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**RESEARCH ARTICLE**

# IMPLEMENTATION OF SMART CLUSTER HEAD SELECTION SCHEME ON LEACH PROTOCOL

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**ABSTRACT**

Energy efficiency in routing protocol is the major concern in the field of Wireless Sensor Networks. Improvement in the energy efficiency is the major task so to sustain the network lifetime of the wireless sensor network. Clustering protocols are one of the energy efficient approaches to extend the network lifetime. Low Energy Adaptive Cluster Hierarchy (LEACH) is one of the basic clustering protocols. This paper mainly focuses on the performance improvement of LEACH protocol when smart cluster head selection scheme (SCHS) is implemented on it.

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## INTRODUCTION

Wireless sensor networks are composed of large number of randomly deployed sensor nodes. These sensor nodes do the job of sensing the physical parameters where they are deployed in various environments [1]-[2].

These sensors are made of tiny processor embedded in it that senses the parameters and sends the collected data to a central data collector know as base station. The activities such as sensing the data and then sending it are carried out by the sensors itself but with a very limited energy battery sources which drain out after some time as these activities of sensing and sending are continued. Thus more of energy is consumed while transmitting the data to the base station. So the clustering algorithms are used in wireless sensor networks to reduce the energy consumption [3].

Clustering in Wireless sensor networks involves grouping nodes into small clusters and electing a cluster head of each formed cluster such that: The members of a cluster can communicate with their cluster head directly. A Cluster head can forward the collected data to the base station through other cluster heads. The communication between the cluster head and the cluster member is known as intra –cluster communication where as the communication between two cluster heads are known as inter – cluster communication. Thus placing the cluster head in appropriate place becomes very important so that the communication distance between them is decreased, thus ultimately reduces the energy consumption of the wireless sensor network . In this paper, a simple scheme of selecting the cluster head is done in such a way that reduces the intra - cluster communication distance. Simulation result shows that smart cluster head selection improves the performance of LEACH in terms of node death rate and energy consumption rate.

### *Clustering*

It is a scheme in which the sensor nodes in a wireless sensor networks are divided into different virtual groups. Each group is known as a cluster. Each cluster consists of a cluster head and cluster members.Fig.1.Shows the cluster formation.

In a cluster, normally a cluster head, serves as a local coordinator for its cluster, performing the duty of communicating between the cluster head and the rest cluster members.

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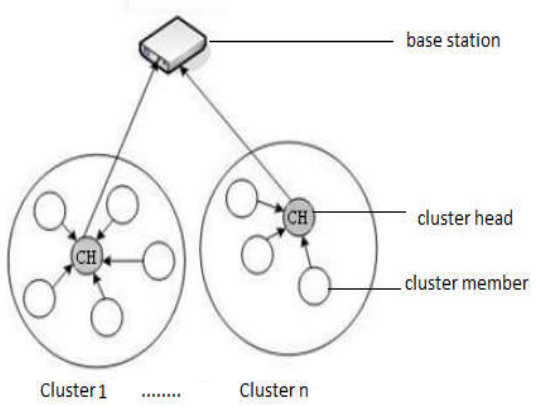


**Figure1** Cluster formation

This type of communication is known as intra-cluster transmission whereas the communication taking place within the cluster heads as well as the communication between cluster head and base station is known as inter communication[7]. Thus for a proper and efficient utilization of energy in a cluster sensor network depends on the proper selection of the heads. In simple words, cluster head selection plays significant role for energy efficiency of clustering algorithms. Fig: 2.describes the dataflow in a clustered architecture [4]

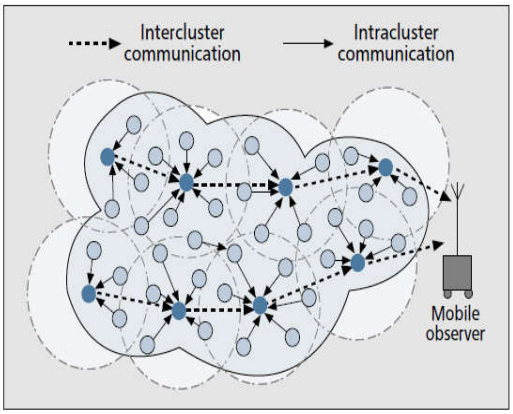


**Figure 2** Dataflow in a clustered architecture

### *Leach Protocol*

The most popular and first clustering protocol proposed for Wireless sensor network by W.R. Heinzelman is the LEACH [5]. LEACH forms clusters by using a distributed algorithm, where nodes make autonomous decisions, this phase is known as the set-up phase.

