

Energy Aware Routing Using Improved LEACH Protocol

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Abstract In this research paper, we propose an energy efficient routing protocol low energy adaptive clustering hierarchy (LEACH) for wireless sensor networks. There are many sensing nodes and sink nodes in wireless sensor network system. Routing protocol and its improvement is a major issue in wireless sensor networks. Our proposed protocol is the modification of LEACH. The main idea is to increase the network life and maximizes the throughput. In this research paper, residual energy is to be considered for the selection of cluster head from various nodes. Time division multiple access (TDMA) technique is used for the communication between common nodes and cluster head. Cluster head (CH) chooses code to be used in its cluster and code division multiple access (CDMA) technique is used between clusters. The comparison between improved versions of LEACH protocol shows that multi-hop LEACH shows significant improvement than energy LEACH (E-LEACH).

Keywords Wireless Sensor Networks (WSN), Cluster Head (CH), E-LEACH (Energy Low-energy Adaptive Clustering Hierarchy), MR-LEACH (Multi-hop Routing LEACH)

1. Introduction

Wireless sensor network (WSN) consists of sensing nodes, base station (BS) and common nodes. Use of efficient energy is the main purpose of sensing nodes in WSN. The main objective of sensing nodes is to sense and aggregate the data towards BS. Comparing with non-cluster algorithm, cluster based algorithm are best with respect to the energy consumption [1-3]. In clustering algorithm LEACH is the best because it is more efficient. In LEACH, network is divided into cluster and run time is divided into rounds. All common nodes have equal probability to be selected as cluster head (CH), it makes balance the distribution of energy such as lifetime of network increases. We improve this protocol by multi-hop routing, data is routed so that routes have minim cost. In M-LEACH there is unequal clustering.

In M-LEACH, nodes with maximum energy perform advertisement, showing the willingness of becoming CH [2, 4]. CH selection depends on the receive strength of the signal. When CH is established, communication starts. Each node chooses its CH in order to arrive at BS. This procedure is continuing until a change is formed to reach the BS. TDMA schedule is used for scheduling network level. In our paper we enhance the LEACH protocol to E-LEACH and modified multi-hop LEACH. We develop comparisons between the traditional LEACH with modified protocols.

2. Leach Protocol

The main idea of LEACH is that whole network is divided into many clusters. There is an equal opportunity of each node to become a CH. The selection criterion for the nodes to become CH first time is random. The networks lifetime can be prolonged. LEACH also provides the concept of rounds. In LEACH protocol each round contains two states, *set up* and *steady state phases*. In cluster set up phase formation of clusters occurs in a self-adaptive mode [5-8]. In steady state, transformation of data takes place. The second state takes more time as compared to the first state, because it saves the protocol payload.

At initial state each sensor node wants to become a cluster head on the basis of suggested percentage of cluster heads in the network [4, 9]. The node decides by selecting a random number between 0 and 1. If this random number is less than $T(n)$, the node become a cluster head for this round. The threshold is given as:

$$T(n) = \frac{p}{1 - p \times (r \bmod p^{-1})}, \forall n \in G \quad (1)$$

$$T(n) = 0, \forall n \in G \quad (2)$$

where in (1), p is the percentage of the required cluster heads, r is the current round and G is the nodes that are not CHs during the last $1/p$ rounds. Each node will be a cluster head at some point within $1/p$ rounds. Using (1), every node becomes CH at any point within $1/p$ round. All those nodes that have been CHs during previous rounds cannot become CHs for $1/p-1$ round. A TDMA schedule is built up by cluster

head node sets up and transmits this schedule to nodes in CH and the set up phase is completed. The steady state phase is phase in which data is transmit among the cluster after the establishment of cluster heads in setup phase and when data is need to transmit, they will send an idle slots TDMA table to the cluster head.

3. Proposed Algorithm

In our proposed algorithm we present LEACH, energy –LEACH and multi-hop LEACH using improved hierarchy. In this improvement we suggest clustering concept and dividing into setup and data transfer phase. As discussed in Section 2, improved formula for the selection of CHs and then collect the aggregated data from common nodes toward BS. For such task, common nodes consume less energy than the cluster head. Some main issues in LEAH are as follows;

