ENHANCEMENT OF NETWORK LIFETIME USING IMPROVED MOD-LEACH IN WSN

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ABSTRACT

Energy consumption is the core issue in wireless sensor networks (WSN). To generate a node energy model that can accurately reveal the energy consumption of sensor nodes is an extremely important part of protocol development, system design and performance evaluation in WSNs. In this paper, by studying component energy consumption in different node states and within state transitions, the authors present the energy models of the node core components, including processors, RF modules and sensors. One of the major issues in wireless sensor networks is developing a routing protocol which has a significant impact on the overall lifetime of the sensor network. This paper presents a new version of LEACH protocol called MODLEACH which aims to reduce energy consumption within the wireless network. The proposed protocol uses simulation model. The simulation tool we used for the purpose is MATLAB. Simulation results show that the New Improved MODLEACH routing protocol reduces energy consumption and increases the total lifetime of the WSN compared to the LEACH protocol.

Keywords

Leach, Wireless, Sensor, Networks, Protocol, Cluster Head, Threshold, WSN.

INTRODUCTION

Wireless Sensor Network (WSN) is a class of wireless adhoc networks which consists of spatially distributed autonomous sensor nodes to monitor physical or environmental conditions, such as temperature, sound, pressure, etc at different locations. Energy consumption is the core issue in wireless sensor networks because nodes are battery operated. It is desirable to make these nodes as cheap and energy-efficient as possible and rely on their large numbers to obtain high quality results. Consequently many protocols have been proposed in order to minimize the energy consumption of these nodes. Wireless Sensor Network (WSN) is a type of wirelessAd-Hoc network in which large numbers of sensor nodesare deployed in the application field [1]. Sensor nodes are inexpensive and low power devices. Each node consists of four main units: Sensing Unit, ProcessingUnit, Communicating Unit and Power Unit. In sensingunit one or more sensors are placed to sense differentenvironment parameters like sound, temperature,vibration, pressure, motion and etc., based on applicationrequirement. Sensed data's (analog or digital) areprocessed and aggregated in the processing unit.

The need for energy-efficient infrastructures for sensor networks is becoming increasingly important. Wireless sensor networks are networks consisting of many sensor nodes that communicate over a wireless media. A sensor node is equipped with a sensor module, a processor, a radio module and a battery. Since the battery limits the lifetime of the sensor nodes it also limits the lifetime of the sensor network, thus energy efficiency is a major issue for sensor networks.
An important goal in many sensor networks is to monitor an area as long time as possible. Hence, it is important to distribute energy consumption evenly across the network. When the energy consumption is evenly distributed, the major part of the sensor nodes will stay alive approximately equally long time. This enables continued information gathering throughout the whole network area during the lifetime of the network. The most power-consuming activity of a sensor node is typically radio communication [10]. Hence, radio communication must be kept to an absolute minimum. This means that the amount of network traffic should be minimized. In order to reduce the amount of traffic in the network, we build clusters of sensor nodes as proposed in e.g. [1, 3, 9]. Some sensor nodes become cluster heads and collect all traffic from their respective cluster. The cluster head aggregates the collected data and then sends it to its base station. When using clustering, the workload on the cluster head is thus larger than for non-cluster heads. The cluster heads should therefore be changed several times during the lifetime of the sensor network in order to distribute the extra workload and energy consumption evenly. Sensor nodes are deployed for pervasive computing. Each of the sensor node is capable of limited amount of processing, upon coordination with the other node's information, gains the power to accomplish complex functionalities. Thus in Wireless Sensor Network (WSN), a collection of the sensor coordinates well with each other, using wireless communication link, in order to pursue some specific tasks.

RELATED WORK

LEACH (Low-Energy Adaptive Clustering Hierarchy) [3] is a TDMA cluster based approach where a node elects itself to be cluster head by some probability and broadcasts an advertisement message to all the other nodes in the network. A non cluster head node selects a cluster head to join based on the received signal strength. Being cluster head is more energy consuming than to be a non cluster head node, since the cluster head needs to receive data from all cluster members in its cluster and then send the data to the base station. All nodes in the network have the potential to be cluster head during some periods of time. The TDMA scheme starts every round with a set-up phase to organize the clusters. After the set-up phase, the system is in a steady-state phase for a certain amount of time. The steady-state phases consist of several cycles where all nodes have their transmission slots periodically. The nodes send their data to the cluster head that aggregates the data and send it to its base station at the end of each cycle. After a certain amount of time, the TDMA round ends and the network re-enters the set-up phase.

