Optimizing the Performance of I-mod Leach-PD Protocol in Wireless Sensor Networks

Sheetal Dixit[1] Dr. Naraendra Yadav[2] Dr. Saroj Hiranwal[3]
[1]M.Tech. Scholar
[1,2]Department of Computer Engineering [3]Department of Information Technology
[1,2,3]Shri Balaji Technical Campus

Abstract— Wireless Sensor Networks (WSNs) is a networks of thousands of inexpensive miniature devices capable of computation, communication and sensing. WSN is being been attracting increasing interest for supporting a new generation of ubiquitous computing systems with great potential for many applications such as surveillance, environmental monitoring, health care monitoring or home automation. In the near future, wireless sensor network is expected to consists of thousand of inexpensive nodes, each having sensing capability with limited computational and communication power which enables to deploy large scale sensor networks. Large scale WSN is usually implemented as a cluster network. Clustering sensors into groups, so that sensors communicate information only to cluster-heads and then the cluster-heads communicate the aggregated information to the base station, saves energy and thus prolongs network lifetime. LEACH (Low Energy Adaptive Clustering Hierarchy) protocol is one of the clustering routing protocols in wireless sensor networks. The advantage of LEACH is that each node has the equal probability to be a cluster head, which makes the energy dissipation of each node be relatively balanced. In LEACH protocol, time is divided into many rounds, in each round, all the nodes contend to be cluster head according to a predefined criterion. This paper focuses on how to set the time length of each round, how to adjust threshold based on the residual energy, and the measurement of energy required for transmission, based on the distance of cluster head from the base station, to prolong the lifetime of the network and increase throughput, which is denoted as the amount of data packs sent to the sink node. The functions of residual energy and required energy, and the time length of each round are deduced, thereby modifying the threshold value calculation. These functions can be used to enhance the performance of cluster-based wireless sensor networks in terms of lifetime and throughput.

Key words: Wireless Sensor Networks, Network Lifetime, Energy Consumption, LEACH protocol, duty cycle

I. INTRODUCTION

Clustering sensors into groups, so that sensors communicate information only to cluster-heads and then the cluster-heads communicate the aggregated information to the base station, saves energy and thus prolongs network lifetime. Low Energy Adaptive Clustering Hierarchy (LEACH) [1] protocol is one of the clustering routing protocols in wireless sensor networks. The advantage of LEACH is that each node has the equal probability to be a cluster head, which makes the energy dissipation of each node be relatively balanced. In LEACH protocol, time is divided into many rounds, in each round, all the nodes contend to be cluster head according to a predefined criterion. This paper focuses on how to set the threshold limit of sensor node, to bias the probability of being selected as cluster head, to prolong the lifetime of the network and increase throughput, which is denoted as the amount of data packs sent to the sink node. The functions of lifetime and throughput related to the time length of each round are deduced. These functions can be used to enhance the performance of cluster-based wireless sensor networks in terms of lifetime and throughput.

A. Problem Statement

Leach Protocol is a dynamic clustering algorithm [2] for clustering networks. The primary motivation behind LEACH protocol is to distribute the power consumption in transmission evenly in all the nodes of the network. However, LEACH employs a purely random approach taking into consideration, only the case that no node can be elected as cluster head, which is elected as a cluster head in previous round. This work proposes an augmentation of the LEACH protocol with the residual energy of the node to bias the original cluster head selection and to distribute the energy consumption more evenly.

