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Advancement in Single Node Data Transfer Energy Protocol Using Gateways in Wireless Sensor Network

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Abstract—we know in wireless sensor network energy consumption is major issue to enhance the life time of WSNs. In wireless sensor network there are different types of nodes which have different and same energy levels of nodes. The heterogeneous and homogeneous shows the energy level of nodes. As we know in homogenous there are same energy levels of nodes and heterogeneous have different 2 energy level of nodes. In this paper we proposed a new data forwarding approach to be improved the lifetime of wireless sensor network using gateways. Gateways reduce the distance between the cluster head and base station in WSNs. So we know if distance decrease between the cluster head and base station it means node life time increases and WSNs lifetime also increase. This will consume less energy in long distance communication. Simulation results show the protocol offer a batter performance.

Keywords- Energy efficient protocol, gateways, multi hoping, leach, routing, and wireless sensor network

I. INTRODUCTION

Wireless sensor networks (WSN's) [1] have gained worldwide attention in recent years, especially in Micro-Electro-Mechanical Systems (MEMS) technology which has facilitated the development of smart sensors. These sensors are small in size, with limited processing and computing resources, and they are inexpensive compared to traditional sensors that are used in networks. Wireless sensor networks combines sensing, computation, and communication into a single tiny device. A WSN having a ten to thousand node that communicate through wireless channels for information sharing and cooperative processing. A sensor node in wireless sensor network is typically equipped with a transducer, a radio transceiver, small micro-controller and a power source deployed in phenomena intended to monitor at diverse locations. Sensor node is capable of sensing many type of information from the environment including temperature, light, humidity, pressure, wind direction and etc. they usually transmit the acquired data through RF channel to the base station or gateway.

These sensor nodes can sense, measure, and gather information from the environment and, based on some local decision process, they can transmit the sensed data and send it to source to destination. A WSN typically has little or no infrastructure. It consists of a number of sensor nodes it may be ten or thousands that working together to monitor a region to obtain data about the environment. These sensors have the ability to communicate either among each other or directly to an external base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. The sensor sends such collected data, usually via radio transmitter, to a command center (sink) either directly or through a data concentration center (a gateway).In the wireless network there is no. node by which we can communicate .the number of node make a cluster and within the cluster all nodes make cluster head. The cluster head communicate with base station through another cluster head. Those whose distance is less to the base station they can communicate direct to the base station of cluster which contain no. of nodes and these nodes make cluster head with in cluster. These cluster head communicate with the base station.

Routing protocol is one of the basic technologies in the WSNs. Due to its inherent characteristics the routing is full of challenge in WSN [1].Clustering is a well-known method and commonly used exploratory data analysis techniques and it is particularly useful for applications that require scalability to hundreds or thousands of nodes in the wireless sensor network[3]. Where large-scale networks are used, the node clustering has been proposed for efficient organization of the sensor network topology, and prolonging the network lifetime of WSNs. During the data transmission in wireless sensor network the energy consumption in sensor node is most critical part of the network. In a clustering organization the intra-cluster communication can be single hop or multi-hop, as well as inter-cluster communication. In this paper, we analyse energy efficient multi-hop clustering by a sensor node for WSN.LEACH Protocol is the first protocol of hierarchical routings which proposed data fusion; it is of milestone significance in clustering routing protocols. Many hierarchical routing protocols are improved ones based on LEACH protocol [3]. So, when wireless sensor networks gradually go into our lives, it is of great significance to research on LEACH protocol. we first describe the new energy based multi-hop with gateway node

scheme using a heterogeneity concept in LEACH, and then simulation results in MATLAB. To calculate the performance analysis of the proposed scheme is compared with LEACH.