LEACH-C (LEACH-Centralized) [2] is a variant of LEACH that uses a centralized cluster formation algorithm to form clusters. The protocol uses the same steady-state protocol as LEACH. During the set-up phase, the base station receives information from each node about their current location and energy level. After that, the base station runs the centralized cluster formation algorithm to determine cluster heads and clusters for that round. LEACH-C uses simulated annealing [4] to search for near-optimal clusters. LEACH-C chooses cluster heads randomly but the base station makes sure that only nodes with "enough" energy are participating in the cluster head selection. Once the clusters are created, the base station broadcasts the information to all the nodes in the network. Each of the nodes, except the cluster head, determines its local TDMA slot, used for data transmission, before it goes to sleep until it is time to transmit data to its cluster head, i.e., until the arrival of the next slot.

A further development is LEACH-F (LEACH with Fixed clusters) [2]. LEACH-F is based on clusters that are formed once - and then fixed. Then, the cluster head position rotates among the nodes within the cluster. The advantage with this is that, once the clusters are formed, there is no set-up overhead at the beginning of each round. To decide clusters, LEACH-F uses the same centralized cluster formation algorithm as LEACH-C. The fixed clusters in LEACH-F do not allow new nodes to be added to the system and do not adjust their behavior based on nodes dying.

In [4], Two-level LEACH (TL-LEACH) is proposed to solve the above mentioned issue. A CH collects the data from nodes and forwards the aggregated data to another CH, which is placed between base and first CH. It reduces transmission cost and another CH act as a relay node. Paper [5], proposed alternate solution called Multi-hop LEACH, which converts one-hop communication to multi-hop communication. But it adds two overloads to the network: first one is the additional routing overload and second is the relay nodes nearby base station that gets overloaded and chance to drain quickly.

V-LEACH in [6] introduces vice-cluster heads, i.e., alternate CH. IT consists of a Ch node, Vice –CH node and member nodes. If CH fails due to low energy, then vice-CH takes charge and continues the transmission without braking the network. But it overloads an additional node (vice-CH) other than CH to main all information including members list and data. This will reduce the life time of the node. In large scale network, paper [2] identifies the hidden area, which far away from base and has high Minimum Reachable Power (MRP). The identified zone is called Far-Zone and it's separated from main cluster, after formation of the current round of cluster. It selects Zone head, which is responsible to collect and forward information from that zone to nearby cluster head. It avoids breakdown of specific area (hidden zone) from the network.

CLUSTERING PARAMETERS

- **Number of clusters (cluster count):** In most recent probabilistic and randomized clustering algorithms the CH election and formation process lead naturally to variable number of clusters. In some published approaches, however, the set of CHs are predetermined and thus the number of clusters are preset. The number of clusters is usually a critical parameter with regard to the efficiency of the total routing protocol.

- **Intracluster communication**: In some initial clustering approaches the communication between a sensor and its designated CH is assumed to be direct (one-hop communication). However, multi-hop intracluster communication is often (nowadays) required, i.e., when the communication range of the sensor nodes is limited or the number of sensor nodes is very large and the number of CHs is bounded.

- **Nodes and CH mobility:** If we assume stationary sensor nodes and stationary CHs we are normally led to stable clusters with facilitated intracluster and intercluster network management. On the contrary, if the CHs or the nodes themselves are assumed to be mobile, the cluster membership for each node should dynamically change, forcing clusters to evolve over time and probably need to be continuously maintained.

- **Nodes types and roles:** In some proposed network models (i.e., heterogeneous environments) the CHs are assumed to be equipped with significantly more computation and communication resources than others. In most usual network models (i.e., homogeneous environments) all nodes have the same capabilities and just a subset of the deployed sensors are designated as CHs.

- **Cluster formation methodology:** In most recent approaches, when CHs are just regular sensors nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination. In few earlier approaches a centralized (or hybrid) approach is followed; one or more coordinator nodes are used to partition the whole network off-line and control the cluster membership.