II. MOTIVATION

With the recent technological advances in wireless communications, integrated digital circuits, and micro electro mechanical systems (MEMS) [3], development of wireless sensor networks has been enabled and become dramatically feasible. Sensor nodes are often left unattended e.g., in hostile environments, which makes it difficult or impossible to re-charge or replace their batteries. This necessitates devising novel energy-efficient solutions [4] to some of the conventional wireless networking problems, such as medium access control, routing, self-organization, so as to prolong the network lifetime. Various routing, power management, and data dissemination protocols [5] have been designed for wireless sensor networks (WSNs) dependent on both the network architecture and the applications that it is designed for. In most of the applications sensors are required to detect events and then communicate the collected information to a distant base station (BS) where parameters characterizing these events are estimated. The cost of transmitting information is higher than computation and hence it is be advantageous to organize the sensors into clusters, where the data gathered by the sensors is communicated to the BS through a hierarchy of cluster-heads [6]. In wireless sensor networks (WSNs), due to the limitation of nodes' energy, energy efficiency is an important factor should be considered when the protocols are designing. As a typical representative of hierarchical routing protocols, LEACH Protocol plays an important role. LEACH Protocol is the first protocol of hierarchical routings which proposed data fusion [7], it is of milestone significance in clustering routing protocols. Many hierarchical routing protocols are improved ones based on LEACH protocol [8]. So, when wireless sensor networks gradually go into our lives, it is of great significance to research on LEACH protocol.

III. RESEARCH APPROACH

The modeling of packet transmission overheads for a surveillance or a general purpose wireless sensor network for energy consumption can be described more accurately using a probabilistic model rather than using analytical equations. In this paper, classical LEACH protocol is realized using Poisson Probability Distribution [9], for packet transmission probabilities and mean number of packets transferred by any node. Thus, this analysis gives a more accurate description of energy consumption as compared to modeling techniques used earlier. Also, the residual energy in a node can be computed using simple logic that can be inculcated using existing hardware with no extra cost. This parameter is critical for network lifetime and has to be considered in cluster head election. Thus, the node having very low energy remaining should possess very low probability of being elected as Cluster Head (CH). Classical LEACH , being based on purely random numbers, does not have any provision for this consideration. In this paper, the classical algorithm has been modified to take into account the variation in the residual battery life and controlled using a strength factor. This paper focuses on how to set the time length of each round, how to adjust threshold based on the residual energy, and the measurement of energy required for transmission, based on the distance of cluster head from the base station, to prolong the lifetime of the network and increase throughput, which is denoted as the amount of data packs sent to the sink node. The functions of residual energy and required energy, and the time length of each round are deduced, thereby modifying the threshold value calculation. These functions can be used to enhance the performance of cluster-based wireless sensor networks in terms of lifetime and throughput.

IV. PROPOSED WORK

A. LEACH Protocol

LEACH is an adaptive clustering routing protocol proposed by Wendi B. Heinzelman, et al. The implementation process of LEACH includes many rounds. Each round consists of the setup phase and the steady data transmission phase. In the set-up phase, the cluster head nodes are randomly selected from all the sensor nodes and several clusters are constructed dynamically. In the steady data transmission phase, member nodes in every cluster send data to their own cluster head, the cluster head compresses the data that received from member nodes and sends the compressed data to the sink node. LEACH protocol periodically elects the cluster head nodes and re-establishes the clusters according to a round time, which ensures energy dissipation of each node in the network is relatively evenly.

The cluster head election algorithm in LEACH is a very simple procedure. All the sensor nodes generate a random number between 0 and 1. Each node is assigned a real number as a threshold value, T(n). If the generated number is less than the threshold T(n), the sensor nodes will broadcast an announcement message to notify others that it is a cluster head. In each round, if a node has been elected as a cluster head, its T(n) is set to zero, so that the node will not be elected as a cluster head again. T(n) can be expressed as:

$$T(n) = \begin{cases} \dfrac{P}{1 - P * [r \bmod \left(\frac{1}{P}\right)]}, & n \in G \\ 0, & otherwise \end{cases} \qquad equation\ 3.1$$

where P is the percentage of the number of clusters in the network (usually P is 0.05) [] , r is the number of the election rounds, r mod(1/ P) is the number of nodes which have been elected as cluster heads in the round r, and G is the set of nodes that have not been elected as cluster heads in round r.

The above formulation for LEACH can be understood in a simple way. The complete interval is supposed to be of length 1 unit. The number of subintervals in the interval is 1/P = 20 (for P =0.05). R refers to the current subinterval and G is the number of nodes that have not yet been elected as cluster heads in the current interval.

