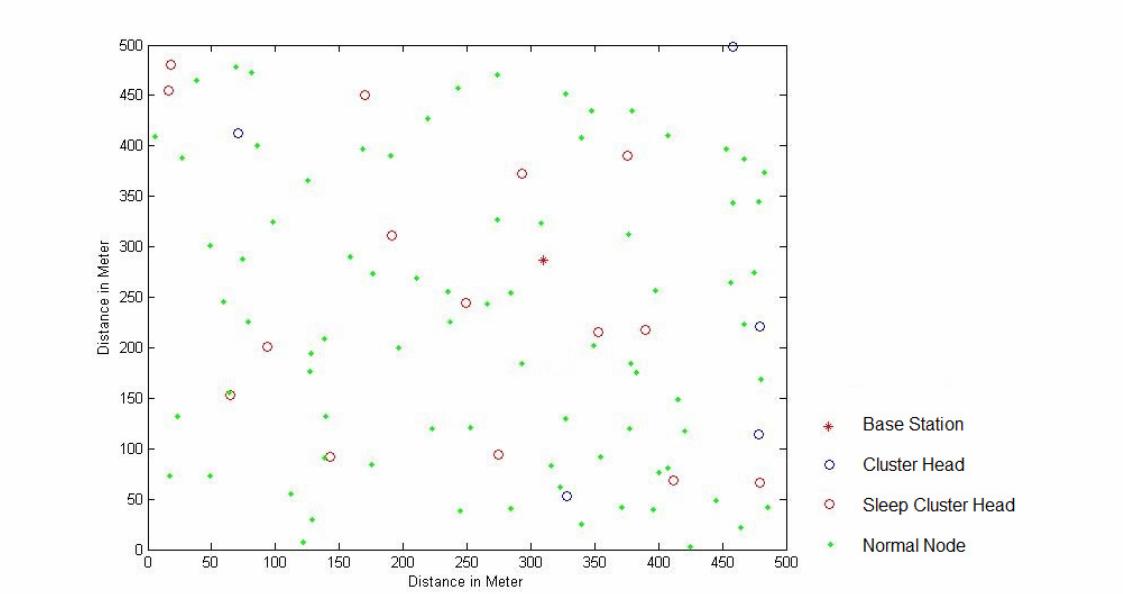

Figure 3.5: The Composition of 100 Nodes

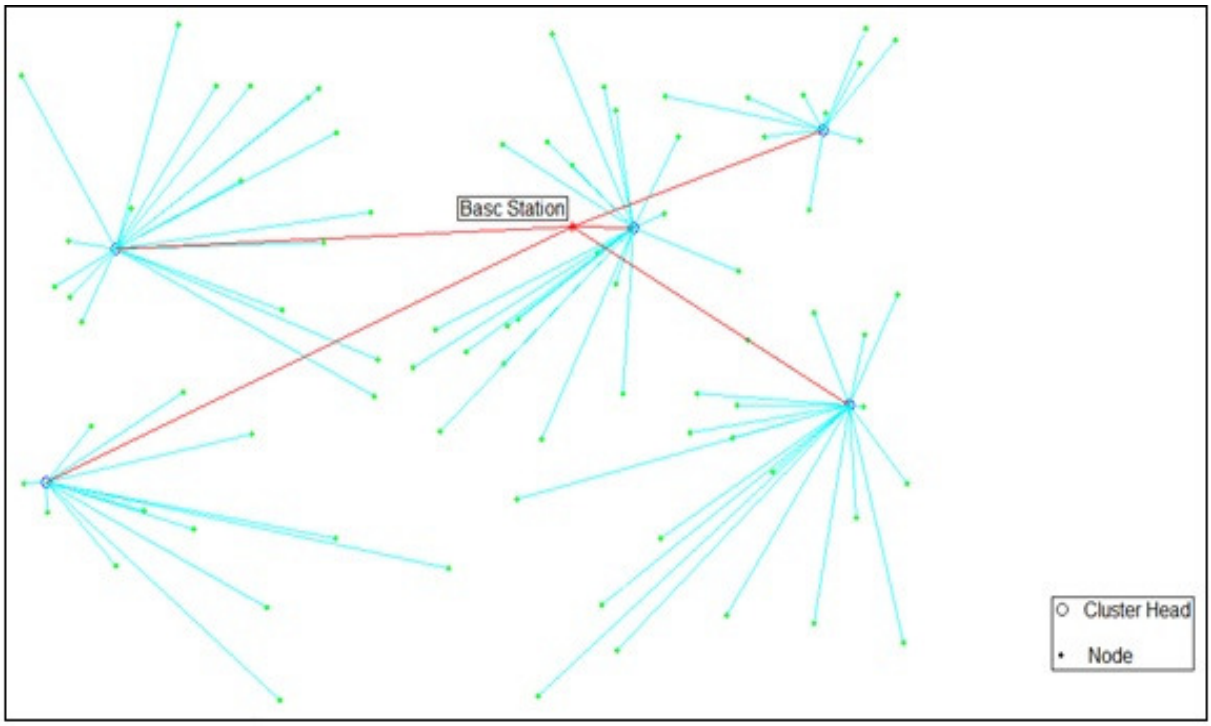

Figure 3.6: Select Five Cluster Heads

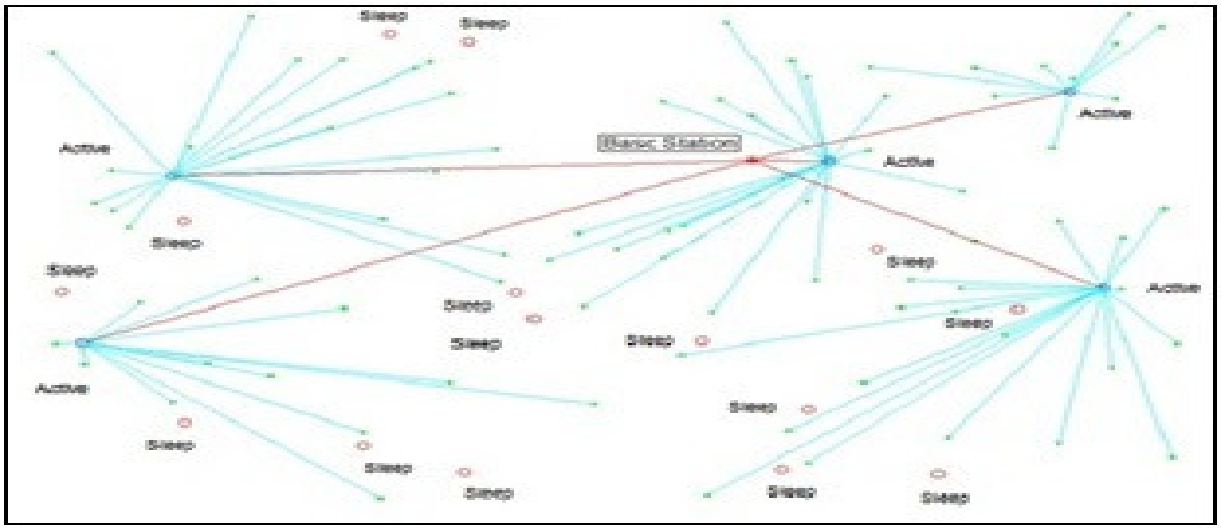

Figure 3.7: Sleep and Active Cluster Heads

3.7.4 Switching Cluster Heads Queue Algorithm

Figure (3.7) explain the process of exchange of roles within the cluster heads and applied the SWIT-CH-Queue algorithm.

The SWIT-CH-Queue is define which CHs are going to the sleep mode and those are continue active mode.

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Number of CHs
99	94	92	88	85	84	83	77	72	66	65	48	47	46	45	33	29	28	7	6	Number of CHs Chosen

Sleeping CHs Queue	Active CHs Queue
	Round1
99 94 92 88 85 84 83 77 72 66 65 48 47 46 45	33 29 28 7 6
	Round2
99 94 92 88 85 84 83 77 72 66 33 29 28 7 6	65 48 47 46 45
	Round3
99 94 92 88 85 65 48 47 46 45 33 29 28 7 6	84 83 77 72 66
	Round4
84 83 77 72 66 65 48 47 46 45 33 29 28 7 6	99 94 92 88 85
	Round5
94 92 85 84 83 77 72 65 48 45 33 29 28 7 6	66 46 99 47 88
	Round6
94 92 85 83 77 72 66 48 46 45 33 29 28 7 6	99 65 84 47 88
	Round7
99 94 92 84 83 77 66 65 47 46 33 29 28 7 6	45 48 85 88 72
	Round8
99 94 88 85 84 72 66 65 48 46 45 33 29 28 6	83 92 77 7 47
	Round9
94 92 85 84 83 77 72 65 48 47 45 33 29 7 6	99 66 88 28 46
	Round10
