# Improving Accuracy in Cluster Based Routing Protocol LEACH for Wireless Sensor Network

Kalyan Krishna Awasthi, Arun Kumar Singh

**Abstract**— A combination of some sensor devices or nodes working together in coherence constitutes a Wireless Sensor Network. A Wireless Sensor Network first of all senses the data, if required performs the computational activity and finally facilitates the communication process. Various cluster-based routing protocols are used for this purpose and LEACH is one such protocol. The major issue with LEACH protocol is the re-selection of cluster-head once the node is dead or about to die. This paper presents a mechanism for improvement in the accuracy of LEACH protocol by avoiding unnecessary clustering.

**Index Terms**— Wireless Sensor Network, Cluster based Routing Protocol, LEACH, Energy Optimization

## 1 INTRODUCTION

A wireless sensor network is assumed as a computer network which maintains communication [1] amongst some nodes without any physical connectivity. The devices used for sensing can form a network amongst themselves to process data for transmission from source to destination. Every wireless sensor network is comprised of mainly four parts: a unit that is dedicated solely for the sensing purpose, a unit that is used to process the received data that is sensed by the sensing unit, a unit dedicated to the transmission and the reception of sensed or processed data and most importantly a power unit which generally comprises of a battery used to maintain the energy supply in the entire process [2]. The sensing unit used in a wireless sensor network consists of an analog to digital converter apart from a sensor. The analog to digital converter converts the sensed data into the digital form which is further sent to the processing unit. A sensing node performs a function of both a data originator and a data router. The communication range of every sensing node has a limit because increased range may result in high power consumption which can affect the efficiency and life of a wireless sensor network.

The design of a wireless sensor network is affected by some issues. There are various unique design challenges which govern the implementation of any wireless sensor network. The two most important constraints are the efficient energy utilization and proper node deployment [3]. The power source of the sensor nodes has a limit. The batteries used as power banks are either replaced or recharged once they get depleted. So power conservation is an important design aspect for any wireless sensor network [4]. The adaptive nature of the sensor nodes is another important aspect. The nodes need to adapt with the failures and maintain a functional synchronization with the neighboring nodes with minimum human intervention.

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## 2 RELATED WORK

Every sensing node has some energy. This energy is used when a node senses, processes, transmits or receives data. The basic objective of our work is to improve the efficiency of cluster based routing protocol LEACH by efficiently utilizing the energy involved in the complete process.

Different routing protocols use different tactics to attain the ultimate goal of energy optimization in wireless sensor networks. A detailed discussion of various approaches is carried in [1], and the comparative results are available.

LEACH has been the most popular routing protocol for wireless sensor networks. Distributed and centralized LEACH are the two variants of LEACH. In applications where we prefer localized communication between the nodes of a cluster over the communication of individual nodes with the base station, LEACH can give better results. In the same application if we need to increase the network lifetime LEACH-C is preferred. The simulation results of the same approach are discussed in [2] and found to be better than their predecessors.

Network lifetime is a major issue when we are dealing with a widespread sensor network. To increase the network lifetime, a new improved protocol Quadrature LEACH (Q-LEACH) is developed [3] which further optimized the results by partitioning the total area into four parts and thus providing better coverage.

The Quality of Service is assured in communications involving real-time data transmission using a new ROL/NDC protocol in [4]. The results were found encouraging.

The life of any network is determined by the time between the death of first node and last node. An increase in the network life is proposed in [5] which give significantly better results compared to LEACH and LEACH-C.

Security in a cluster-based wireless sensor network is enhanced by using two new protocols SET-IBS and SET-BOOS as proposed in [6] and the results obtained dealt with the orphan node problem in secure communication.

The energy issues and the ability to cope up with the faults is addressed in [7] by proposing a new algorithm called Distributed Fault-tolerant Clustering and Routing (DFCR) which significantly improved the tolerant ability of network.

A further improvement in the existing LEACH and LEACH-C protocols is proposed in [8] by selecting the nodes which become cluster-head dynamically by the energy left in any node at any instant. The simulation results showed that the network thus has a longer life.

A balanced distribution of energy amongst the nodes can improve the life of the network. An improved dynamic General Self-Organized Tree-Based Energy Balance protocol (GSTEB) proposed in [9] achieves the objective, and the results reflect the same.

All the latest developments in cluster-based routing protocols are summarized in [10], and a comparative study is carried out which facilitates the better selection of protocols based on applications.

