IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 10, Issue 6, Ver. III (Nov - Dec .2015), PP 95-100
www.iosrjournals.org

Maximizing Network Lifetime by Using Smart Cluster Head Selection

Simimol.Surendran[1], Ajitsinh.N.Jadhav[2]
[1](*Electronics & Telecommunication, D. Y. Patil college of Engg. & Tech. Kolhapur / Shivaji University ,India)*
[2](*Electronics & Telecommunication, D. Y. Patil college of Engg. & Tech. Kolhapur /India)*

Abstract: *In wireless sensor network, one of the major issues is how to optimize the network lifetime. The network lifetime depends on the life of the nodes that are deployed on the field area where these sensor nodes are left unattended and unmonitored. Most of the energy is consumed by the nodes during communication amongst cluster members and the cluster head. More energy is dissipated while communication as compared to sensing of the data done by sensor nodes. Hence to reduce the communication distance proper selection of cluster head is necessary. Hence a simple technique of smart cluster head selection is implemented on the basic LEACH protocol to enhance its performance by all aspects and sustain the network lifetime.*
Keywords: *Smart cluster head selection (SCHS), LEACH, energy efficiency, Network lifetime.*

I. Introduction

Wireless sensor network is composed of a large number of tiny sensors that communicate with each other and coordinate activities amongst themselves in a very orderly manner to achieve a particular purpose. The applications of sensor networks range from environmental monitoring, military surveillance, health care, home automation and so on. These sensors are made of very small battery with limited battery life and are deployed uncertainly and in such regions or areas where humans cannot reach hence these sensor node batteries cannot be replaced nor can they be charged [1]. Thus network lifetime of a wireless sensor network depends on the battery life of the sensors. Hence energy efficient clustering protocols play a crucial role in enhancing the performance of a Wireless sensor network.

II. Clustering

In clustering, the sensor nodes in a wireless sensor network are divided into different virtual groups, and they are allocated geographically adjacent into the same cluster according to some set of rules defined. These sensor nodes are assigned a different status or function, such as cluster head or cluster member [2].The cluster head is elected for each round and the rest cluster members senses the data and communicates it to the cluster head. The cluster head then aggregates the data and only informative data is forwarded to the base station.

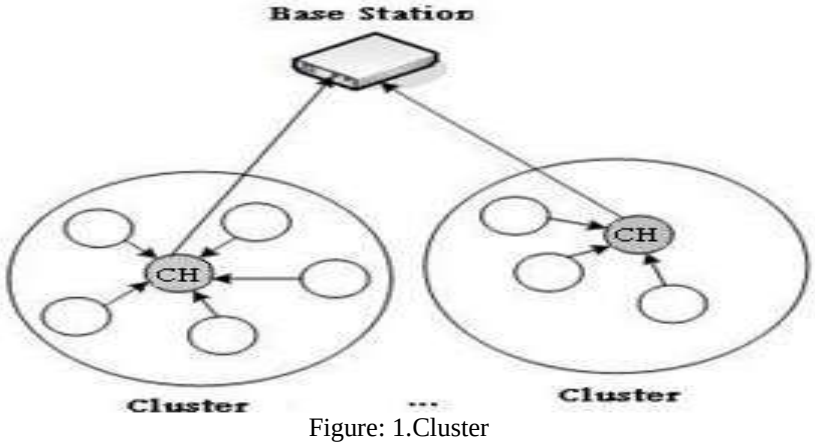

Figure: 1.Cluster

The communication between the cluster members and its head in known as intra cluster communication whereas the communication between the cluster heads in a wireless sensor network is known as inter cluster communication. More energy is consumed while transmitting as compared to sensing of the data [3].