After cluster head election, the cluster head broadcasts its identity message to non-cluster head nodes. The non-cluster head nodes send a join-REQ message to the nearest cluster head to join in the corresponding cluster. After the cluster head receives all the join-REQ information, it will produce a TDMA schedule, and notify all the member nodes in the cluster. After a member node receives the schedule, it sends data in its own time slots, and remains in the sleep state in other slots. After a frame time of data transmission, the cluster head runs the data compression algorithm to process the data and sends the results directly to the sink node. LEACH protocol lets the data transmission phase last for a fixed period of time[5], then enter into a new round of cluster head election. The time length of round has obviously influence on the performance of LEACH protocol. In order to decrease the overhead of set-up phase, it is desirable to increase the time length of round, which increases the time for data transmission. However, prolonging the time length of round also increases the energy consumption of cluster head, which will causes some nodes die early and in turn shortens the lifetime of wireless sensor networks. So, regarding to configuration of time length of round, there is a trade -off between lifetime and throughput.

Suppose that the time of set-up phase is α , and the steady data transmission time is t , then the time length of every round is $t_r = \alpha + t$. It is assumed that the time when the first sensor node dies as the lifetime of the network, which is denoted as t_{fd} . It is noted that the following analysis can be easily extended to other definition of lifetime.

The relationship of the lifetime t_{fd} and t is shown in Fig. 3.1

It is clear from the figure that

$t_{fd} = n*(\alpha + t) = n*t_r$

where n is the number of rounds after which the first sensor nodes dies.

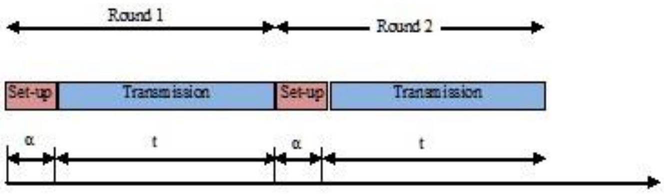

Fig. 3.1: Setup and Transmission Phase of LEACH

According to LEACH protocol, there are m frames in the time t, so t = m*T_{FRAME} . Here T_{FRAME} is the time length of each frame. Therefore

t_{fd} = n*t_r = n*(α + m*T_{FRAME})

Given the initial energy E_0 of sensor node, the t_{fd} can be deduced according to the energy dissipation in cluster set-up phase and data transmission phase.

The energy dissipation model of cluster head and member node can be derived using average number of clusters in the network. Let there be n nodes in the cluster network and the number of clusters be k. Then the average number of sensor nodes per cluster is n/k. Thus, in any cluster, there is one head node and (n/k) - 1 member nodes.

It is assume *N* nodes are evenly distributed in *M*×*M* area, the coordinate of the sink node is (X_{sink}, Y_{sink}), the initial energy of each node is E_0, the length of data message is *L* bits, and the length of control message is *P* bits.

A simple radio hardware energy dissipation model can be used to find out the dissipation of energy in the setup phase, by the cluster head and the member nodes. The transmitter dissipates energy to run the radio electronics and the power amplifier. The receiver dissipates energy to run the radio electronics. The radio energy dissipation model is shown in Fig.2. Then the energy expenditure for transmitting *L*-bit message to *d* distance is:

$$E_{TX}(\mathrm{L,d}) = \mathrm{L} * E_{elec} + \mathrm{L} * \epsilon * d^{\gamma} \quad equation\ 3.2$$

And the energy expenditure for receiving *L*-bit message is

$$E_{RX} = \mathrm{L} * E_{elec} \quad equation\ 3.3$$

In Eq. (3) and Eq. (4), the electronics energy expenditure for one bit, E_{elec} , depends on factors such as the digital coding, modulation, filtering and spreading of the signal. whereas the amplifier energy expenditure for one bit, $\varepsilon * d^{\gamma}$, depends on the distance from the sender to the receiver and the acceptable bit error rate. In this paper, the channel model in the cluster is free space propagation model, and the channels between cluster head nodes and the sink node are multi-path fading channel. For the free space propagation, γ = 2, and ε is denoted as ε_{fs} . For multi-path fading channel, γ = 4 , and ε is denoted as ε_{mp}.