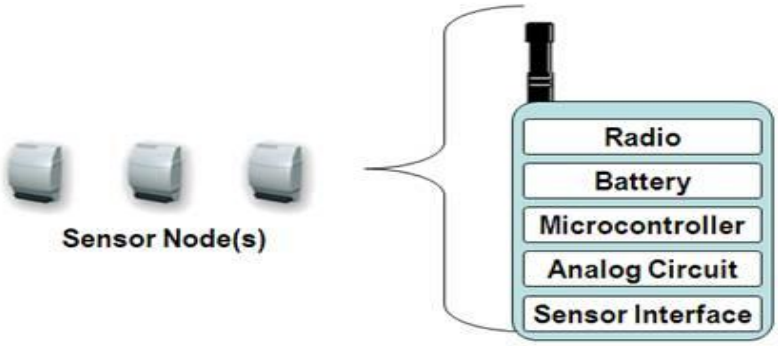


Fig.1: BASIC ARCHITECTURE OF WSN

II. BRIEF INTRODUCTION TO LEACH PROTOCOL

LEACH Protocol is a typical representative of hierarchical routing protocols. LEACH stands for Low Energy Adaptive Clustering Hierarchy was the first protocol of clustering, whose basic goal was to reduce the power consumption. Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which partitions the nodes into clusters, in each cluster a dedicated node with extra privileges called Cluster Head is responsible for creating and manipulating a TDMA schedule and sending aggregated data from nodes to the BS where these data is needed using CDMA .Remaining nodes are cluster members. LEACH (Low Energy Adaptive Clustering Hierarchy) is a hierarchical-based routing protocol which uses random rotation of the nodes required to be the cluster-heads to evenly distribute energy consumption in the network. It is self adaptive and self-organized. LEACH protocol uses round as unit and each round are made up of cluster set-up stage and steady-state stage. The purpose of reducing unnecessary energy costs, the steady state stage must be much greater than the set-up stage. The process of it is shown in Figure 2.

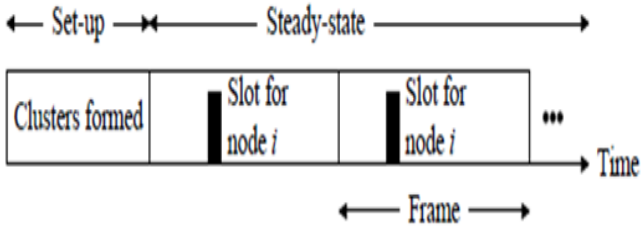


Fig 2: Leach protocol process

At the stage of cluster forming in network, a node randomly picks a number between 0 to 1 and compared this number to the threshold values t(n). if the number is less than t(n) then it become cluster head in this round, else it become common node. Threshold energy t(n) is determined by the following:

$$t(n) = \begin{cases} \dfrac{p}{1 - p * (r \bmod \frac{1}{p})} & if\ n \in G \\ 0 & if\ n \notin G \end{cases}$$

Where p is the percentage of the cluster head nodes in all nodes of network, r is the number of the round in network is the collections of the nodes that have not yet been head nodes in the first 1/P rounds of threshold. On the bases of threshold all nodes will be able to be head nodes after 1/P rounds. According to analysis each node becomes a cluster head with probability p when the round begins. The nodes which have been head nodes in this round will not be head nodes in the next 1/P rounds. Because the number of the nodes which is capable of head node in cluster will gradually reduce, so for these remain nodes of network, the probability of being head nodes of cluster must be increased. After 1/P-1 round perform all nodes which have not been head nodes will be selected as head nodes with probability 1. When 1/P rounds finished, then all nodes will return to the same starting line. When clusters have formed, the nodes start to transmit the inspection data to sink. Cluster heads receive data sent from the other nodes with in cluster, the received data was sent to the gateway after fused in sink. This is a frame data transmission in wireless sensor network. To reduce unnecessary energy cost, steady stage is composed of multiple frames and the steady stage is much longer than the set-up stage in WSNs.

A. A new improved algorithm based on LEACH Protocol (A-LEACH)

In LEACH protocol when the cluster forming randomly, than the energy of cluster head is very different, so do the distances between cluster heads and sink (base station). Cluster heads are responsible not only for sending data to the sink (base station) but also for collecting and fusing the data from common nodes in their own clusters within the network. During the process of data collection and transmission, the nodes consumed more energy in case of fusion as compares to the transmission. If the current energy of a nodes or cluster head is less and the distance to base station is much far, then the node or cluster head will be died quickly because of a heavy energy burden. Due to the lack of cluster energy network faces lot of problem. To address these kind issues, this article proposes a new improved algorithm (A-LEACH) to enhance the life time of wireless sensor network and how to balance the energy loads of these cluster heads.