### *Set-Up Phase*

In this phase, each sensor node chooses a random number between 0 and 1. If this is lower than the threshold for node n, T (n) becomes the cluster head for that particular round. This is calculated by the following equation given as:

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

Where P is the desired percentage of cluster heads r is the current round ,G is the set of nodes that have not been cluster head in the last 1/P rounds. The nodes that are cluster heads for any particular round are not eligible for becoming cluster head in next 1/P rounds. All nodes have a chance to become cluster head to balance the energy spent per round by each sensor node.

### *Advertisement Phase*

After its election, in the advertisement phase each cluster head broadcasts an advertisement message to the other nodes and each one of the other nodes determines a cluster to belong to, by choosing the cluster head that can be reached using least communication energy.

### *Steady Phase*

The steady phase, data transmission takes place based on the TDMA schedule and the cluster-heads performs data aggregation through local computation, leading to energy consumption. After a certain period of time, again set-up phase will start. LEACH uses TDMA/CDMA to reduce intra-cluster and inter-cluster collisions [6]. The cluster formation process is given in a more clear view:

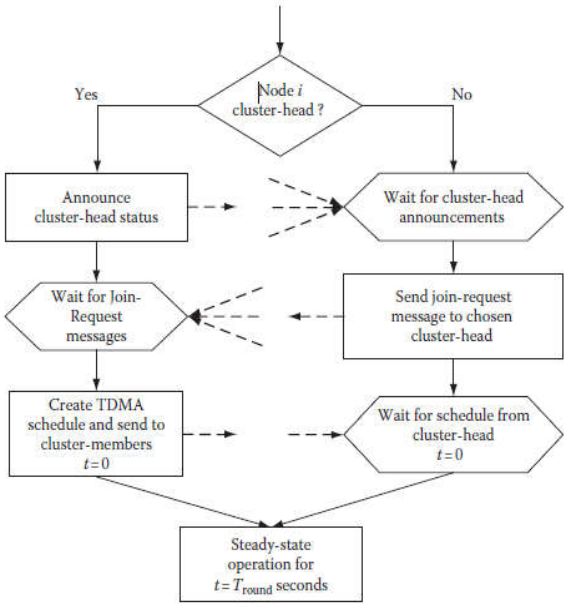


**Figure 3** Flowchart of the cluster formation process of LEACH

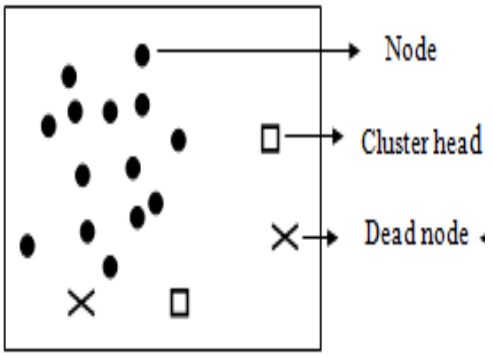


**Figure 4** Bad distribution of cluster head in LEACH

### *Disadvantage of Leach*

LEACH protocol allows random selection of some nodes to Become cluster head nodes for every particular round, and also

allows every node to become a cluster head. Since the cluster heads as in figure below are far away placed, the communication distance amongst them increases. Due to this rate of energy consumption is increased which leads to sudden depletion of network lifetime.

### *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 [3]. Thus for sending m-bit data at a distance d, the total energy utilized by the node is given by,

$$E_{Tx}(m,d) = E_{Tx-elec(m)} + E_{Tx-amp(m,d)}$$

$$E_{Tx(m,d)} = \begin{cases} m \times E_{elec} + (m \times E_{fs} \times d^2) & d < d_o \\ m \times E_{elec} + (m \times E_{amp} \times d^2) & d \geq d_o \end{cases}$$

Where $d_o$=sqrt ($E_{fs}/E_{amp}$ ) denotes the threshold distance$E_{elec}$ represents the energy consumption for transmitting and receiving data. $E_{fs}$ and $E_{amp}$ depends on the transmitter amplifier model. And the energy consumption for receiving that message is given by:

$$E_{Rx}(m) = m * E(elec)$$

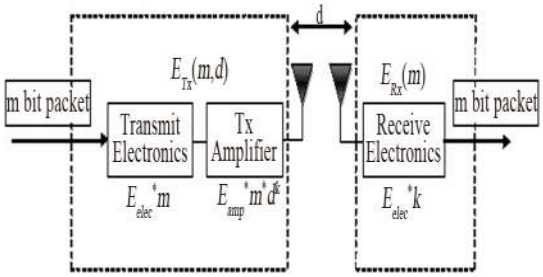


**Figure 5** Energy Dissipation Model

### *Smart Cluster Head Selection Scheme*

This scheme is implemented that contributes in selecting the cluster head (CH) that lies only in the inner area and does not allow the border nodes to become a cluster head as shown in figure 5.