Considering the first order radio energy dissipation model, one can write the following equations for energy consumption in transmitter and receiver circuitry.

$$E_{TX}(\mathrm{L,d}) = \mathrm{L} * E_{elec} + \mathrm{L} * E_{amp} d^2 \ equation\ 3.4$$

$$E_{RX}(\mathrm{L}) = \mathrm{L} * E_{elec} \quad equation\ 3.5$$

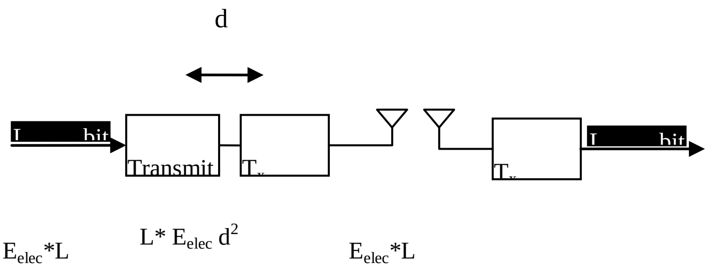

Fig. 3.2: Radio energy dissipation model

B. Modified LEACH Algorithm for Cluster Head Election

The LEACH protocol assumes a region of spatially distributed cluster nodes and a base station. For the sake of simplicity, an M *X* M square region is considered having n sensor nodes, evenly distributed in the entire region. It is assumed that the coordinates of every nodes are known as priori. Let the coordinates of the base station B being (X_{BASE}, Y_{BASE}). Let the total energy consumption in the setup phase be E_{CH} by the cluster heads and E_{NCH} by non-cluster heads. The core technique of LEACH protocol for cluster head election is based on pure randomness, excluding those nodes that were elected as cluster heads in the previous cycle. However, a more uniform energy consumption model can be obtained if the cluster head election will also consider the following:

(1) The residual battery power of the sensor node.
(2) The spatial location of the elected sensor node with respect to the sink or base station.
(3) The count of the number of cluster heads to be elected (P) should be a function of the Frequency/Traffic of sensed data.
(4) An optimal cycle time for election must be chosen to reduce the overhead of setup phase.

Points 1 and 2 can be tackled simultaneously by considering an n *X* 2 matrix for the entire network. Both these issues are dependent on the energy dissipation model of the sensor node in transmitting over a distance and the residual battery power. Points 3 and 4 depends together on the traffic of sensed data. More traffic needs more processing for message aggregation and frequent transmissions, and consequently, more energy consumption by the cluster head. This energy consumption also depends upon the spatial location of the cluster head with respect to the base station.

The n *X* 2 matrix for each of the sensor node can be constructed as shown:

$$\begin{bmatrix} E_{R1} & d_1 \\ E_{R2} & d_2 \\ \\ . & . \\ E_{Rn} & d_n \end{bmatrix}$$

Here, E_{Ri} refers to the residual energy left in the node i. Also, d_i refers to the distance of node i from the base station B (X_{BASE}, Y_{BASE}), which can be computed as:

$$d_i = \sqrt{(X_{BASE} - x_i)^2 + (Y_{BASE} - y_i)^2}$$

From the matrix shown above, the power needed in the transmission operation can be obtained as that is a function of d_i.

For isotropic omni-directional antenna, the power needed for transmission is proportional to the square of the distance from the antenna. Thus, four times more power is needed for transmission if the distance between the two nodes is doubled.

Let P be the fraction of nodes which are to be elected as the cluster heads. Thus, P must be a function of traffic intensity, which in turn depends on the transmission time interval (after the setup interval).

The threshold value for every node contending to be cluster head must be suitably chosen as a function of the following parameters:

(1) The residual battery power
(2) The power needed for transmission
(3) The transmission time t

The probability of a node being chosen as the cluster head must inversely be proportional to the difference between the residual battery life and the power consumption in transmission during the transmission period. This latter term depends upon the probability distribution of the mean number of packets transmitted during the transmission period, the length of the active period and the distance between the cluster head and the sink node.