99 92 88 85 83 77 72 66 65 48 46 45 28 7 6	29 84 94 47 33
	Round11

94	92	85	84	83	77	72	66	48	46	45	33	29	28	7	99	47	6	88	65
															Round12				
99	94	92	84	83	77	65	48	47	45	33	29	28	7	6	85	66	88	46	72
															Round13				
90	92	88	85	84	83	77	72	66	65	46	33	29	28	6	99	7	47	45	48
															Round14				
99	94	85	83	72	66	48	47	46	45	33	29	28	7	6	65	92	88	77	84
															Round15				
99	94	92	85	84	77	72	66	65	48	45	33	29	7	6	88	28	46	83	47
															Round16				
92	88	85	84	83	77	72	65	48	46	45	29	28	7	6	94	47	33	99	66
															Round17				
99	94	92	83	77	66	65	47	46	45	33	29	28	7	6	84	48	85	88	72
															Round18				
94	92	88	85	84	83	77	72	66	48	46	33	28	7	6	99	65	47	45	29
															Round19				
99	94	92	85	84	83	77	72	65	48	47	45	33	29	28	6	7	66	88	46
						----------											----------		
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																	Last Round 261		

99	92	85	84	83	72	66	65	46	45	33	29	28	7	6	47	48	88	77	94

Table 3.1 Queuing Cluster Heads

Table (3.1) shows a Switching Cluster Head Queue process after 1 rounds. We measure the amount of energy remaining for each cluster head. The active cluster heads are then selecting a highest five cluster head while the remaining fifteen cluster head will go to the sleep mode.