B. The idea of improved algorithm

A-LEACH (LEACH Protocol with Two Levels Cluster Head and introducing gateways) is an improved one based on LEACH Protocol. The methods of cluster-head selection and clusters forming are same as LEACH protocol. If a cluster head's current energy is less than the average energy, that is

(1) E*cur*<*Eave* *where* *Eave* = $\sum E(i)$ *cur* is the total average energy of all nodes in the networks, or the distance between the cluster head and base station(sink) is greater than the average distance. That distance is d>d *ave*, where d*ave*= $\sum di$ *di* is the total average distance of all nodes' distance to base station(sink), then the common node with maximum energy node in this cluster will be selected as the secondary cluster head. If $E_{cur} \geq E_{ave}$ and $d \leq d_{ave}$, then it is unnecessary to select a secondary cluster head.

In a cluster which has cluster head, the cluster head is responsible for receiving and fusing data collected from the member nodes in the cluster and sending them to its cluster head, the cluster head is only responsible for transporting data to base station through gateways node. The Cluster head is responsible for collecting data from the member node and sending them to base station through gateway after the data was fused. It is clear from the first-order energy transfer model that the energy consumption of data receiving and data fusion are less than that for data transferring during communication, especially for long distance data transferring in WSNs. so the life of clusters with cluster heads will not be extended a lot so as to bring new energy imbalance of energy consumption of entire network for network. The network topology of the enhanced algorithm is shown in Figure 3

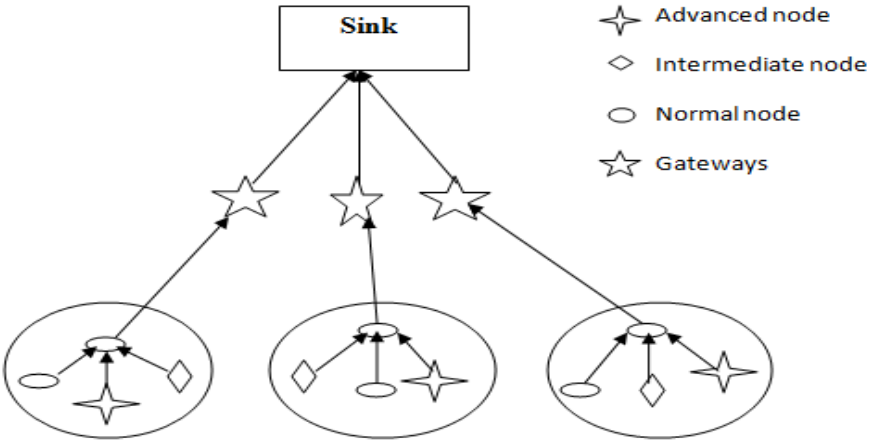


Fig 3: Network Topology

Wireless communication model: This is the wireless communication channel this shows the communication from source to destination.

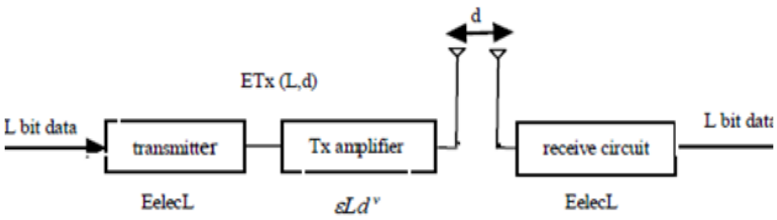


Fig 4: The wireless communication model

Total energy consumed in fig 4 during communication when it transmit and receive.

$$E_{Tx}(L,d) = \begin{cases} LE_{elec} + L\varepsilon_{fs}d^2, d \le d_0 \\ LE_{elec} + L\varepsilon_{mp}d^4, d > d_0 \end{cases}$$

$$E_{Rx}(L) = LE_{elec}$$

Where Eelecrepresents the energy consumed to transmit or receive 1 bit message: ε fs is the amplification coefficient of free-space signal and ε mp is the multi-path fading signal amplification coefficient, their value depend on the circuit amplifier model; d represents the distance between transmitter and receiver; L is the bit amount of sending information.