1) Computation of the optimal transmission time

In this work, slotted CSMA as the Medium Access Protocol for data link layer level transmission is considered. Let t be the steady state data transmission time. For improving network lifetime, it is required to construct a scheme such that the dissipation of energy of the nodes in the network occurs uniformly.

Let n be the mean number of packets transmitted by each node in entire interval. Assuming a Poisson Probability Distribution for the number of packets transmitted with mean value λ, the probability of k packet transmission during the interval is:

$$P(n=k) = \frac{\lambda^k e^{-\lambda}}{k!} \quad equation\ 3.6$$

Also, the mean value of packets transmitted by each node in the subinterval is λ/(1/P) = λP.

The probability of packet transmission during the subinterval can be obtained by the formula

$$P(n=k) = \frac{(\lambda P)^k e^{-(\lambda P)}}{k!} \quad equation\ 3.7$$

giving;

$$P(n=1) = \frac{(\lambda P)^1 e^{-(\lambda P)}}{1!} \quad quation\ 3.8$$

which is the probability of packet transmission by a node in a subinterval. Let the total number of nodes in the network be N, using established results, the optimal value of the cluster heads is the percentage P = 0.05. Thus, the number of cluster nodes being elected is

$$\#CH = N * P \quad equation\ 3.9$$

The number of non cluster heads being N -N*P = N*(1-P). These are the nodes which probably sends the data in the transmission phase of the subinterval. Assuming a uniform distribution of nodes under the territory of cluster heads, the approximate number of transmitting nodes under each cluster head is

$$S = \frac{N(1-P)}{NP} = \frac{(1-P)}{P} \quad equation\ 3.10$$

Thus, for a total of S transmitting nodes under each cluster head with the probability of transmission being

$$P(n=1) = \frac{(\lambda P)^1 e^{-(\lambda P)}}{1!}$$

The average number of packet transmissions is

$$Trans_{avg} = S * P(n=1) = \frac{(1-P)}{P} * \frac{(\lambda P)^1 e^{-(\lambda P)}}{1!} \quad equation\ 3.11$$

The optimal transmission time must be equivalent to this value for optimal power consumption. However, using this result, some nodes may having data to sent may not get a time slot in the TDMA schedule and may wait for the subsequent subinterval, neverthless, it yields optimal network utilization at the cost of latency.

2) Computation of the optimal threshold value based on the optimal transmission time

As stated in the previous section, the optimal transmission time is given by

$$Trans_{avg} = S * P(n=1) = \frac{(1-P)}{P} * \frac{(\lambda P)^1 e^{-(\lambda P)}}{1!}$$

Let E_{RI} be the residual battery life of node id I. Let its distance from the base station be d_I . Assuming data aggregation without any compression, the energy required for transmission of $Trans_{avg}$ number of packets over d_I is

$$E_{TX}(Trans_{avg} * \mathrm{L}, \mathrm{d}) = (\mathrm{L} * E_{elec} + \mathrm{L} * E_{amp} {d_I}^2) * Trans_{avg} \quad equation\ 3.12$$

The above equation reflects the expenditure of energy from the sensor node. In any case, if the residual energy is less than this, the node cannot be chosen as the cluster head. However, if the residual energy is greater than this, it is the difference between the two that matters.

Moreover, the higher the threshold value for a node, the greater the chances of it being the cluster head. Therefore, the threshold value must directly be proportional to

$$E = E_{RI} - E_{TX}(Trans_{avg} * \mathrm{L}, \mathrm{d}) \quad equation\ 3.13$$

However, a mathematical analysis of the standard LEACH protocol shows that the threshold values increases after each round of election.

Let E_{FULL} denotes the quantity of energy when the node is have full energy level. The quantity E/E_{FULL} is a quantity below 1 which is a measure of likelihood of node being cluster head. The inculcation of this parameter in the standard LEACH can be done in the following way

$$T(n) = \begin{cases} \frac{P}{1 - P * [r \bmod (\frac{1}{P})]} + \alpha * (E/E_{FULL}), n \in G \\ 0 \quad , otherwise \end{cases} \quad equation\ 3.14$$

The parameter α is chosen suitably to manage the process of election for cluster heads to evenly distribute the energy consumption over the entire sensor network.