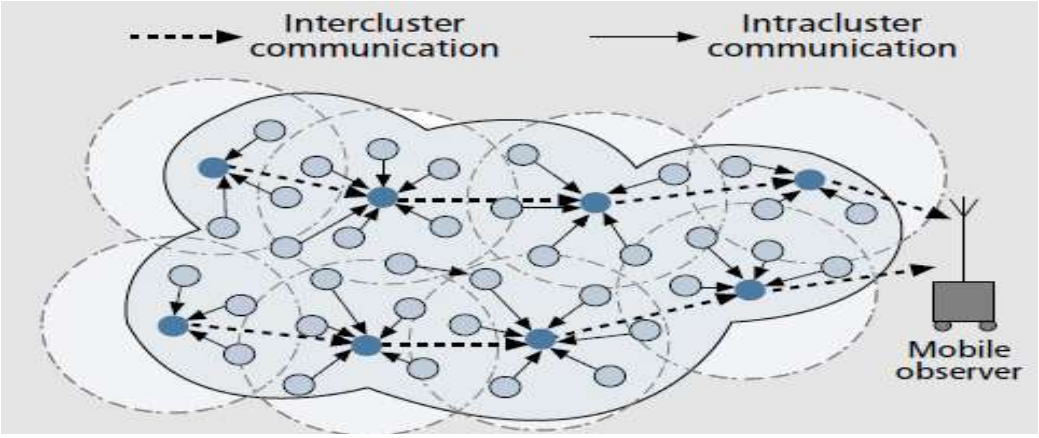

Fig: 2 Data flow in a clustered network [4]

Hence the energy is consumed more during communication. More the distance between the members and the associated cluster head for that round more will be the energy consumption. Thus placing the cluster head at proper place will help to reduce the communication distance between themselves and so in this paper a smart cluster head selection scheme is implemented on the LEACH protocol to increase its network lifetime by reducing the energy consumption, node death rate and ultimately contributing more data to be received at the base station

III. Low Energy Adaptive Clustering Hierarchy (Leach)

This is the first hierarchical cluster-based routing protocol for wireless sensor networks. LEACH arranges the nodes into small clusters and chooses one of them as the cluster-head. The other member nodes of that sensor network senses and send the information to its cluster head. The role of cluster head is to aggregate the information received from all the member nodes and sends it to the base station. This protocol is divided into rounds and each round consists of two phases. [5]

Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
Steady Phase
(1) Schedule Creation
(2) Data Transmission

3.1 Set-Up Phase:

Every member decides independently decides if it can become a cluster head for that particular round. This decision is based depending upon the threshold value T(n). The threshold value depends upon the desired percentage to become a cluster-head- p, the current round r, and the set of nodes that have not become the cluster-head in the last 1/p rounds, which is denoted by G.

The equation is as

$$T(n) = \begin{cases} \dfrac{P}{1 - P * (r \bmod \frac{1}{P})} & if\ n \in G \\ 0 & otherwise \end{cases}$$

Based on all messages received within the cluster, the cluster head creates a TDMA (Time Division Multiple Access) schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members every node wanting to be the cluster-head chooses a value, between 0 and 1. If this random number is less than the threshold value, T (n), then the node becomes the cluster- head for the current round. Then each elected cluster head broadcasts an advertisement message to the rest of the nodes in the network to invite them to join their clusters. Based upon the strength of the advertisement signal, the non-cluster head nodes decide to join the clusters. In the set-up phase, the cluster head nodes are randomly selected from all the sensor nodes and several clusters are constructed dynamically.

3.2 Steady Phase

During the steady phase, the sensor nodes i.e. the cluster members starts sensing data and sends it to their cluster-head according to the TDMA schedule. The cluster-head node, after receiving data from all the member nodes, aggregates it and then sends it to the base-station. After a certain time, the network again goes

back into the setup phase and new cluster-heads are chosen. Each cluster communicates using unique CDMA codes in order to reduce interference from nodes belonging to other clusters.
In the LEACH protocol, the cluster heads are not distributed uniformly hence there is a chance of cluster head getting located at the edges of the cluster as shown in Fig3.a.