At the round 2 the active cluster heads 45, 46, 47, 48, 65 and the rest nodes number are 6, 7, 28, 29, 33, 66, 72, 77, 83, 84, 85, 88, 92, 94, 99 will go to sleep mode. This process continue until the energy of the most cluster heads are declined.

Finally, at last round most of CHs are died, and this will make the network completely stopped work.

3.7.5 Distribution Tasks For Cluster Head

Based on the above and in order to understand how implementation of the distribution of tasks between the various cluster head in the (SWIT-CH-Queue). This process clearly showed in figure (3.7) and table (3.1), where shows the first step of cluster performed and cluster head selected according to a highest five cluster heads. Where the energy is the same for all the cluster head in the beginning as we assumed. Showed that round one will be normal and there is no change for queue order just only five cluster head of the first round and will be the tail fifteen cluster head of the queue with sleep, the round 1,2,3,4..... showed that will be the cluster head because it has the highest energy in this round, the summary could explain as following :

1- Requirement that the cluster heads that has the highest energy to be highest order within the (SWIT-CH-Queue).

2- Restructuring queue and cluster heads based on energy.

3- Distributive justice, in the restructuring case of the cluster heads because of the specified period end in current session and the current session in which the network is inactive, could choose the same cluster head. This leads to fairness in the distribution of functions of all cluster heads according to the energy remaining in each cluster heads.

4- The queue size depends on the cluster heads active and sleeping.

5-This process continues until most of the cluster heads in the queue reach the minimum energy which cannot used for transmit or receive any more signal, then the network going down.

3.8 Energy Model for Wireless Sensor Node

(Hoang & Motani 2007) Show that we can calculate the energy consumed by sensors as following:

First of all, we assume that the sensing operation of each sensor consumes a fixed amount of energy during each data gathering round. In order to achieve energy efficiency for sensors, we only focus on controlling their communication related activities. For the communication related energy consumption, we adopt the first order energy model used in particular

1- The energy consumed to receive r bits is

$$E_{rx}(r) = E_e \times r \qquad \text{(Heinzelman et al.2000)} \qquad (3.1)$$

Where E_e (in Joules/bit) is the energy consumed in the electronic circuits of the transceiver when receiving or transmitting one bit of information. Typical value for E_e is from 10 nJ/bit to 100 nJ/bit.

2- The energy consumed to transmit r bits over a distance of d meters is

$$E_{tx}(r, d) = E_e \times r + E_a \times d_\alpha \times r \quad \text{(Heinzelman et al.2000)} \qquad (4.2)$$

where d (in meters) is the transmission distance, and α is the channel loss exponent which is typically in the range $2 \leq \alpha \leq 4$ is. For short communication distances, a free-space path loss model can be assumed and α =2. As the transmission distance increases, a multipath model is more appropriate and in such cases α =3 or 4. E_a (in Joules/bit/ m^{-}) is the energy consumed in the power amplifier to transmit one bit of information aver a distance of one meter. E_a depends on the receiver sensitivity and its range is from 10pJ/bit/m^{-} to 100pJ/bit/m^{-} for the free-space path loss model.

Chapter Four

Result and Discussion of "SWIT-CH-LEACH"

4.1 Overview

This chapter explains, in detail, how to use the proposed algorithm. This will be done through implementation SWIT-CH-LEACH to increases lifetime for wireless sensor networks, and we also compare SWIT-CH-LEAC with another protocols DTx , LEACH, EEE-LEACH and SRDC-LEACH.

4.2 Methodology

We use MATLAB for the implementation of algorithm, MATLAB version 12 is a powerful language for technical computing, the name

MATLAB stands for MATrix LABoratory, because its basic data elements is a matrix (Array), MATLAB can be used for math computations, modeling and simulations, data analysis and processing, visualization and graphics, and algorithm development.

4.3 Implementations Details

The SWIT-CH-LEACH has been simulated accurately in MATLAB. These have been made assuming a network having dimensions 500m x 500m, the nodes are generated and placed randomly, the parameters that are used to calculate the energy of nodes are given below:

1. Distance between the normal nodes and CHs.

2. Distance between the CHs and BS.

Value	Parameters
SWIT-CH-LEACH	New Algorithm Routing Protocols
500 x 500 Meters	Environment Size
20%	Special Node Ratio (Percentage from all node)
100	Number of Nodes
5 Active , 15 Sleep	Number of Cluster Heads
3J	Special Node Power
2J	Normal Node Power
1 to 1000 rounds	Number of Rounds

Table 4.1 Parameters Experiment

Let the nodes at which we are starting be called the initial node. Let the distance of nodes X be the distance from the initial nodes to Y. as show in figure (4.1).