The network lifespan and energy performance was enhanced in wireless sensor network using multi-hop cluster based routing approach in [11]. The result related to energy efficiency in the simulation is found competent and satisfactory.

It is important to study the nature and behavior of the network under various protocols which first maintains a routing table and then initiate the communication. These proactive protocols make sure that the routing table keeps on updating as the network dynamics changes [12].

The sensor network can alternatively topple between the active modes and sleep mode. In sleep mode, a node does not coordinate with any other node. An active mode may be a semi-active one or a fully active one depending on whether the node is allowed to sense, transmit, receive data or only relay the data [13].

## 3 PROPOSED ALGORITHM

Some LEACH algorithms are pre- existing. The present work modifies the pre-existing algorithm to improve the efficiency. A new mechanism is added into the LEACH algorithm to reduce the number of needed re-clustering. The algorithm has two phases: the setup phase and the steady phase. The proposed algorithm is mentioned as under:

1. Deploy WSN by initializing the parameters and selecting appropriate topology.
2. Select the cluster head in the sensor network by using cluster head selection mechanism.
3. Initialize the communication by sending the data packets.
4. Implement LEACH, a routing protocol used for finding an optimal solution in both Homogeneous and Heterogeneous WSN.
5. Implement optimal Leach (EN-LEACH).
6. Evaluate the performance and observe the comparative results.

When the node which is acting as cluster head stops working before the round time ends, the network switches the cluster-head to another node within the cluster. Another node with the highest energy becomes a new cluster-head.There is an optimal threshold value, which decides the selection of cluster-head. In our mechanism, we propose to fix the round time within a certain time range which is determined by the cluster which has the largest population in WSN. The round time equals the communication time of each node multiplied by the largest cluster population. Within the round time, if a cluster-head notifies energy below the threshold, the node within the cluster that has the largest energy takes over the task as temporary cluster-head before the end of the round. In this mechanism, the whole network does not need re-clustering. The proposed algorithm adopts a monitoring mechanism, which controls the energy of the cluster-heads, and a predefined threshold value. The purpose of this monitoring mechanism is to transfer cluster head based on the comparative result of the energy of cluster-head and known threshold value. If cluster head's energy is lower than the predefined threshold value, another loop is applied to replace cluster head by another node which poses the highest energy within the cluster. The new cluster head continues to cooperate with cluster members, and a continuous hoping is carried for the entire round of set period. EN-LEACH tends to minimize network energy consumption by efficient cluster head replacement after very first round and dual transmitting power levels for intra-cluster and cluster head to base station communication. In EN-LEACH, a cluster head will only be replaced when its energy falls below some threshold. This minimizes the routing load of the protocol.

## 4 EXPERIMENTS & RESULTS ANALYSIS

The simulation assumed that there are sensor nodes randomly and densely scattered in a two-dimensional square field, and the sensor network has the properties shown in figure 1.

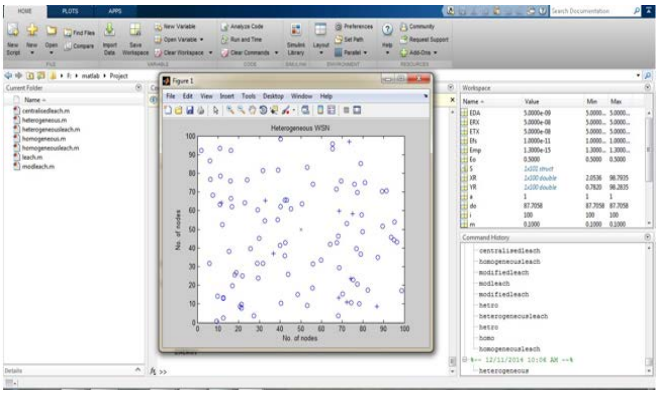


**Figure 1: Simulation Scenario for sensor nodes**

The network parameters set for the simulation are shown in Table 1.s

**Table 1: Network Parameters for Simulation**

| Parameters | Value |
|---|---|
| Network Area(meter) | 100x100 |
| Number of Nodes | 100 |
| Location of Sink | 50,50 |
| Cluster Radius | 30m |
| Sensing Radius | 10m |
| Initial Energy | 0.5 J |
| ETX | 50 nJ |
| ERX | 50 nJ |
| Eamp | 0.0013pJ/bit/m4 |
| Efs | 10pJ/bit/m2 |
| Eda | 5nJ/bit/signal |
| Number of Rounds | 6000 |
| Routing Protocol | LEACH |

Firstly, Homogeneous and Heterogeneous WSN is created, and the simulations are obtained for LEACH protocol. Further optimal LEACH (EN-LEACH), a variant of LEACH for WSNs is simulated. It shows an improvement in the network lifespan of WSN. The result and analysis conclude that EN-LEACH implemented on MATLAB improves the network lifetime. The results of non-dead nodes are shown in figure 2, figure 3 and figure 4.