III. ENHANCED LEACH PROTOCOL

Clustering is an energy efficient method for wireless sensor networks. In clustering, the network is divided into many clusters; each cluster consists of cluster head and many other member nodes. LEACH protocol is one of the clustering protocols. The operation of LEACH is divided into rounds and each round consists of two phases:

- cluster setup
- Steady data transmission. In the cluster setup phase, clusters are formed and the cluster head is generated randomly. In steady data transmission phase, other member nodes send data to the cluster head; cluster head fuses the data and sends it to the sink.

To overcome the inefficiency of the LEACH in the neglect of residual energy of the nodes and the non distribution of the cluster heads, in Enhanced LEACH, both the residual energy and the location is considered for choosing the cluster head. The routing technique followed is multi hop routing. The network is uniformly plotted to clusters. Each cluster consists of cluster head and many member nodes. N nodes are randomly distributed in S×S region space. The sink is located far from the monitoring area.

In this scheme, operations are performed in respective stages: area partition, cluster head generation and data transmission.

A. Area partition

In our scheme, firstly, the network is partitioned by the sink by applying the optimum clustering angle: k-angle that forms different clusters. Then, further k-angle is split into h-opt by the following strategy:

0≤ h-opt ≤ k-angle -1

Here h-opt varies from

0: .1: k-angle -1

This partitioning makes the sensor nodes centralized in the cluster and uniformly randomly deployed, which avoids the non-uniformity distribution of the cluster heads. Network partition helps in reducing energy consumption and prolongs the network lifetime.

B. Cluster head generation

In the network based on clustering, cluster head is responsible for coordinating the operations among other sensor nodes in the cluster, collecting and fusing the data and then sending it to the sink. Thus, the load on cluster head is more and it consumes more energy. So during the generation of cluster head, both the position and the residual energy of the node are considered to balance the energy.

In the first round, node whose position is close to the sink is chosen as the cluster head. In the following rounds, the member node can be the cluster head if it follows two conditions:

1) The location of the node must be close to the sink.

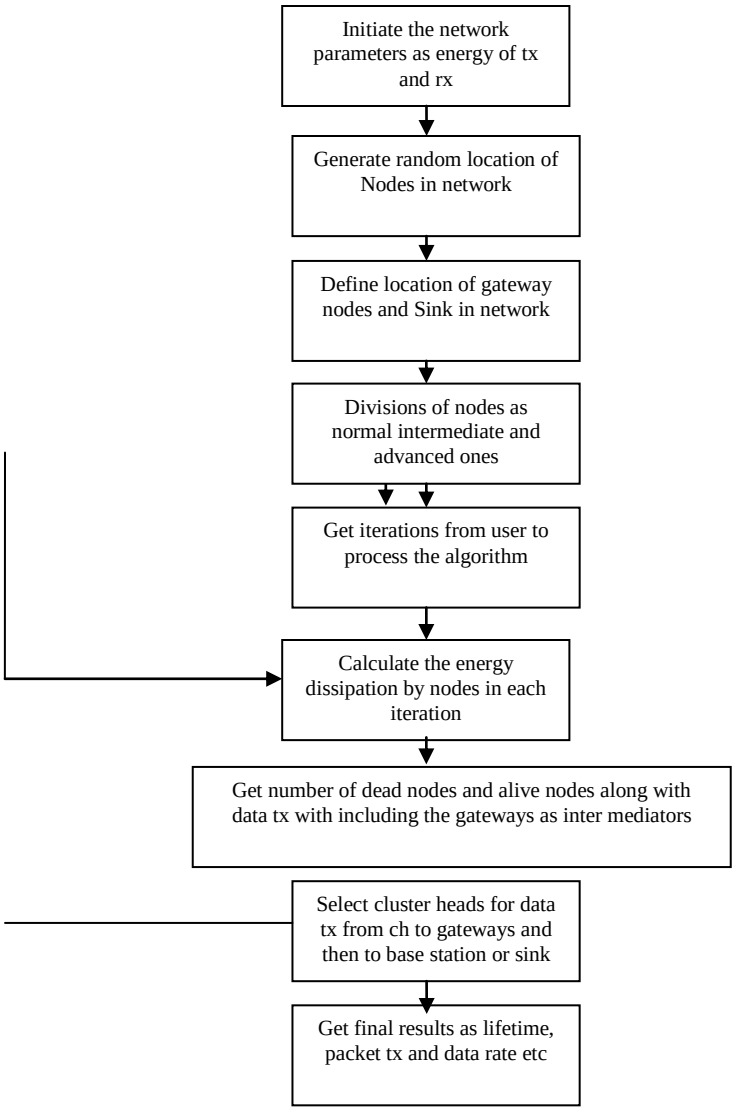
2) The residual energy of the nodes must be greater than the threshold. Then the strategy followed is: (j)