Now the normal nodes, CHs sleep, CH active and base station are recognized to detect and follow the operation simulation we are using the different color and special character in the programming.

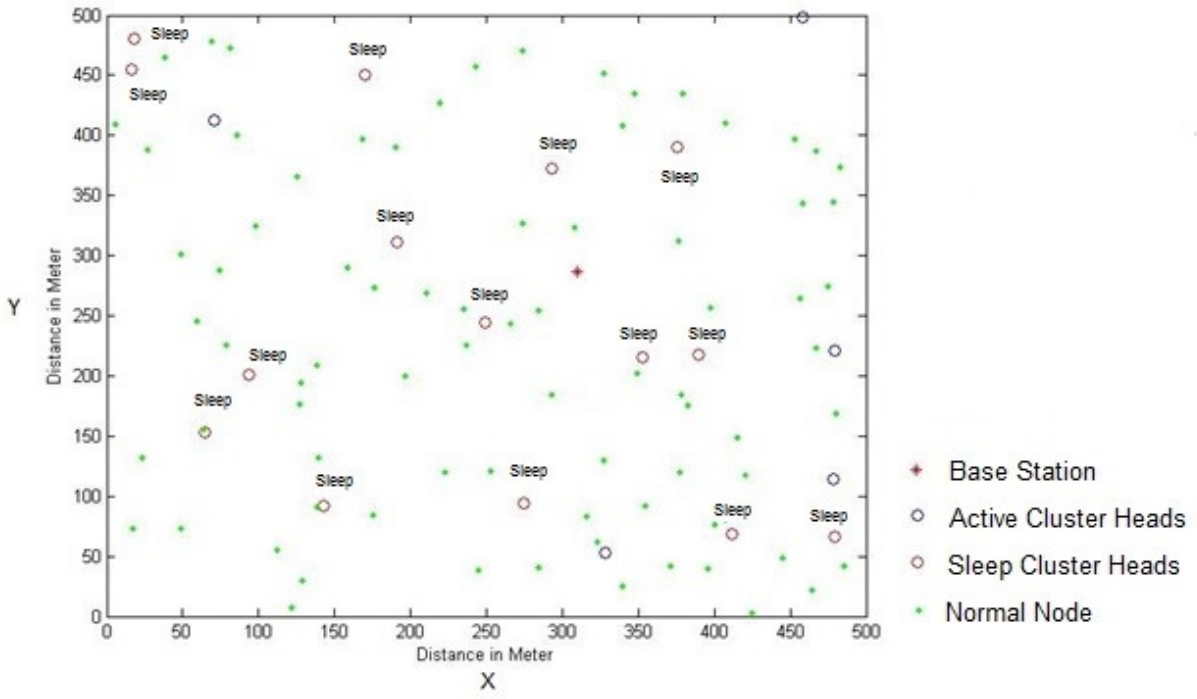

Figure 4.1 Initial Node

In experiment, our field dimension is 500m x 500m and we randomly distributed 100 sensor nodes in the search space. We chose 20%

of the nodes as CH and located the BS randomly in field. For this experiment we allocated each normal sensor node and special sensor with an initial energy. We implemented our algorithm based on the above network features and parameters using MATLAB.

Figure 4.2 shows the connecting of normal nodes with the nearest active cluster heads. Also many of special node are slept. Rounds before Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step. Show in figure (4.2) almost of node select the neighbor cluster heads on another hand the sleeping special node help them to save the energy.