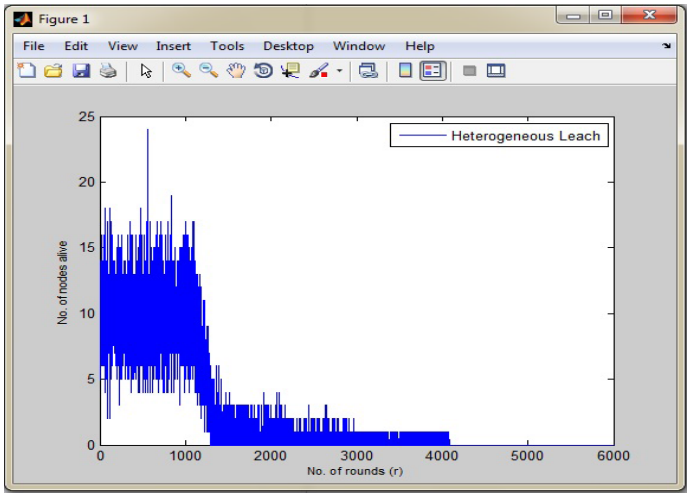


**Figure 2: Homogeneous LEACH- Non-Dead Nodes**

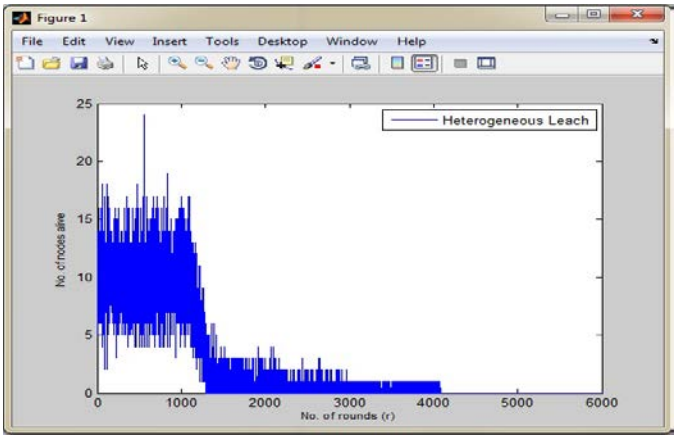


**Figure 3: Heterogeneous LEACH- Non-Dead Nodes**

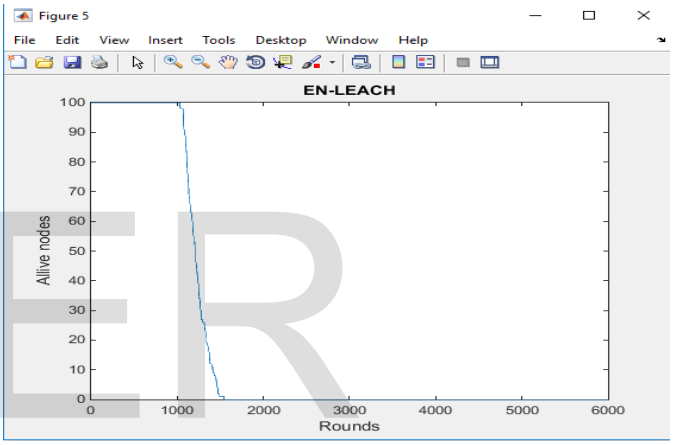


**Figure 4: EN-LEACH- Non-Dead Nodes**

## 5 CONCLUSION

Cluster based routing protocols are playing a vital role in wireless sensor networks. LEACH is the algorithm used for this purpose. The non-dead nodes are approximated in this algorithm, and a threshold value is generated to detect the probable dead nodes before they die. The simulation shows that the performance of the wireless sensor network is improved if we allow the hopping before the node dies. The result obtained can further be modified and provides a good scope for future work.

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