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ENHANCING THE PERFORMANCE OF LEACH PROTOCOL IN WIRELESS SENSOR NETWORKS

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ABSTRACT

Low Energy Adaptive Clustering Hierarchy protocol is one of the clustering routing protocols in wireless sensor networks which uses distributed cluster formation & randomized rotation of the cluster head to minimize the network energy consumption and increase network life. In this paper we propose an algorithm which is modified version of existing protocol and is based on selection of cluster heads and vice-cluster heads on the basis of energy, residual energy & distance parameters. Simulation results show that the New Improved routing protocol reduces energy consumption and increases the total lifetime of the network compared to the existing protocol.

KEYWORDS
Wireless sensor networks; LEACH protocol, Energy efficiency, Routing protocol.

1. INTRODUCTION

Wireless Sensor Networks (WSN) has many applications in military, medical, meteorological, agricultural, industrial and aerospace areas. A Wireless Sensor Networks (WSN) is a set of hundreds or thousands of micro sensor nodes that have capabilities of sensing, establishing wireless communication between each other and doing computational and processing operations. These nodes are typically tiny, disposable, low-power, and usually derive their energy from attached batteries.[1] A sensor node is made up of four basic components: a sensing unit, a processing unit, a transceiver unit and a power unit. These sensor nodes can self organize to form a network and can communicate with each other in a wireless manner. Each self-organized node collects data from the environment, exchanges these data with other nodes and sends the final information to the sink node or the base station. Energy plays an important role in wireless sensor networks because of the sensor nodes being battery operated. In order to save energy dissipation caused by communication in wireless sensor networks, it is necessary to schedule the state of the nodes, changing the transmission range between the sensing nodes, use of efficient routing and data routing methods and avoiding the handling of unwanted data. In general, routing in WSNs [4] can be divided into flat, hierarchical, and location based routing depending on the network structure. Hierarchical Routing is the well-known technique with special advantages related to scalability and efficient communication. LEACH, PEGASIS, TEEN [6] and APTEEN use this technique for routing. In hierarchical architecture, higher energy nodes can be used to process and send the information, while low-energy nodes can be used to perform the sensing in the proximity of the target.

LEACH (Low- Energy Adaptive Clustering Hierarchy) is a clustering based protocol that minimizes energy dissipation in sensor networks. However, LEACH outperforms classical clustering algorithms by using adaptive clusters and rotating cluster-heads, allowing the energy requirements of the system to be distributed among all the sensors. Instead, when the cluster-head dies, the cluster will become useless because the data gathered by cluster nodes will never reach the base station. So, there is a requirement to improve LEACH protocol to enhance the performance. In this paper we propose an Improved Leach Protocol that further enhances the Power consumption, simulation results bring out that our protocol outperforms Leach protocol in terms of energy consumption and increases the total lifetime of the WSN.

2. LEACH PROTOCOL

Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol for sensor networks was proposed by W. R. Heinzelman et.al [3] which minimizes energy dissipation in sensor networks. LEACH is a very famous hierarchical routing algorithm for sensor networks which make clusters by using a distributive algorithm, where nodes make autonomous decisions without any centralized control. It is a self-organized, adaptive clustering protocol, in which the sensor nodes are grouped into clusters to achieve network scalability. Every cluster is often lead by a node called Cluster Head (CH)which can be elected by the sensor nodes based on some criterion or may be pre-assigned by the network designer. The Cluster Head (CH) is responsible for creating and manipulating a TDMA (Time division multiple access) schedule and sending aggregated data from nodes to the BS (Base Station) where these data is needed using CDMA (Code division multiple access).