Where djis the distance from the member node j to the sink, (j) is its residual energy and is the threshold energy. The threshold energy is set to be the average residual energy of all the alive nodes in the cluster.

C. Data Transmission

After the above phases, data transmission takes place: nodes send their data during their allocated TDMA (time division multiple access) slot to the (CH) cluster head. Then CH creates and broadcasts its own TDMA schedule which includes time slots for data transmission from member nodes to the cluster head and then from the cluster head to the sink. During the rest time, nodes fall asleep to save energy.CH fuses the data packet received from member nodes and then transfer it to the sink.

FLOW CHART:



PROPOSED FLOW DIAGRAM

IV. SIMULATION OF IMPROVED PROTOCOL

This article uses Matlab2010a as simulation platform to emulate LEACH protocol and the improved protocol (A-LEACH), the improved algorithm aims at balancing the total energy consumption of nodes and extending the network's survival time. So we measure the improved protocol performance from two aspects: the lifetime and the total energy consumption of the network. The lifetime of network means the time from the beginning of simulation to the time when the last node died. As the energy of WSN is limited, so the energy consumption in its lifetime is a meaningful indicator to measure the performance of it.

A. Simulation parameters

Simulation scenarios for this article are:

1. Sensor nodes are randomly distributed in a square region of network.
2. Sensor nodes are heterogeneous and nodes are multi hop, nodes energy is limited. The location of is fixed after deployed in the network.
3. The base station is considered at the (100,250) with fixed location.
4. Nodes communicate with base station via multi-hop. They communicate through gateways to base station.
5. The wireless transmitter power is adjustable in network.
6. Gateways introduced to reduce the distance between nodes and the base station.

Specific parameters for the proposed protocol are shown in table 1.

Table1: Simulation environment parameter

Parameters	Value
Simulation Round	5000
Sink Location	(100,250)
Network Size	(200x250)
Number of Node	200
Number of Gateways node	16
CH Probability	0.1
Fusion Rate (cc)	0.6
Initial Nodes Power	0.5 joule
Node Distribution	Node are uniformly distributed
Control Packet Size	500 bits
Data Packet Size	4000 bits
Energy Dissipation	10*0.000000000001 joule
Energy for Transmission	50*0.000000000001 joule
Energy for Reception	50*0.000000000001 joule
Energy for Data Aggregation	50*0.000000000001 joule

B. Analysis and simulation results

Table1 shows the parameters which are used in the A-LEACH to enhance the life time of wireless network. Here the first parameter that is simulation rounds or iteration that is 5000. On the 5000 we check the life time of nodes where nodes dead or alive its shows on the results. Sink location (base station) is the area where nodes communicate to sink through the gateways that are intermediate between the base station and the nodes. Total size of network is (200x250) in which the sink located at the (100,245) and the nodes are in the area of (200x200). The total nodes are distributed in the network area is 200 with 16 gateways that work as intermediate to reduce the distance. Energy for a transmission, energy for reception and energy for data aggregation is same that is 50*0.000000000001 joule. Data packet size is 4000 bits for the transmission and control packet size 500 bits.