- 1) There is random selection of CHs in the LEACH because of the equal probability in the selection of CHs, some short coming occur in LEACH protocol [5]. There are many rounds in LEACH and there is equal probability of node with less energy and with more residual energy to become a cluster head. In case, a node having less energy become as cluster head, its energy will be consume and thus quickly died. Hence, lifetime of the whole network will be effected and shortened.
- 2) In LEACH protocol clusters are randomly formed and unequal distribution of clusters occur. This leads to the fact that divided clusters are not best. Some cluster heads will be in center of cluster has more energy than the others in edge of clusters. To overcome these issues our proposed protocols are:
 - Energy LEACH protocol
 - Multi hop LEACH protocol

4. Energy Leach Protocol

In E-LEACH selection criteria of CHs is improved. The two main categories of routing and transfer of information in network are discussed here. E-LEACH will select those cluster head which have none uniform initial energy level among other sensing node [10-15]. It can be determine that CHs which are required has to scale the total sensing node in order to minimize energy distribution in network. All the remaining aspects other than above two of E-LEACH are equal to traditional LEACH protocol as is shown in Fig. 1.

In E-LEACH after first round either a node will become a CH on not depend upon residual energy. In E-LEACH on the basis of probability each node turn as CH .i.e., there is random selection of CHs initially. In second round residual energy of each node is differ from each other. Thus node have more energy will become CH rather than less energy node.

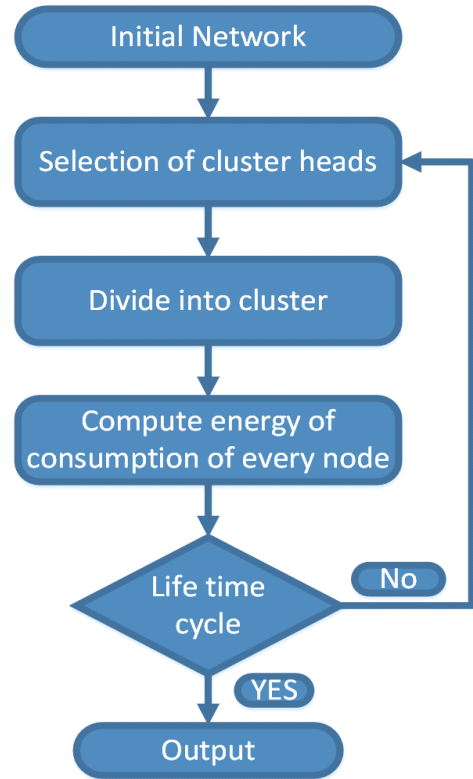


Figure 1. Flow chart of Energy LEACH protocol

5. Multi-hop Routing Leach Protocol

M-LEACH is same as the traditional LEACH protocol, the only difference is that in M-LEACH communication occurs from single hop to multi hop between CH and common node. The basic idea behind the M-LEACH is to reduce the energy consumption between cluster head and BS. On the basis of TDMA, every CH has its own schedule for all nodes [3].

In M-LEACH CHs collect the data in order to route data to BS [7, 16]. This process yield longer network life. This process of multi-hope clustering is provided in Table-1. In MR-LEACH approach variable number of intermediate nodes will forward data to the base station, depending on the location of the sensed data.

Table 1. MR Leach Protocol Algorithm

MR-LEACH	Description
Step1	In the first hop, each node send data towards CH
Step2	An efficient energy node is selected to forward packet from previous node.
Step3	After that nearest node is selected for data
Step4	In the last hop data is send to selected node

6. Simulation Results

The sensor nodes are randomly distributed in a square region. After the normal nodes are deployed, the base stations and nodes are fixed and the cluster-heads rotate randomly. The energy of node may be heterogeneous, but the energy restriction cannot be added, the energy and the storage capacity of the base station are not limited [8]. Nodes can communicate not only with each other in the network, but also with the base station directly. Node can adjust the wireless transmission power according to the distance. To evaluate the algorithm performance, we simulate both E-LEACH and Multi-hop LEACH by MATLAB.

The simulation parameters are provided in Tab-2. Figure 2 shows the performance of residual energy of LEACH protocol, our E-LEACH and MR-LEACH.