Chapter 4 discusses the analytical plots for equations described above. It also discusses the results of the simulation model against energy consumption and network lifetime as facilitated by standard LEACH.

V. ANALYSIS OF PROPOSED WORK

A. Calculation of the optimal transmission time

For optimal transmission time, the expression derived is stated in equation 3.11 repeated here for ready reference

$$Trans_{avg} = S * P(n = 1) = \frac{(1 - P)}{P} * \frac{(\lambda P)^1 e^{-(\lambda P)}}{1!}$$

The setup time can be assumed to be a constant as it virtually takes the same time to broadcast a joining message and to get the acknowledgements.

Consider the following values of parameters used in the expression:

Parameter (Symbol)	Specification	Value
P	Fraction of Nodes to be electred as cluster heads (CH) or Ratio of CH from among the total population of sensor nodes	[0.05, 1]
λ	Mean number of Packets transmitted by nodes in a time interval	[1,50]

Table 4.1: Parameter Specification for Wsn Model

Figure shows the plot of the optimal transmission time against mean packet transmission rate and Cluster Head percentage.

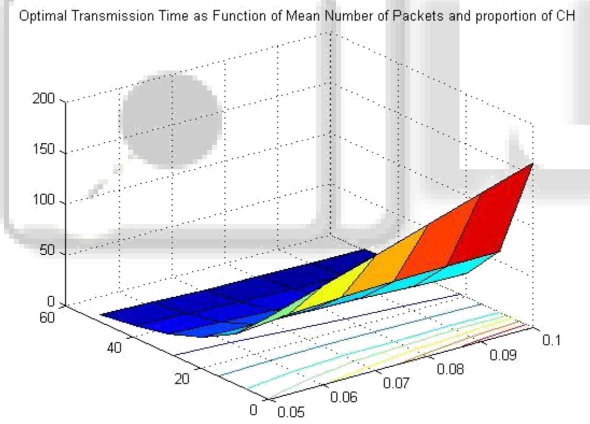

Fig. 4.1: Horizontal Plane axis show mean packet arrival rate and proportion of cluster head at any time from total population of clusters and the vertical axis shows optimal transmission time for generation of TDMA schedule.

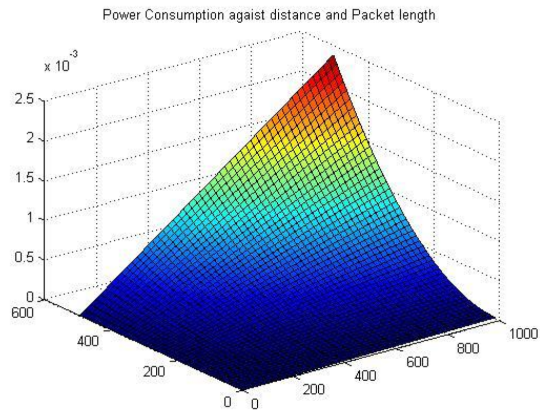

Fig. 4.2: Horizontal Plane axis show transmission range and packet length and the vertical axis shows energy consumption.

	1	2	3	4	5
86	0.0526	0.0556	0.0588	0.0625	0.06
87	0.0526	0.0556	0.0588	0.0625	0.06
88	0.0526	0.0556	0.0588	0.0625	0.06
89	0.0526	0.0556	0.0588	0.0625	0.06
90	0.0526	0.0556	0.0588	0.0625	0.06
91	0.0526	0.0556	0.0588	0.0625	0.06
92	0.0526	0.0556	0.0588	0.0625	0.06
93	0.0526	0	0	0	
94	0.0526	0.0556	0.0588	0.0625	0.06
95	0.0526	0.0556	0.0588	0.0625	0.06
96	0.0526	0.0556	0.0588	0.0625	0.06
97	0.0526	0.0556	0.0588	0.0625	0.06
98	0.0526	0.0556	0	0	
99	0.0526	0.0556	0.0588	0.0625	0.06
100	0.0526	0.0556	0.0588	0.0625	0.06