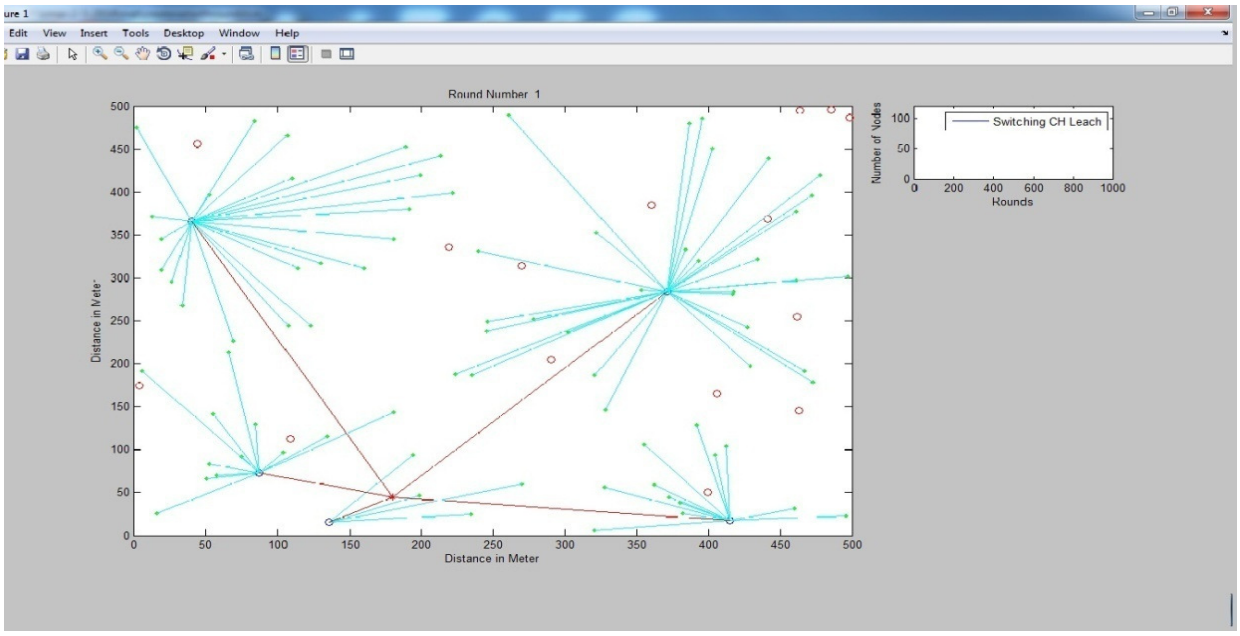

Figure 4.2 Initial Distance Values

After many of rounds, the cluster head are changed, some of a normal nodes have dead, as shown in figure (4.3) as a black points. But the all cluster heads still active or in sleep mode.

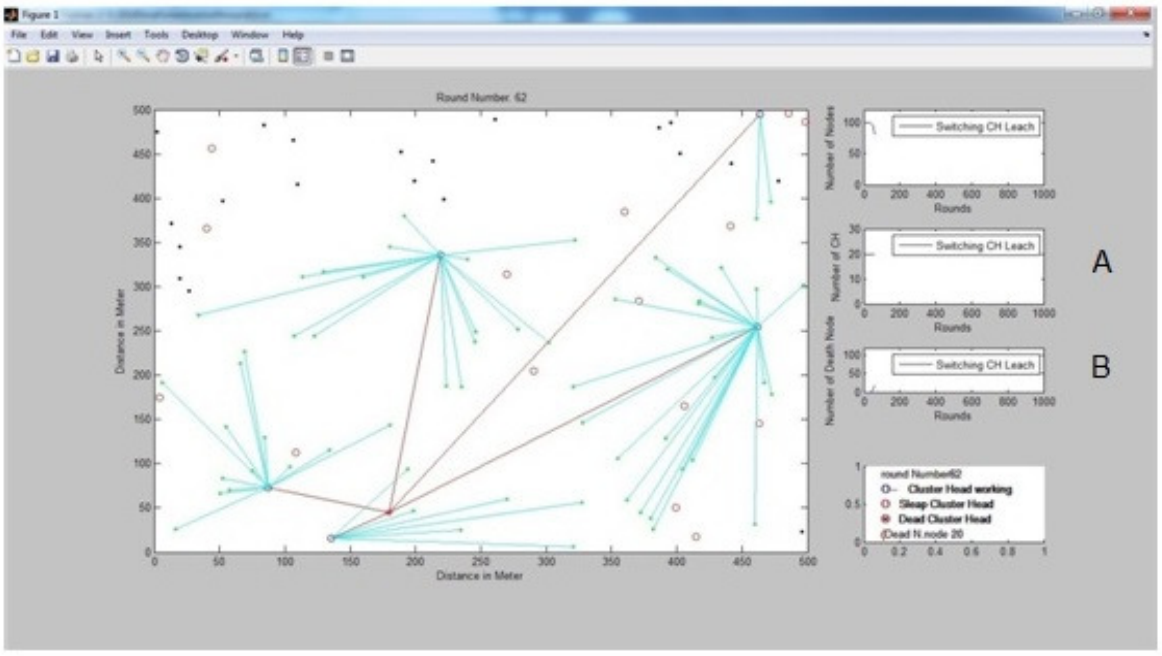

Figure 4.3 Dead of Normal Node

The sub figure (4.3.B) represent to the died of nodes. While the sub figure of (4.3.A) could see the all cluster heads not died.

4.4 Experiment results

For many scenarios have been implemented to obtain accurate results and effective through which we can evaluate the proposed algorithm accurately. It is through many of the tests show that there are

significant developments in the performance of the wireless senor network.

Figure (4.4) shows that the wireless sensor network with SWIT-CH-LEACH reached to 201 rounds. The part (4.4.A) explained the motivation of new algorithm are applied, while other parts (4.4.B) and (4.4.D) showed the number of death nodes are increasing, but the cluster head still in life for this round, as part (4.4.C) the energy of cluster heads kept for long time. Because the new technique supposed the special nodes have the special properties, contrary to what is happening with SWIT-CH-LEACH where we note that 20% of the total capacity of the network was exploited.