Table 2. Simulation parameters

Simulation Parameters	Values
Distance between member node and CHs	R
Average distance between two successive CHs	1.5R
Total sensing field	100m×100m
Average distance between node and CHs	135m
Total number of layers in network	N
When message is relayed using clustering hierarchy	[N/2]
In LEACH average distance between cluster head and BS =	110m
Data packet size = K	200 bits
The energy being dissipated to run the transmitter: E_{elec}	50nJ / bit
The energy dissipation of the transmission amplifier: \mathcal{E}_{amp}	100pJ / bit

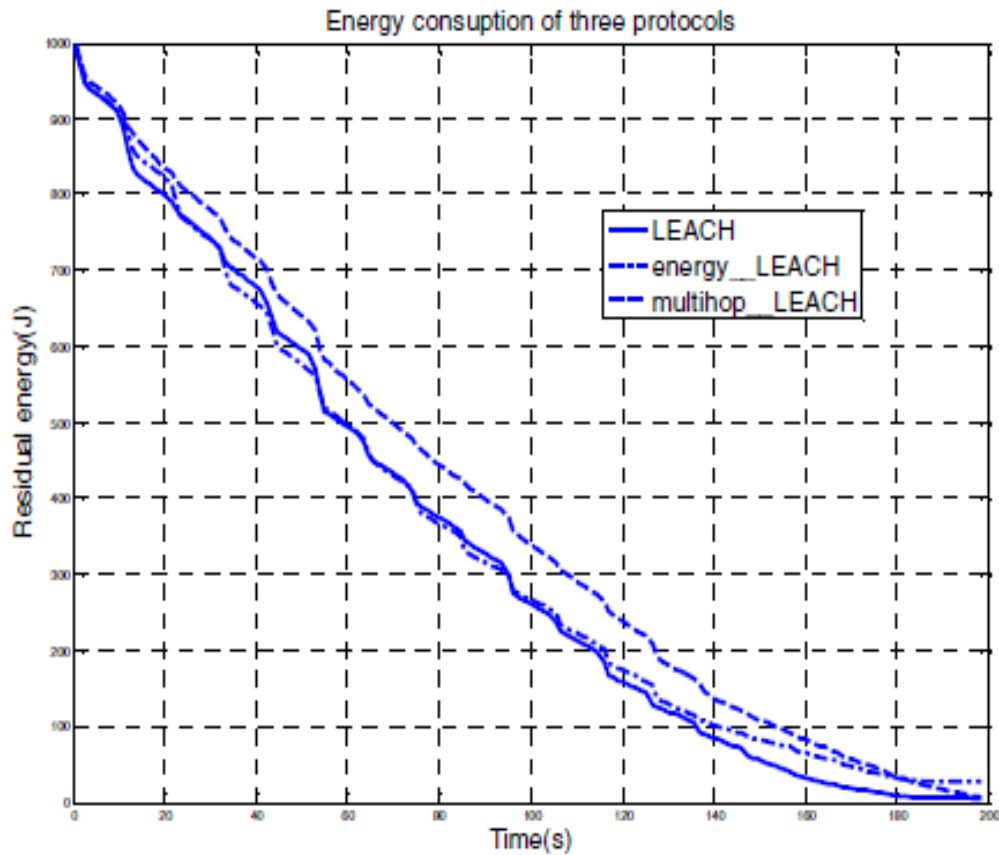


Figure 2. Residual energy versus time.

In Fig. 3, Multi-hop-LEACH protocol has more residual energy than LEACH and energy-LEACH protocols. Energy-LEACH protocol has the same residual energy as LEACH protocol in the beginning.

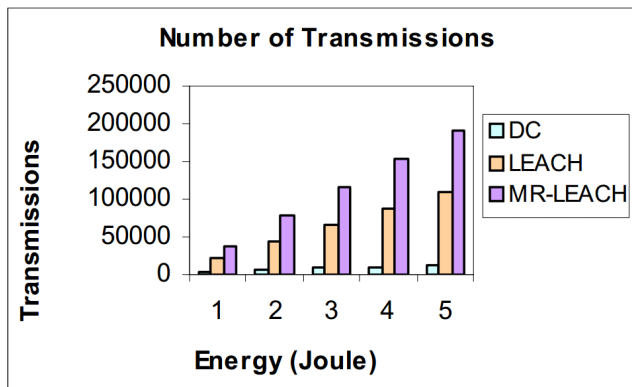


Figure 3. Histogram of Transmissions

7. Conclusions

In this paper, energy aware routing using improved LEACH protocol shows that M-LEACH protocol is better than the traditional LEACH and E-LEACH. We solve the issue of selecting CH, by equal distribution of each node becoming cluster head. The energy consumption issue is also solved by above two modified protocols. In our simulation result, we compare the LEACH with improved LEACH and we observe that the improved LEACH protocol achieves the balance of network's flow. In this research paper, energy efficiency is achieved by minimizing the packet size in multi-level data aggregation among cluster head and particular selection of CHs among nodes of cluster.

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