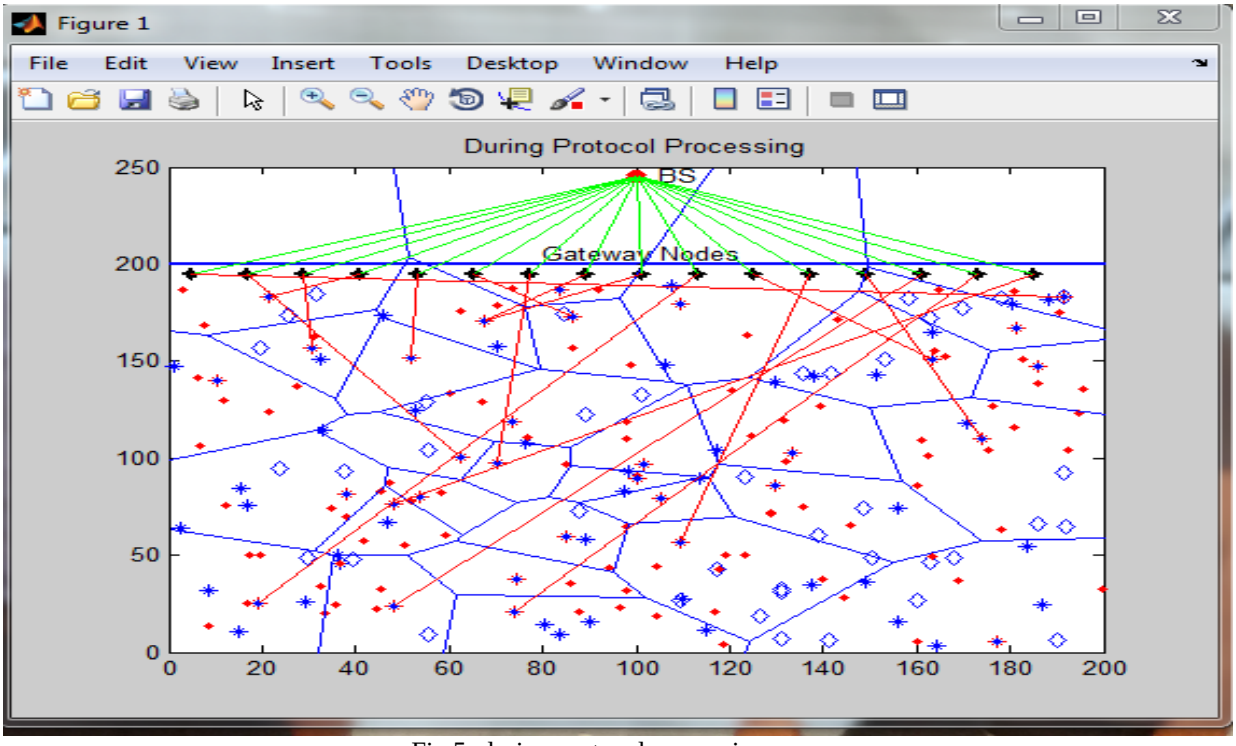


Fig 5: during protocol processing

C. The Network life time

The network lifetime in this article is defined as the time from the beginning of the simulation to the time when the first to last node died, mainly lifetime of network is depends on the last node. In WSN, the network life is divided into two ways one is stable and second is unstable period [5]. Stable period usually means the time from the beginning of the simulation to the time when the first node dies during protocol processing and the unstable period refers to the time from the death of first node to the end node of simulation. If it happened that some nodes begin to die, the network operation may become unstable and unreliable data transferring will occur. Therefore, the longer the stable period means first node die is, the better the performance of the networks. In LEACH Protocol cluster heads are responsible not only for communicating with the base station or sink, but for the data fusing in destination point. Randomly distribution of node and clusters head causes some cluster heads die earlier because of the low energy or the long distance to base station of network. Secondary cluster heads on the bases of probability are set for these clusters to be responsible for the communication with common nodes and data fusing to destination point; it balances the energy load of cluster heads and ignores premature death of these cluster heads. So the stable period of network lifetime will be prolonged to network.