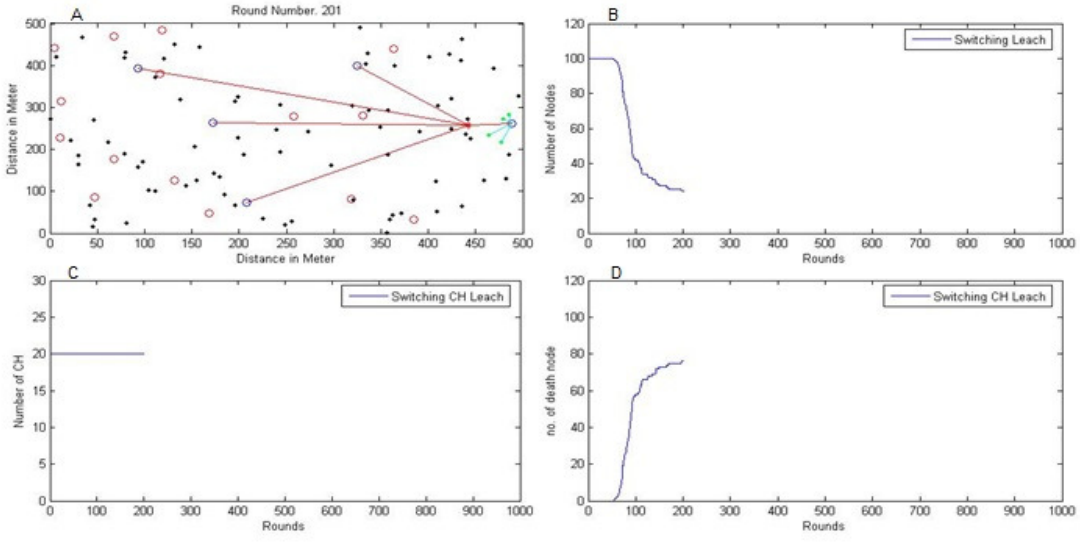

Figure 4.4 Result of Implementation

Figure (4.5) showed the sensors lifetime and the network performance for each round, the network still working until round 257

with SWIT-CH-LEACH whereas died in very earlier round when we are using for example the former LEACH.

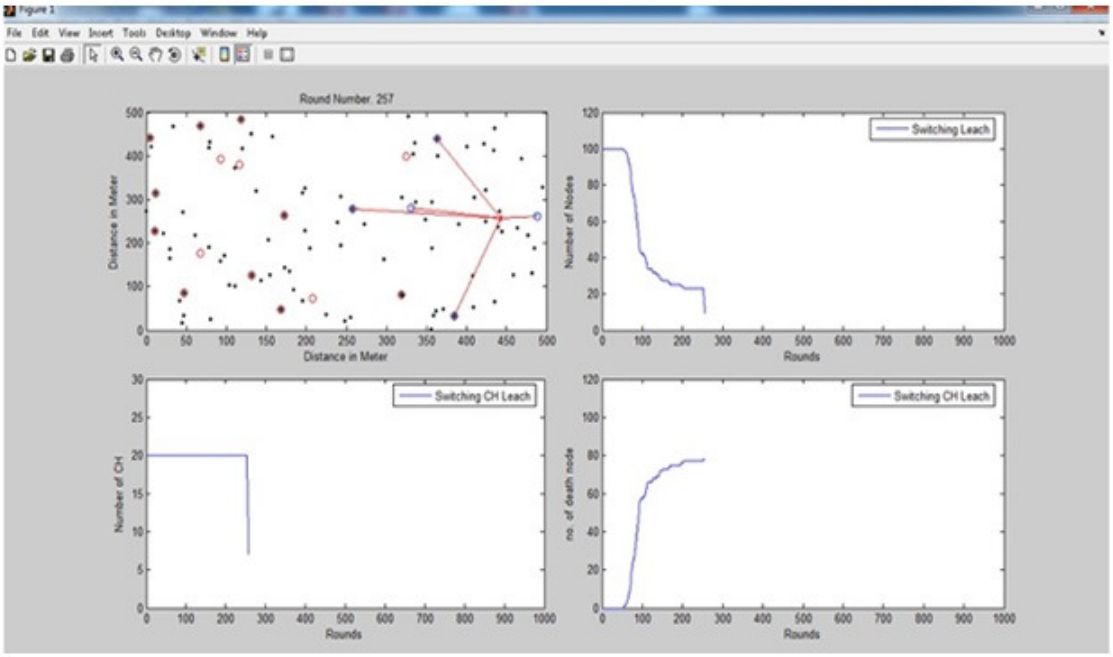

Figure 4.5 Lifetime For Each Round

4.5 Simulation Results and Discussions

Network models are established based on the LEACH. We calculate each cluster heads energy consumption from data transmission and aggregation per- round.

SWIT-CH-LEACH compared with DTx, LEACH, SRDC-LEACH and EEE-LEACH. In our implementation of SWIT-CH-LEACH, routing is used during cluster heads delivering the data to the base station.