Fig. 4.3: Illustration of Threshold values of nodes (values that determine the probability of cluster heads)

	1	2	3	4	5
42	0	0	0	0	
43	0	0	0	0	
44	0	0	0	4	
45	0	0	0	0	
46	0	0	0	0	
47	0	0	0	0	
48	0	0	0	0	
49	0	0	0	0	
50	0	0	0	0	
51	0	0	0	0	
52	0	0	3	4	
53	0	0	0	0	
54	0	0	0	0	
55	0	0	0	0	

Fig. 4.4: Illustration of 5 rounds and the Cluster Heads

For a total of N = 100 nodes with the proportion of cluster heads being P = 0.05, figure 4.5, 4.6 and 4.7 gives the simulation results of the LEACH protocol implementation in MATALB.

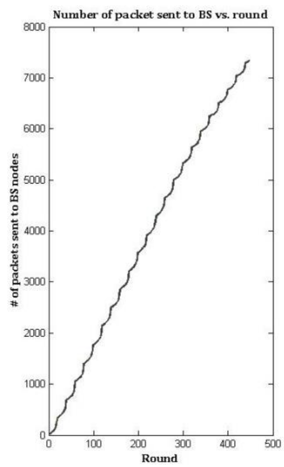

Fig. 4.5: Plot of Number of Packets sent to the base station versus number of rounds. Poisson Probability Distribution is assumed with mean value λ = 10.

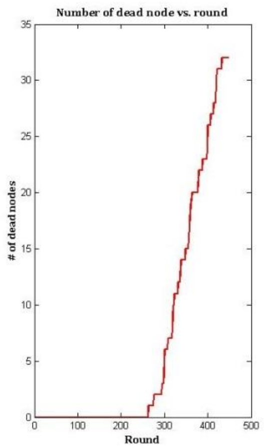

Fig. 4.6: Plot of Number of Dead Nodes versus number of rounds. First order Radio Energy dissipation model is assumed as specified in [22].

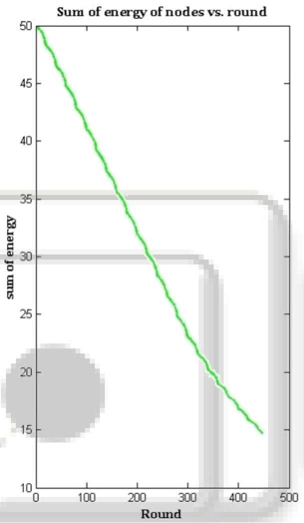

Fig. 4.7: Plot of the total energy remained in the network versus number of rounds.

Consider the proposed solution of the identified problem to ensure longest possible network lifetime where the lifetime of the network is defined as the shortest time when the any node belongs to the network runs out of battery life. Equation 3.14 is repeated here for ready reference:

$$T(n) = \begin{cases} \dfrac{P}{1 - P * \left[r \bmod \left(\frac{1}{P}\right)\right]} + \alpha * (E/E_{FULL}), n \in G \\ 0 \quad , otherwise \end{cases}$$

As illustrated in figure 4.6, the first dead node occurs at round r = 260-265, where N = 100 is the number of nodes in the network and P = 0.05 is the percentage of nodes to be choosen as Cluster Heads (CH) in each round. The fluctuation in the value occurs due to consideration of probabilistic value of the mean number of packets transmitted in accordance with Poisson Probability Distribution.

The basic LEACH protocol is purely random, and all those nodes that have not yet been elected as cluster heads have equal probability of becoming cluster heads. However, even the nodes that have not yet been elected as cluster heads may have varying amount of remaining battery life due to the following reasons:

(1) Placement of sensor node might be at a place which might attract other sensor nodes to use it at a router and therefore results in high energy dissipation.
(2) Node Malfunctioning, thereby resulting in high energy dissipation.
(3) The node might have been chosen as CH in some previous round at which time it had served a large number of nodes in its cluster, therby had already dissipated significant amount of energy in data aggregation and transmission.
(4) Leakage in Battery or battery malfunction.