Figure 6 show network lifetimes in simulation, simulation results indicates that the network lifetime of the improved protocol (A-LEACH) and LEACH Protocol are about the same, the first node died in LEACH Protocol in round 957, the first node died in the improved Protocol in round 1029. When most of nodes died is 90%, the network reliability is extremely reduced and the running is almost meaningless in the wireless sensor network. We may as well to define the time from the simulation beginning iteration of network to the time 90% nodes died as effective lifecycle, analyzing from figure 6. We know that the effective lifecycle of the improved algorithm (A-LEACH) is longer than that of LEACH protocol. The percentage of stable period of lifecycle in LEACH Protocol is more than the improved A-LEACH protocol. The percentage of stable period of lifecycle in improved algorithm increases. Same in case of unstable period the last node die in case of LEACH is 3213 and A-LEACH is on 5102. This indicates that the running performance of improved A-LEACH protocol is much better than that of LEACH Protocol. The analysis of simulation result for A-LEACH is consistent with the theoretical analysis.

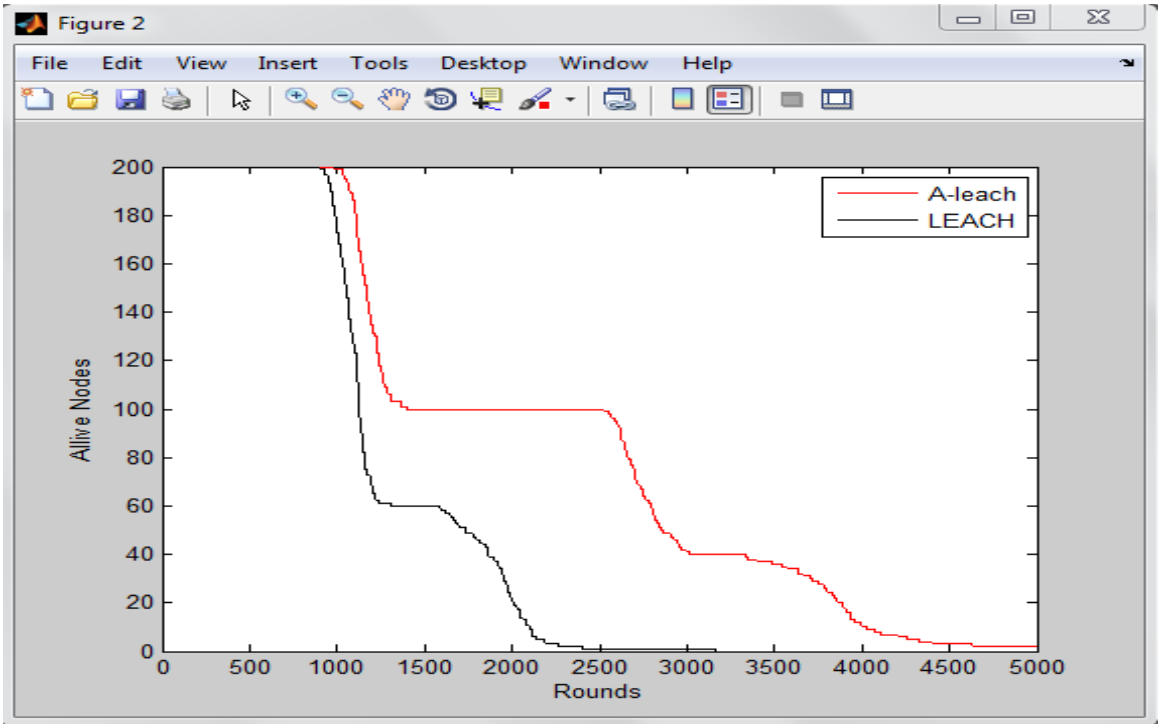


Fig 6: Life time of network

D. The Residual energy

Figure 7 is the residual energy curve. Improved A-LEACH protocol or algorithm reduced the energy consumption of few cluster heads which has low energy or is far away to base station by setting secondary cluster heads reasonably for communication. It balanced the residual energy of the whole networks. To extend the lifetime of cluster heads which may die earlier during communication and optimized the performance of the network thereby reduced the total energy consumption of the effective lifecycle.