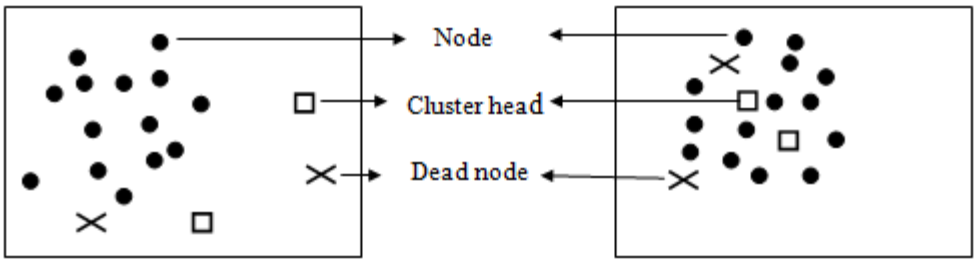

Figure: 3.a. Bad distribution of cluster head

Figure: 3.b.Expected distribution of cluster head

To overcome this drawback of non-uniform distribution of cluster head, a scheme known as smart cluster head selection is implemented on LEACH which almost allows having a good distribution as shown in Fig.3.b.

IV. Smart Cluster Head Selection (SCHS)

In this scheme only the inner nodes are eligible to become the cluster head. Due to this the intra-cluster communication distance is decreased and hence less energy is consumed in sending the data to the cluster head which is located in the inner area. This protocol also works in the same manner as the LEACH does, the only difference is that this scheme checks if the node is placed at the border area as shown in Fig.4.

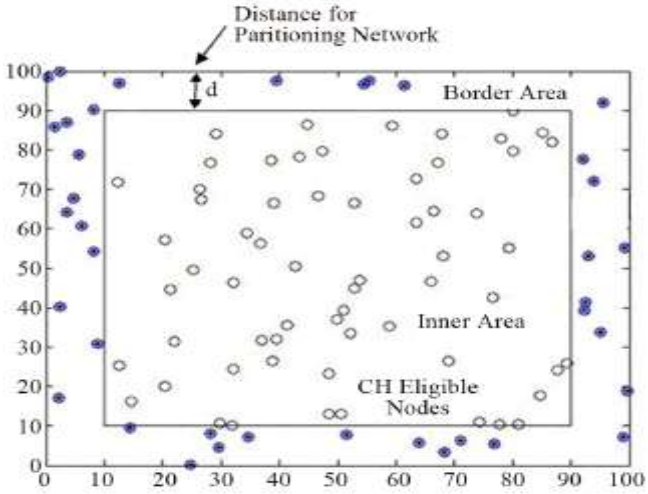

Figure: 4.Partioning of network area [3]

In the set-up phase, each node is checked whether it belongs to border area or to inner area. If a node belongs to inner area, it will participate for cluster head role and if it belongs to border area then it will be a member node. Cluster heads announce their status message and wait for the response from nodes. Cluster head constitute the TDMA schedule for the cluster members. In the steady phase, the nodes wake up as the time slot allotted arrives and sends the data to cluster head. To conserve energy nodes go back to sleep state and wait for the next wake up slot. Cluster head aggregates the data and sends the data to base station. The steady phase is repeats itself till the round time is over. After completion of round time, set-up phase is executed again. [3]

V. Energy Model

In wireless sensor network, nodes are deployed randomly but we make an assumption that in the radio channel the energy required to transmit and receive a message from one node to another node is same [6]. Thus for sending l-bit data at a distance d, the total energy utilized by the node is given by,

$$ETx(l,d) = \begin{cases} Eelec * l + Efs * l * d^2 & d \leq do \\ Eelec * l + Emp * l * d^4 & d \geq do \end{cases} \quad (1)$$

Where d_o=sqrt (E*fs*/E*mp*) denotes the threshold distance

E*elec* represents the energy consumption for transmitting and receiving data. E*fs* and E*mp* depends on the transmitter amplifier model. And the energy consumption for receiving that message is given by:

$$ERx(l) = Eelec * l \quad (2)$$

The energy dissipation model is shown in Fig: 5.