- **Cluster-head selection:** The leader nodes of the clusters (CHs) in some proposed algorithms (mainly for heterogeneous environments) can be preassigned. In most cases however (i.e., in homogeneous environments), the CHs are picked from the deployed set of nodes either in a probabilistic or completely random way or based on other
- more specific criteria (residual energy, connectivity etc.).

OBJECTIVES

• To modify existing MOD LEACH algorithm by considering parameters like residual energy, number of neighbors and separation distance between the two clusters.
• To improve the network lifetime by reducing the energy spent in transmission.
• To compare the performance of the proposed algorithm with the existing algorithms.

METHODOLOGY

This paper describes an Intra Cluster Multi-hop Routing based on modifying parameters like soft threshold and hard threshold available in the MODLEACH. In this algorithm, cluster heads collect data from the member nodes, aggregate and transmit the data to route node. Route node is selected based on shortest distance between node and cluster head. Finally, route nodes forward received data to base station (BS) as shown in Figure 1.

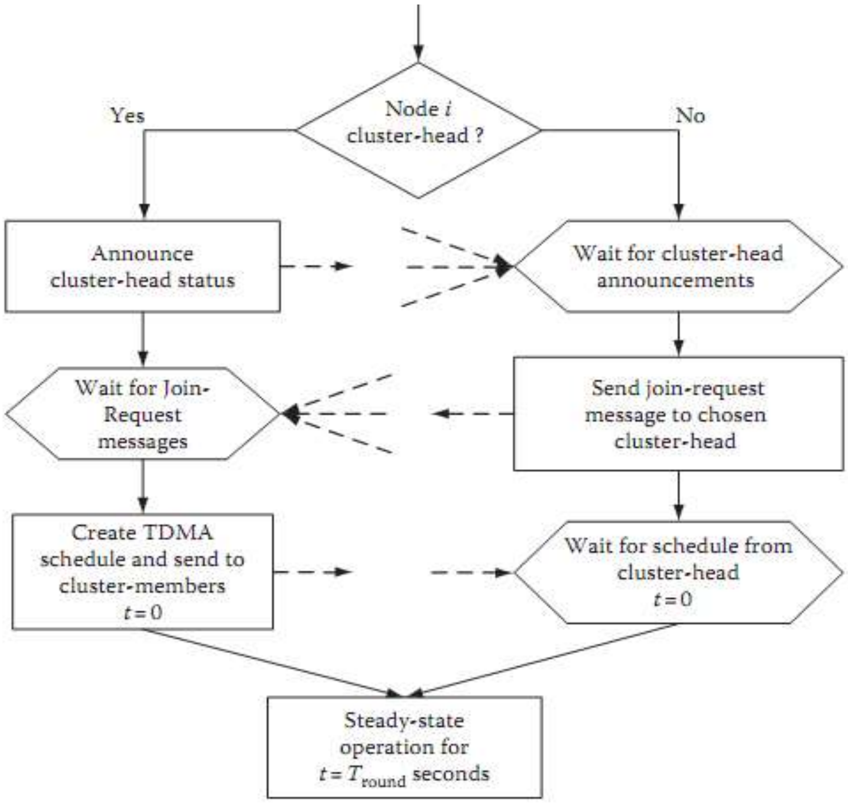


Figure 1. Flowchart of Cluster Formation

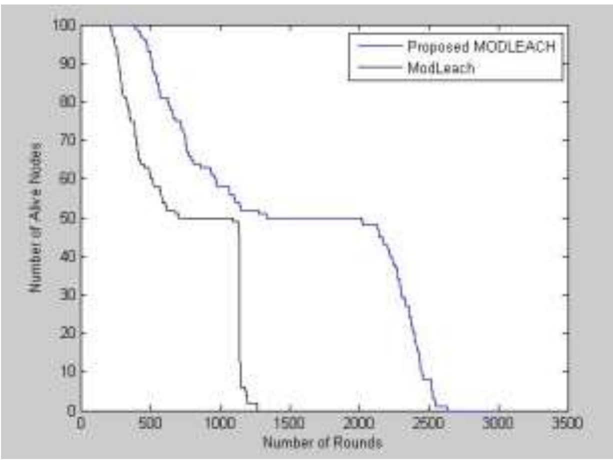
- BS will advertise the CH's to all the nodes.
- Nodes will come to know whether they are CH or not.
- All the CH's will convey (advertise) to the nodes in their respective zones
- Depending upon the min distance, the clusters will be formed.
- Now near CH's will advertise to the far zone cluster heads.
- Minimum distance relay will be chosen for data transmission
- We have also applied the Threshold values that will decide when the node will send the data or not.
- We have also calculated the threshold values when the cluster heads are dead according to its FND and LND in HT and ST.
- Transmission power levels have been adjusted according to intra cluster transmission, inter cluster transmission or cluster head to base station transmission.
- Different network areas have been used for experimental purposes