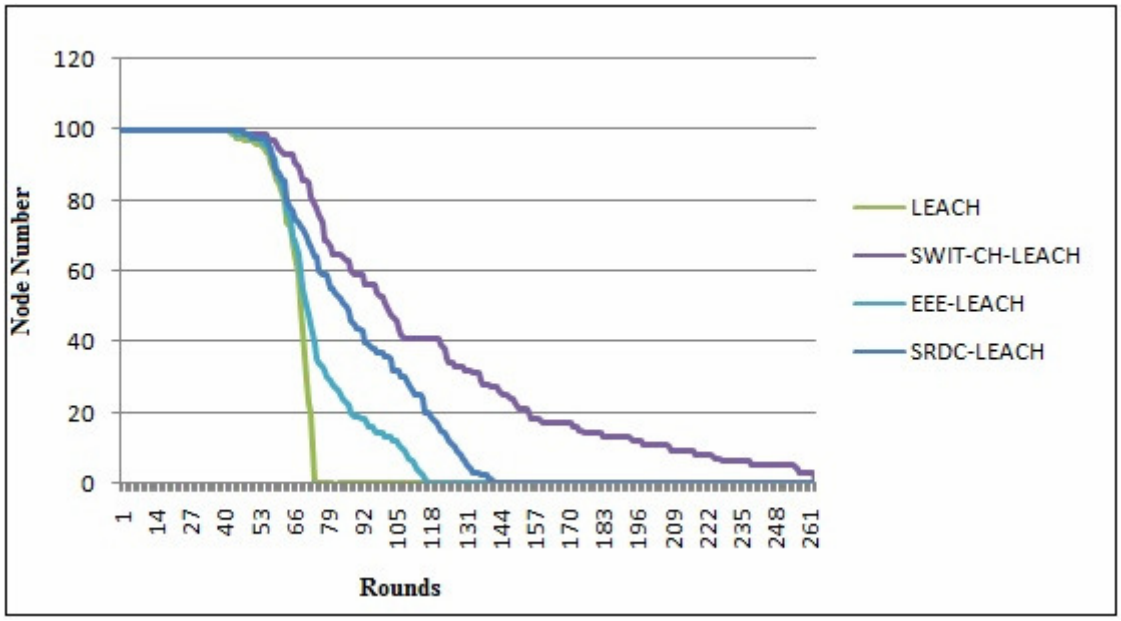

Figure 4.6 Comparison For Different Developing Leach Protocol

We use the data given in paper DTx, traditional LEACH protocol, EEE-LEACH and SRDS-LEACH, we compare this data with our proposed algorithm.

We found that the lifetime of the wireless sensor networks is more than 200 rounds while the lifetime of other algorithms is less than 200 rounds. This confirm that our algorithm gave an improvement in the lifetime, is following figure shown (4.6)