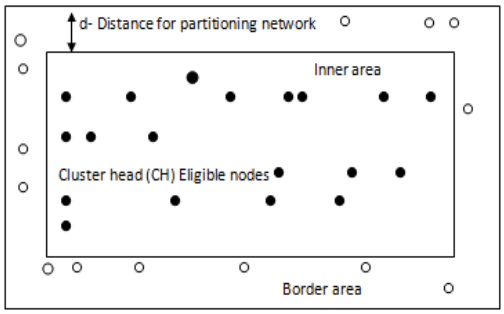


**Figure 6** Division of network area

Due to this approach, the nodes on the border area (which are far distance placed) are not eligible for being cluster head and only the inner nodes can become cluster head. Hence the intra communication distance between the member nodes and the cluster head is reduced. This improves the energy efficiency of the network.

### *Cluster formation process in SCHS*

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].

### *Simulation Results*

The simulation of SCHS and LEACH are carried out in MATLAB. Simulations helped to make a comparative study about the node death rate and the energy consumption rate. The parameters set are as shown in Table I.

**Table 1** Simulation Parameters

| Parameter | Value |
|---|---|
| Network area | 100m*100m |
| Base station | 75m |
| Number of nodes | 100 |
| Number of clusters | 10 |
| Initial Energy | 0.5J |

### *Node Death Rate*

Node death rate gives number of alive nodes at a time. The figure shows the node death rate of SCHS is lower than LEACH. The graph shows that as the rounds have increased number of alive node of LEACH have decreased compared to SCHS.

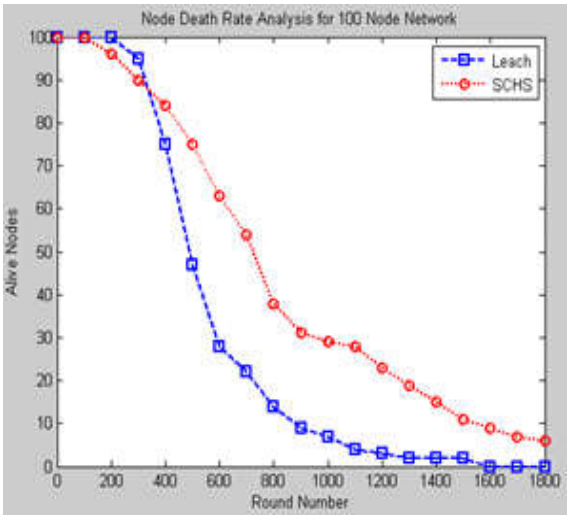


**Figure 7** Node Death Rate

### *Energy Consumption rate*

Energy consumption rate defines the energy consumption of whole network against the time .The figure shows the energy

consumption rate of both LEACH and SCHS.As the rounds have increased more energy was consumed by LEACH whereas less energy is consumed by the SCHS.This concludes that energy consumption by LEACH is more as compared to SCHS.

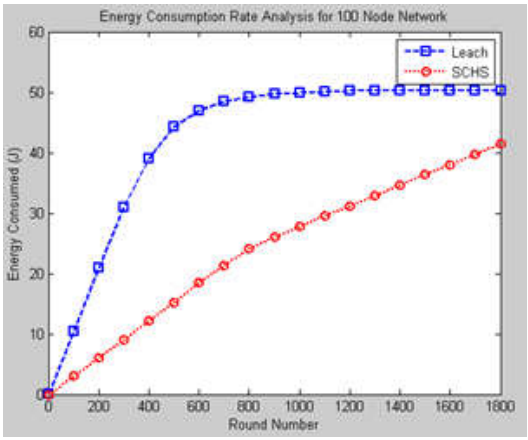


**Figure 8** Energy Consumption rate

## CONCLUSION

Cluster head selection marks a very important factor that helps to reduce the issue for energy efficiency of clustering schemes. This cluster head selection is implemented on the LEACH protocol. SCHS partition the network into two parts: border area and inner area. Cluster head selection is restricted to nodes of inner area nodes. SCHS reduces the intra-cluster communication distance. Hence this scheme which is implemented on the LEACH protocol has helped to enhance the performance of the network lifetime. Simulation analysis shows that SCHS extended the lifetime of network as node death rate and energy consumption rate of nodes is low for SCHS as compared to LEACH.

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