SIMULATIONS AND RESULTS

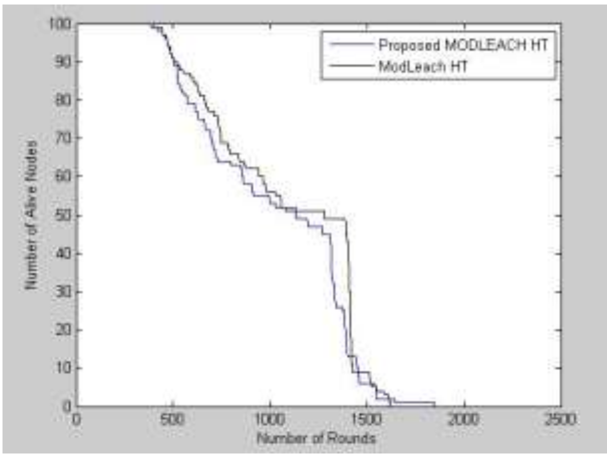
In this section, we present simulation result for Modleach, ModLeach-HT and Modleach-ST for three-level heterogeneous WSNs using MATLAB. WSNs consist of N = 100 nodes which are randomly placed in a field of dimension 100m× 100m. For simplicity, we consider all nodes are fixed and ignore energy loss due to signal collision and interference between signals of different nodes that are due to dynamic random channel conditions. The performance metrics used for evaluation of clustering protocols for heterogeneous WSNs are stability period, lifetime of the heterogeneous WSNs and data packets which are successfully sent to BS. Matlab software MATLAB (matrix laboratory), a numerical computing environment and fourth-generation programming language has been used to simulate the result. The result refers to the measurement of life time. Life time of network is related to no. of alive nodes, no. of dead nodes, and rate of packet transmission and how long time cluster of nodes is formed in network. System which is proposed here gives good output in all four parameters. To validate the performance of modified LEACH protocol, we simulate the protocol and utilize a network with 100 nodes randomly deployed between (x=0, y=0) and (x=100, y=100).

Table 1. Simulation Parameters

Parameter	Value
N (Number of nodes)	100
P (Probability Vector)	0.1
Eo (Initial Energy)	0.5
ETX (Energy loss on Transmission)	50*0.000000001
ERX (Energy loss on receive)	50*0.000000001
Efs (Energy loss on forward)	10*0.000000000001
Emp (Energy loss on cluster switch)	0.0013*0.000000000001
EDA (Energy loss on delay)	5*0.000000001
Rmax (Number of round)	5000
Do (Distance vector)	sqrt(Efs/Emp)



(a)



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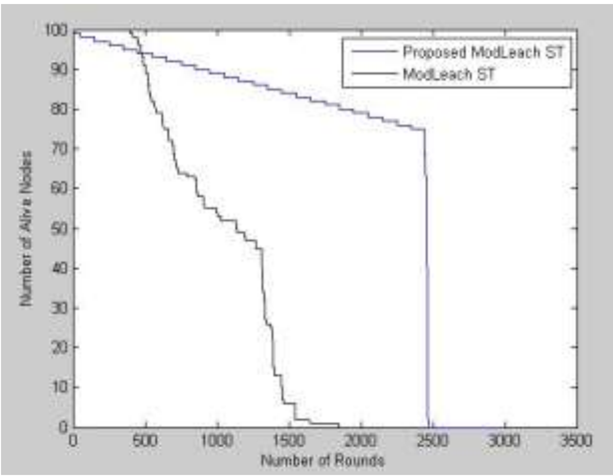