The LEACH operates based upon rounds. Each round includes two stages: 1. Cluster-constructing
(Set-up phase) 2. Working steadily (Steady-state phase)

2.1 SET-UP PHASE: During this phase, each node decides whether or not to become a cluster head (CH) for the current round. This decision is based on choosing a random number between 0 and 1, if number is less than a threshold T(n), the node become a cluster head for the current round. The setup phase [4] is further divided into

- Advertisement Phase
- Cluster set-up phase

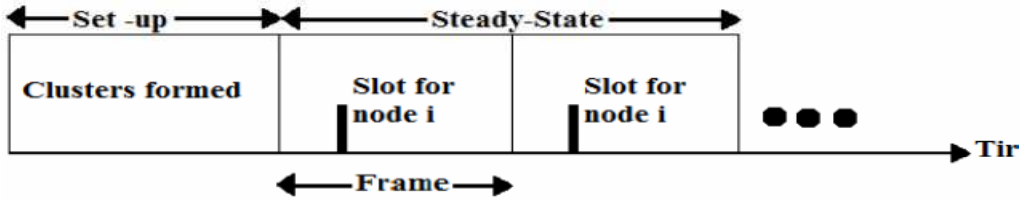
In the advertisement phase, the randomly generated CHs advertise their election as clusters to its neighborhood sensor nodes. This is followed by the Cluster set-up phase where the sensor nodes which received the advertisement can join the CH with higher signal strength. Then the steady-state phase begins.

2.2 STEADY-STATE PHASE: The Data transmission from the source sensor node to the destination sink happens in the Steady state phase where the CH is maintained. Like set-up phase, the Steady-state phase [4] can be further classified into

- Schedule Creation
- Data transmission

The Schedule is created by breaking the Steady-state operation into frames, and the timeslots are allocated for each of the sensor nodes. The nodes send their data to their CH during their allocated TDMA slot [4]. When all the data are received, the CH aggregates them and sends the aggregated data to the Sink Node. Fig 1.describes the operation of LEACH during different phases.

FIG.1: LEACH PROTOCOL PHASES [7]



The main problem with LEACH protocol lies in the random selection of cluster heads. There exists a probability that the cluster heads formed are unbalanced and may remain in one part of the network making some part of the network unreachable.

3. RELATED WORK

3.1 F- LEACH PROTOCOL

FLEACH ( ),is a protocol for securing node to node communication in LEACH-based network. It uses random key pre-distribution scheme with symmetric key cryptography to enhance security in LEACH. FLEACH provides authenticity, integrity, confidentiality and freshness to node-to-node communication. But it is vulnerable to node capturing attack.

3.2 S-LEACH PROTOCOL

This is the first modified secure version of LEACH called SLEACH [9], which investigated the problem of adding security to cluster-based communication protocol for homogeneous wireless sensor networks consisting of sensor nodes with severely limited resources.SLEACH provides security in LEACH by using the building block of SPINS (Security Protocol for Sensor Network), symmetric-key methods and MAC (Message Authentication Code). SLEACH prevents intruder to send bogus sensor data to the CH and CH to forward bogus message. But SLEACH cannot prevent to crowd the time slot schedule of a cluster, causing DoS attack or simply lowering the throughput of the CH and does not guarantee data confidentiality. The solution is meant to protect only outsider attack.

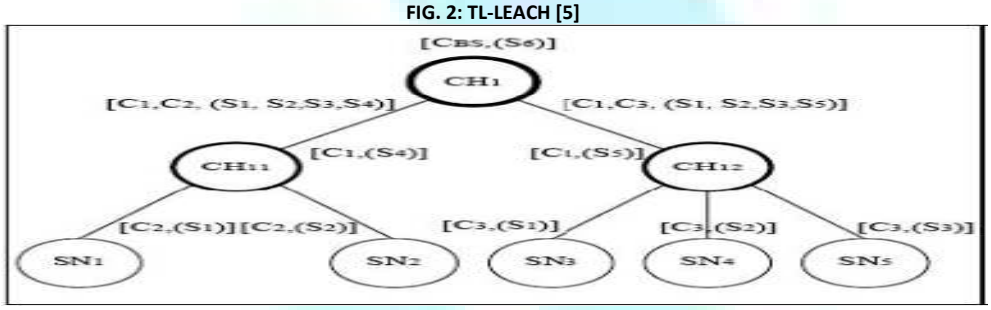
3.3 E-LEACH PROTOCOL

Energy-LEACH protocol improves the CH selection procedure. It makes residual energy of node as the main metric which decides whether the nodes turn into CH or not after the first round [1]. Same as LEACH protocol, E-LEACH is divided into rounds, in the first round, every node has the same probability to turn into CH, that mean nodes are randomly selected as CHs, in the next rounds, the residual energy of each node is different after one round communication and taken into account for the selection of the CHs. That mean nodes have more energy will become a CHs rather than nodes with less energy