The formulation proposed in this work is identical to the pure LEACH for its 1 complete round, consisting of a total of 1/P = 20 sub-rounds of Cluster Head election. This is because every node which is elected as cluster head during any one sub-round of a round has its threshold value set to zero and so cannot be elected as CH again in the same round. However, after the completion of the round, each node is left with varying amount of battery life probably due to its operation as cluster head which needs more energy consumption, as compared to non cluster nodes.

With the inclusion of the energy parameter in the Pure Leach formulation for setting the threshold values in the CH election, the threshold values of the nodes with low power becomes smaller, thereby reducing the probability of them to be elected as cluster heads, thereby increasing the battery life.

The simulation with proposed modification is described as follows:

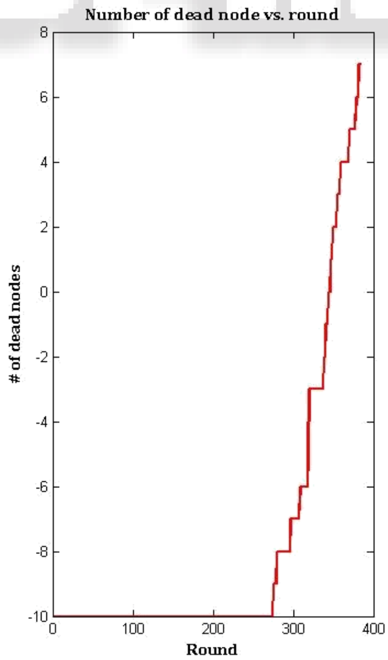

Fig. 4.8: Plot of Number of Dead Nodes versus number of rounds as per the proposed modification. First order Radio Energy dissipation model is assumed as specified in Ch 3

The given simulation shows improvement over traditional Leach as the round at which the first node dies is 260-265 in pure LEACH whereas it is 273-280 in case of implementation with proposed modification with α = 0.1. Thus, the relative improvement in performance is 15/260 = 5.7% over [22]. Chapter 5 discusses the result of the paper and outline the conclusion and future scope.

VI. Conclusion And Future Scope

The LEACH is a well-known routing protocol for cluster based wireless sensor networks. This paper analyses the performance of LEACH-based wireless sensor networks in terms of lifetime and throughput. Electing cluster head randomly in LEACH protocol causes that the current energy of some cluster heads are less or their distances to base station are far, because of the heavy energy burden, these cluster heads will soon die. For this issue, this paper proposed a new improved algorithm of LEACH protocol which is aim at balancing energy consumption of the whole network and extending the network lifetime by balancing the energy consumption of these cluster heads. The reasonable number of frames in a LEACH round is deduced to prolong the lifetime and increase the throughput. In work proposes a modification of the LEACH is described based on stochastic cluster-head selection algorithm by considering two additional parameters, viz, the residual energy of a node relative to the residual energy of the network and the energy needed to work as cluster head in the sub-round based on the geographical placement of the node. The new improved algorithm is simulated by Matlab platform, the simulation results indicate that the energy efficiency and the lifetime of network are both better than that of LEACH Protocol.

The analytical results obtained are in agreement with the simulation results thereby proving the validity of the equations. However, the proposed algorithm increases the lifetime of the network but it does so at the cost of complexity of the logic circuitry which had to include the logic for computation of remaining battery life and an additional logic to compute the projected estimate of energy consumption if it is being elected as cluster head. This also results in additional computation as overhead. Also it results in increased cost because of this additional logic realization in hardware. It also includes, in some way, the Latency in the network for the obvious reason of the computational complexity of the proposed equations.

For the development of proposed model, this has been assumed that that distribution of load in the network is approximately identical over all parts of the network. However, under heavy loads with large fluctuations, additional parameters need to be considered based on certain heuristics and past trends in the network flow. Thus, a feedback network can be used to provide inputs based on the values of past outputs of the network so as to provide a guiding light in the process of obtaining most optimal results. These are to be considered in the future scope of the work.

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