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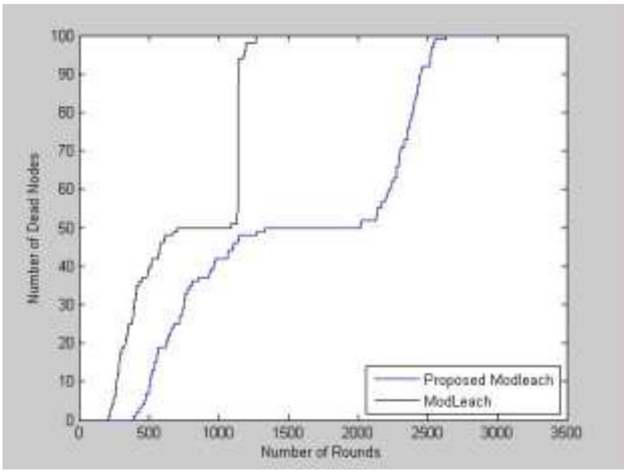

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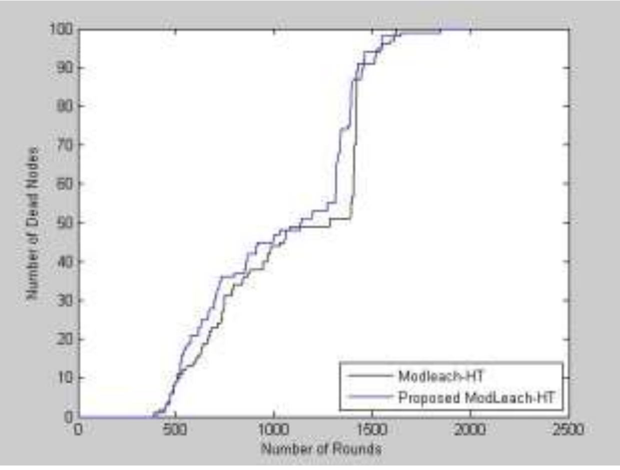

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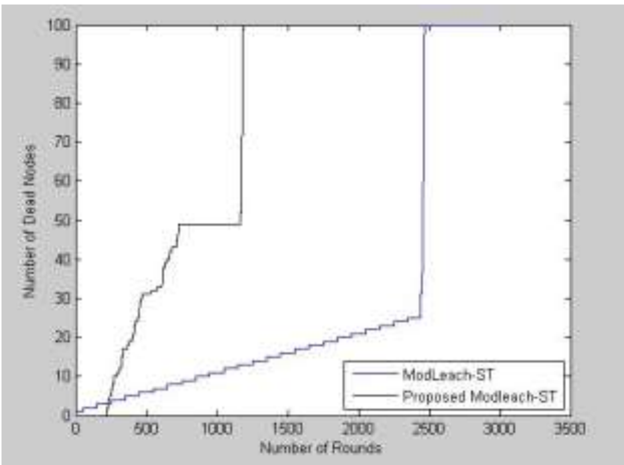

(f)

Figure 2. Various Results showing No of Dead and Alive Nodes

In the Figure 2, we have plotted the graphs of dead nodes and alive nodes. Various comparisons have been between the existing modleach and the proposed modleach work. We have also compared different threshold values like soft and hard threshold of the modleach. The results are far much better in the proposed work than in the existing work. In the below mentioned Table 2, we have listed different values of First Node Dead (FND) and Last Node Dead(LND) for the different number of nodes and different network areas.

Table 2. Network Lifetime values

N/w lifetime according to HT by changing area			
NODES	AREA	FND	LND
50	100,100	0.123	0.2367
100	90,80	0.2461	0.468
200	80,70	0.389	0.3121
300	70,60	0.4121	0.5682
400	75,85	0.5345	0.7307
500	95,85	0.6136	0.8754