From the analysis of Figure 7, we know that in the whole running of the network, the residual energy of improved algorithm is more effective than that of LEACH Protocol at the same round of simulation. These results are in simulation for purposes of improved algorithm.

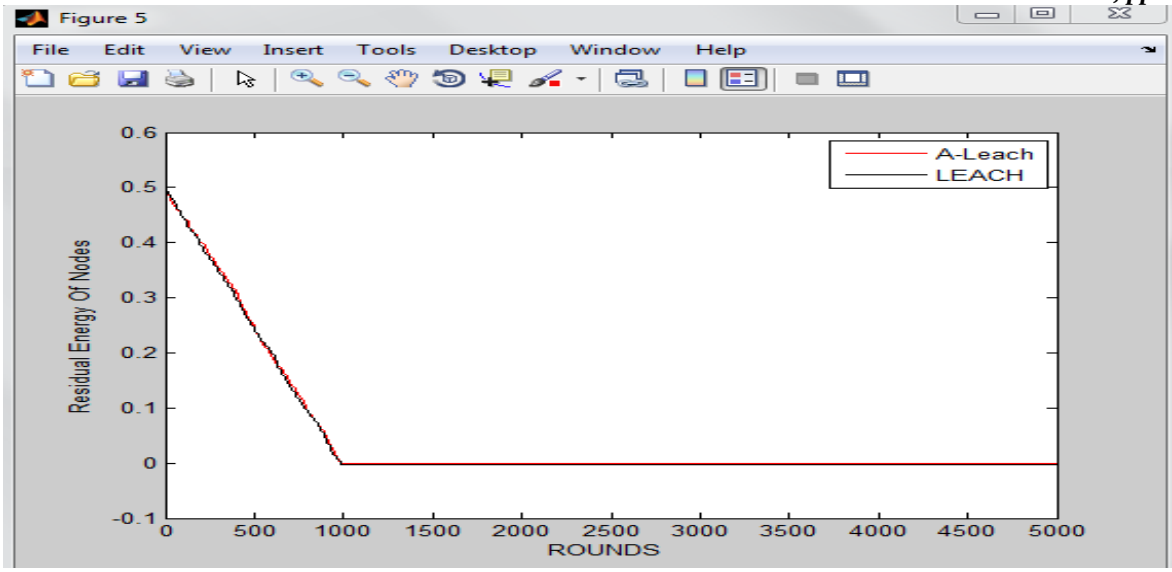


FIG 7: RESIDUAL ENERGY

V. CONCLUSION AND FUTURE SCOPE

We describe an energy-efficient multi-hop routing protocol using gateway node to maximization the life time wireless sensor network and for the minimize energy consumption of sensor network. Choosing cluster head randomly in LEACH protocol causes that the current energy of some cluster heads of cluster are less or their distances to base station are far from the nodes, due to the heavy energy burden the cluster head will soon die and life time of network minimized. To reduce the distance between cluster head and base station we introduce a new method. In this work we proposed gateways as intermediate between the cluster head and base station that reduce the distance. A new multi-hop routing A-LEACH protocol for the heterogeneous wireless sensor networks has been presented and the performance of the system is evaluated to maximization of wireless sensor network, minimize the energy consumption of sensor network. The simulation results reveal that the LEACH protocol consumes more energy and the network has shorter lifetime than proposed multi-hop A-LEACH protocol with gateway nodes. Finally, simulation results indicate that proposed A-LEACH protocol can more efficiently balance energy consumption of an entire sensor network and thus enhance the network lifetime of wireless sensor network. The proposed work is for the heterogeneous network using the gateways as intermediate and we proposed to extend this work for the gateways introduced in 3 dimensions in wireless sensor network.

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