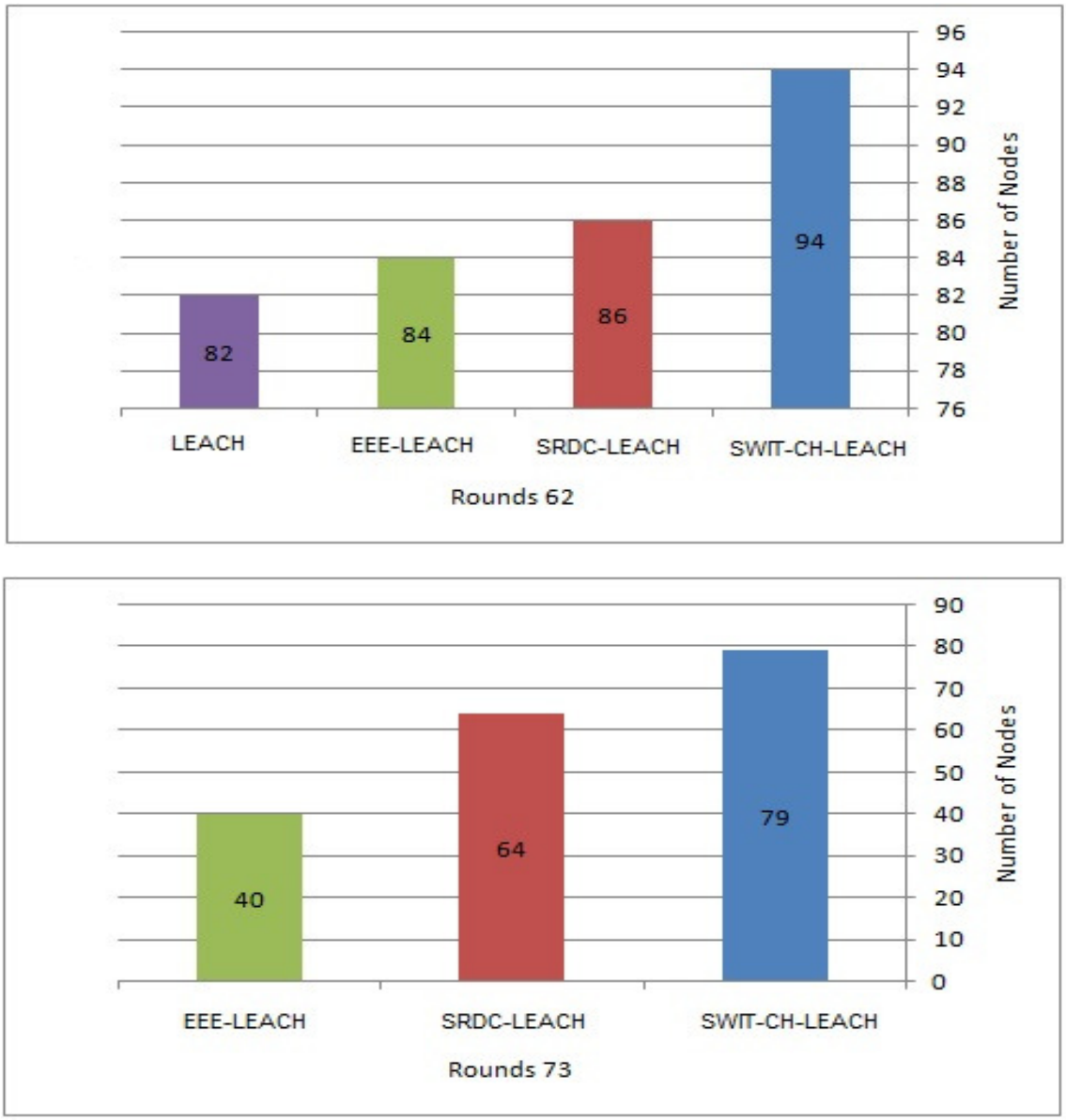

Figure 4.7 : Life Node at Round 62,73

At the round 73 the number of active node in the new proposed algorithm is higher than EEE-LEACH by 40 and 64 active node in SRDC-LEACH. Clear the SWIT-CH-LEACH continue for many rounds more than other algorithm because in this algorithm have a kept policy of the CH life better than in other as shown in figure (4.7).

Table 4.2 shows the comparison of SWIT-CH-LEACH with SRDC-LEACH, EEE LEACH, LEACH and DTx protocols in different terms specially cluster heads, sleep CH only, network lifetime energy and efficient CH.

SWIT-CH-LEACH	SRDC-LEACH	EEE-LEACH	LEACH	DTx	Protocol
Yes	Yes	Yes	Yes	No	**CH**
No	No	Yes	No	No	**Master CH**
Yes	No	No	No	No	**Special CH**
Yes	Yes	No	No	No	**Sleep Node**
Yes	**No**	**No**	**No**	**No**	**Sleep CH Only**
Fixed BS	Fixed BS	Fixed BS	Fixed BS	Fixed BS	**Mobility**
TDMA	TDMA	TDMA	TDMA	TDMA	**Scheduling**
Excellent	Very Good	Very Good	Good	Average	**Lifetime**
Very Good	Good	Good	Least	No	**Energy Efficient CH**
Single-hop	Single-hop	Multi-hop	Single-hop	Single-hop	**Communication**

Table 4.2 Comparison for Different Properties LEACH Protocols

Chapter Five

Conclusions & Future works

5.1 Conclusions

1-Wireless sensor networks pose interesting challenges for networking research. Foremost among these is the development of long lived sensor networks in spite of the energy constraints of individual nodes.

2- Introduces a brief background of sensor nodes covering structured and limitation.

3- In this thesis we proposed a new algorithm SWIT-CH-LEACH to increase the lifetime of the wireless sensor networks. This algorithm improves the results of the traditional LEACH protocol. We selected 20% of the total deployment nodes to be cluster heads. In each round the highest energy of five cluster heads has been chosen and the rest of cluster heads will be in sleep mode.

4-The SWIT-CH-LEACL algorithm will continue to process until the cluster heads will lose all energy. We discussed the problem of energy consumption for duplicated information among the cluster heads in the same area.

5-In this thesis the simulation results indicate that our proposed algorithm can increase the lifetime of wireless sensor networks better than traditional LEACH protocol.

6-Presented the basic theoretical background and a review of related research in the area of wireless sensor network energy-efficient.

5.2 Summary

1-In this thesis we studied wireless sensor networks protocols using LEACH protocol.

2-We presented a proposed SWIT-CH-LEACH Algorithm to reduce the energy consumption for wireless sensor network.

3-The proposed algorithm using on LEACH Protocol.

4-The proposed algorithm result confirm an important increase in the wireless sensor networks lifetime compared to the wireless sensor networks lifetime of the traditional LEACH Protocol.

5.3 Future Works

The topic of increasing lifetime in WSNs is still open to research. Better solutions which take care of mobility constraints like computing power, battery and storage. As a continuation of this research, future work could involve the study of LEACH and its secure version.

Finally, this research put forward an idea reflect the flow of data used wireless sensor networks and their use in the daily life of the robot, including the ability to give it to take appropriate decisions and provide him an opportunity to think and deal with the events the same way as the common man.

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