3.4 TL-LEACH PROTOCOL

TL-LEACH [5] is the extension of the LEACH, where TL stands for Two-Level. In this protocol; CH collects data from other cluster members as original LEACH, but rather than transfer data to the BS directly, it uses one of the CHs that lies between the CH and the BS as a relay station. It utilizes two level of clustering where primary CH communicate with secondary CH in order to send the data, for better throughput. TL-LEACH form clusters based on minimum distance of nodes to their corresponding CH.

FIG. 2: TL-LEACH [5]



3.5 M-LEACH PROTOCOL

In LEACH, Each CH directly communicates with BS no matter the distance between CH and BS. It will consume lot of its energy if the distance is far. On the other hand, Multihop-LEACH protocol selects optimal path between the CH and the BS through other CHs and use these CHs as a relay station to transmit data over through them [8].First, multi-hop communication is adopted among CHs. Then, according to the selected optimal path, these CHs transmit data to the corresponding CH which is nearest to BS. Finally, this CH sends data to BS.M-LEACH protocol is almost the same as LEACH protocol, only makes communication mode from single hop to multi-hop between CHs and BS.

3.6 LEACH-CENTRALIZED (LEACH-C)

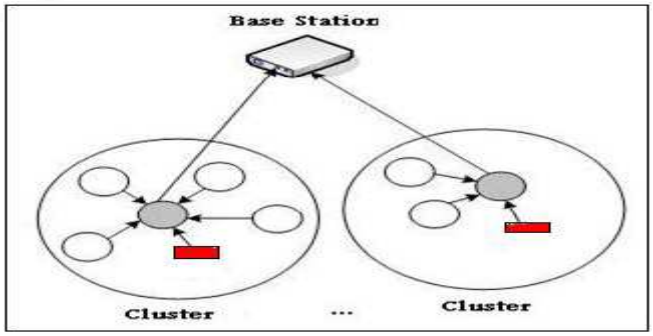
LEACH-C protocol offers a configuration algorithm [6] to perform efficient clustering. The efficient heads are selected based on the minimum exchanged data between cluster heads and their cluster nodes. In LEACH-C,during the setup phase, in each iteration the base station receives information about node state, node location and each node's remaining energy. LEACH-C uses this information to calculate the mean value of network nodes energy, and then selects efficient cluster heads between nodes with higher energy level than mean energy value.

The LEACH-C protocol can be used to detect nodes that have an energy value higher than the average and then the evolutionary algorithm is applied to select the optimum cluster heads, therefore achieving proper clustering.

3.7 V-LEACH

In the V LEACH [5] protocol, the cluster contains; CH (responsible only for sending data that is received from the cluster members to the BS),vice-CH (the node that will become a CH of the cluster in case of CH dies), cluster nodes (gathering data from environment and send it to the CH).

FIGURE3: V LEACH (5)



In the original LEACH, the CH is always on receiving data from cluster members, aggregate these data and then send it to the BS that might be located far away from it. The CH will die earlier than the other nodes in the cluster because of its operation of receiving, sending and overhearing. When the CH die, the cluster will become useless because the data gathered by cluster nodes will never reach the base station.

In V-LEACH protocol, besides having a CH in the cluster, there is a vice-CH that takes the role of the CH when the CH dies and there is no need to elect a new CH every time increasing the network lifetime.

4. PROPOSED PROTOCOL

V Leach uses the concept of alternate Cluster Head called Vice Cluster Head. As a Cluster Head dies it is replaced by the Vice Cluster Head. But in case of Vice Cluster Head Dies, it does not provide solution for that and the network start reducing the energy very fast and finally the network dies completely. The proposed protocol is the improvement over the V-Leach; In this, initially when the cluster heads are selected based on the energy and the distance parameters; the Vice Cluster Head are also selected. Now when the cluster head dies, it is replaced by Vice Cluster Head and new Vice Cluster Head will be selected at the same time. It means the cluster head will stay over the life of network. The decision of the Cluster head and Vice Cluster head selection is on the basis of Energy, Distance and Residual Energy.