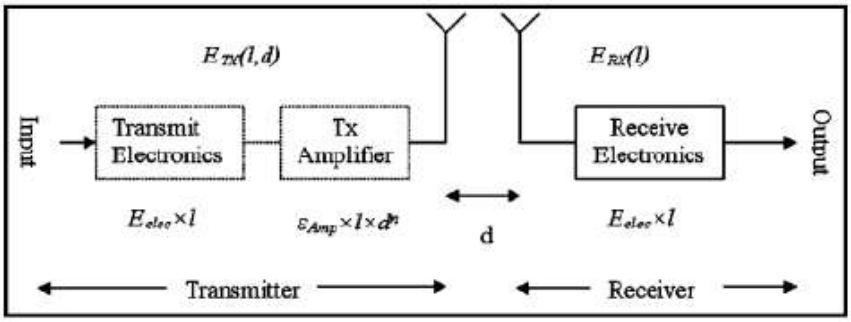

Figure: 5. Energy Dissipation Model

VI. Simulation Results

In the simulation, distance of 10 m is considered as border area for the smart cluster head selection scheme. The simulation parameters as well as the energy model parameters are kept similar for both LEACH and SCHS and are as shown in Table1**.**

Table1.

Parameter	**Value**
Network area	100m*100m
Base station	75m
Number of nodes	100
Number of clusters	10
Initial Energy	0.5J
E*fs*	10pJ/bit/m^2
E*mp*	0.0013pJ/bit/m^4
E*DA*	5nJ/bit/message
E*elec*=ET*x*=E*Rx*	50nJ/bit

Simulations helped to make a comparative study about the node death rate, energy consumption rate network lifetime and data units send to base station.

Node Death Rate:

It is defined as number of alive nodes with respect to time and from the Fig.6, the node death rate of SCHS is lower than LEACH.

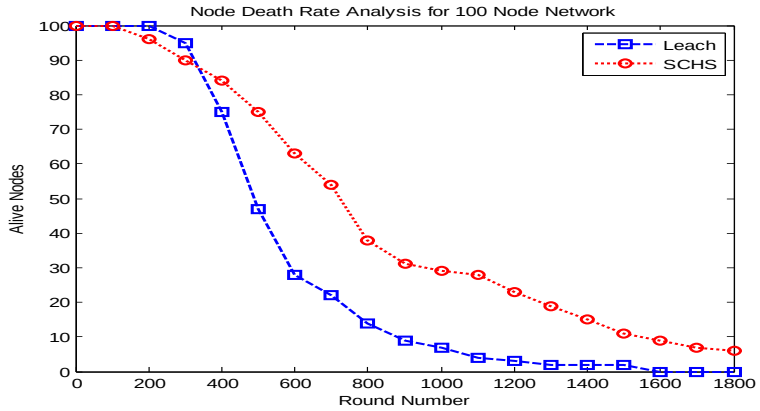

Figure 6

Energy Consumption Rate:

It is defined as energy consumption by the whole network with respect to time and the comparative graph from Fig.7 shows that the curve of SCHS is lower than the slope of LEACH which indicates that the energy consumption rate in case of SCHS is always lesser than LEACH.

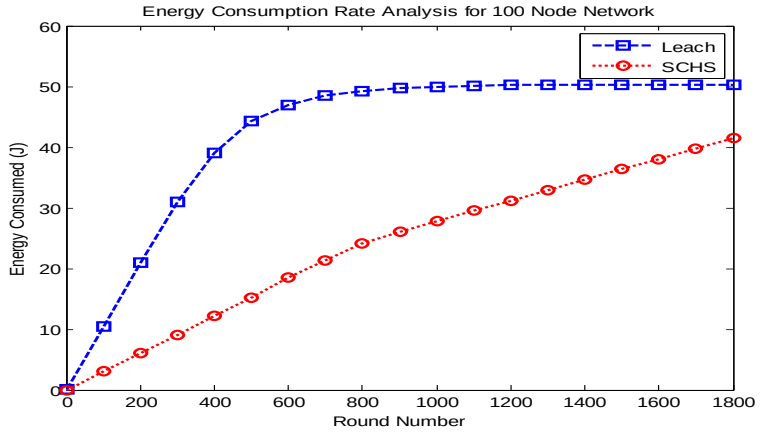

Figure 7

Data Units Received at Base Station:

This metric is important for data gathering networks. It states the data units received successfully at base station