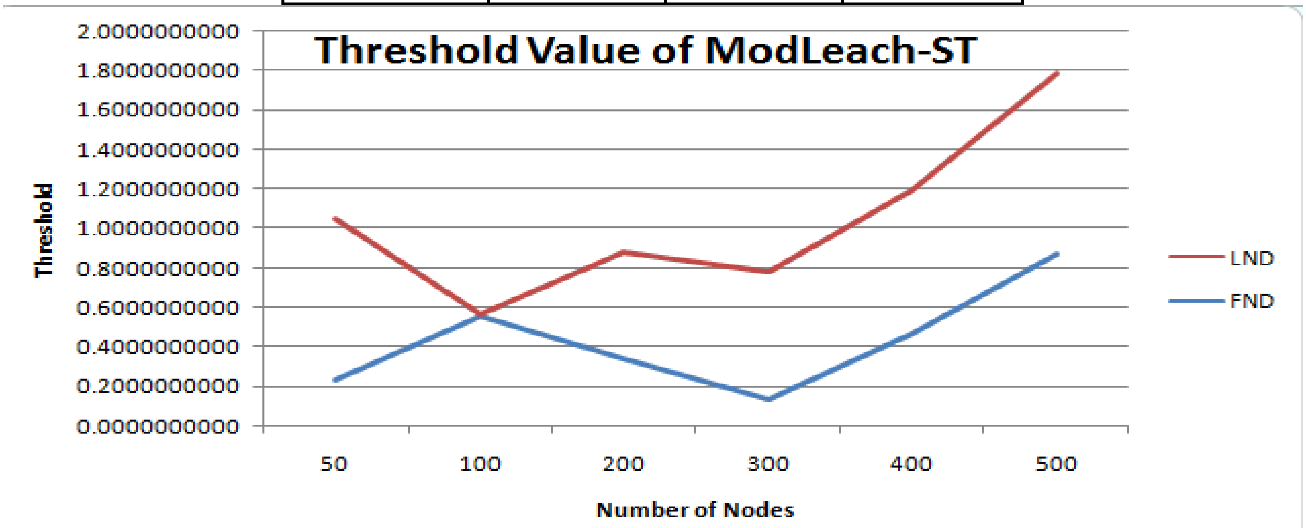

Figure 3. Modleach-ST Threshold Value

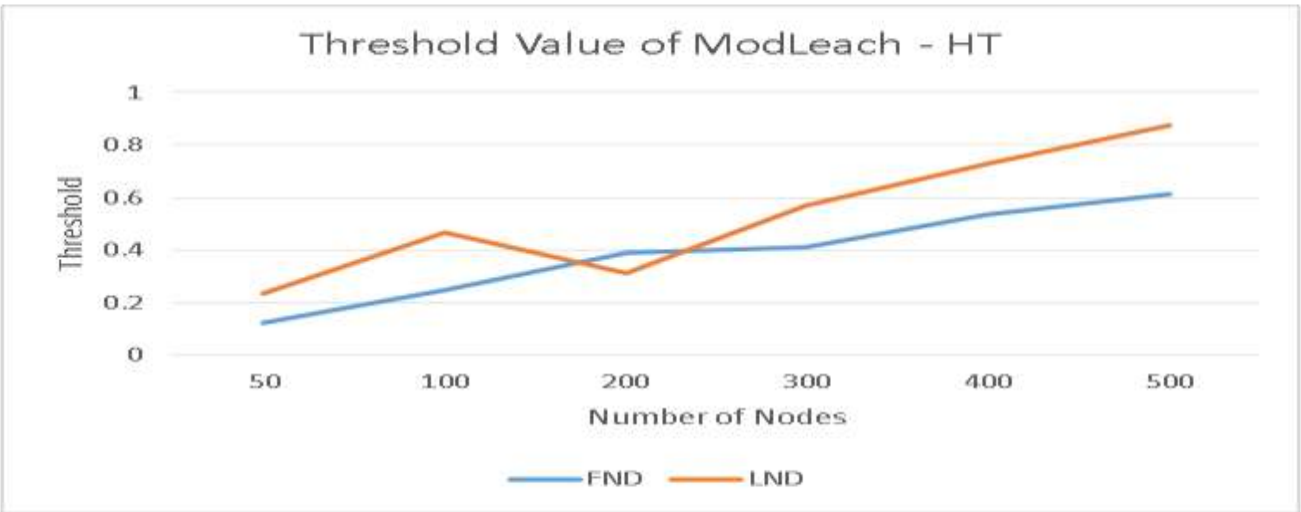

Figure 3. Modleach-HT Threshold Value

CONCLUSION

In this paper, we have presented a new approach for minimizing the total energy consumption of wireless sensor network applications based on the soft and hard threshold for improving the overall network lifetime. By analyzing the results and graphs, we have reached upto the solution that the by changing the threshold value in the MODLEACH, MODLEACH-HT and MODLEACH-ST, the overall lifetime of the complete network can be improved.

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