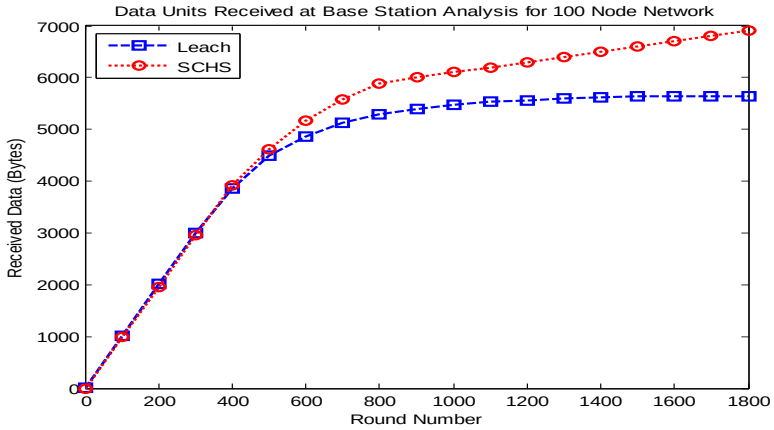

Figure 8

Network Lifetime:

Network lifetime is the main measure for an energy efficient approach

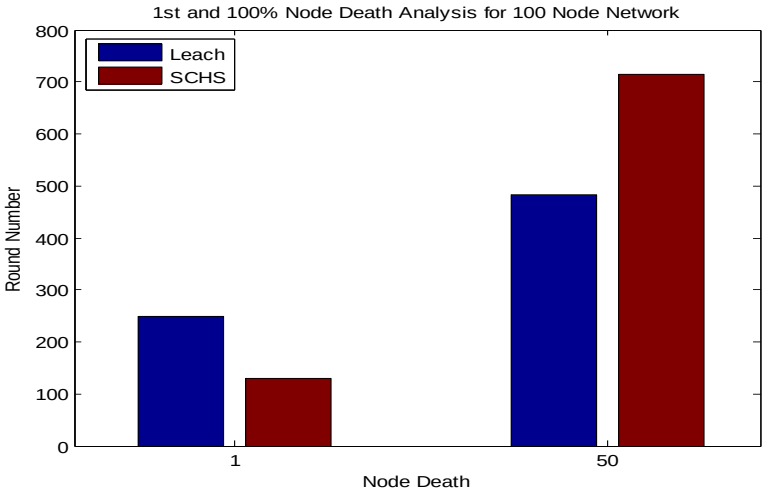

Figure 9

VII. Conclusion

Clustering approach are energy efficient protocols used in wireless sensor networks. More over reduction in the communication distances reduces the energy utilization. Proper cluster head selection places an important factor for enhancing the network lifetime of a wireless sensor network. In this paper, smart cluster head selection is implemented on the very first basic clustering protocol known as LEACH to analyze if there is any enhancement in the performance of the network parameters and simulation results shows that SCHS extended the lifetime of network since the node death rate and energy consumption rate of nodes is low for SCHS when compared with LEACH. As well as more data units are received at the base station in SCHS as compared to LEACH.

References

[1] Ning Xu, "A Survey of Sensor Network Applications," University of Southern California, Jan. 2004
[2] Asis Kumar Tripathy and Suchismita Chinara," Comparison of Residual Energy-Based Clustering" International Scholarly Research Network ISRN Sensor Networks Volume 2012, Article ID 375026, 10 pages doi:10.5402/2012/375026
[3] V.Pal,R .P.Yadav,"Cluster Head Selection Scheme For Data Centric Wireless Sensor Networks" , Volume 2, PP. 395 - 399, April 2013, Advance Computing Conference (IACC), 2013 IEEE 3rd International
[4] Ossama Younis,et.al.University of Arizona-"Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges"
[5] M. Bani Yassein, A. Al-zou'bi, Y. Khamayseh, W. Mardini," Improvement on LEACH Protocol of Wireless Sensor Network (VLEACH)"
[6] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, "Wireless Sensor Networks: A Survey," Com-puter Networks, Vol. 38, No. 4, 2002, pp. 393-422. doi:10.1016/S1389-1286(01)00302-4