The proposed protocol will improve the network life and total communication over the network.

5. SIMULATION RESULTS

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 V 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). The initial power of all nodes is considered to be 2J and maximum number of rounds is 5000. These parameters are summarized in Table1.

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)

The above mentioned values were set for simulation and the results indicate that there are less dead nodes and more alive nodes in proposed system. Also rate of packet transmission is enhanced and due to more alive nodes and cluster formation process is ensured for a long time which tends to increase life time of wireless sensor network.

FIG. 4: DEAD NODES IN WSN (EXISTING VS PROPOSED)

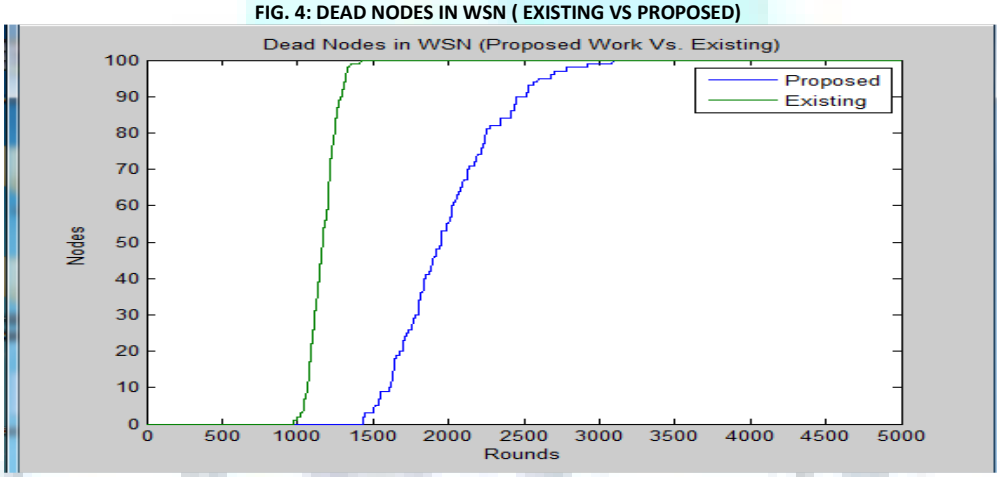


FIG.5: ALIVE NODES IN WSN (EXISTING VS PROPOSED)

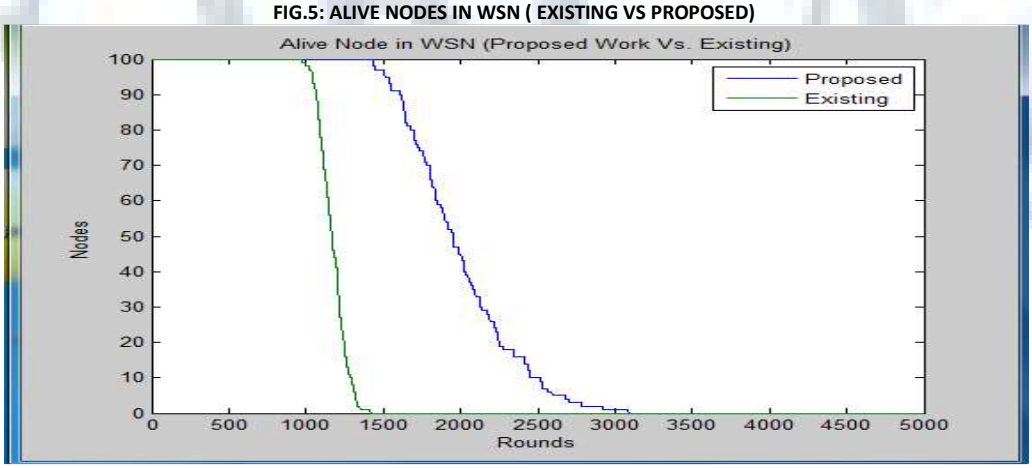


FIG.6: PACKETS TRANSMITTED TO BASE STATION(EXISTING VS PROPOSED)

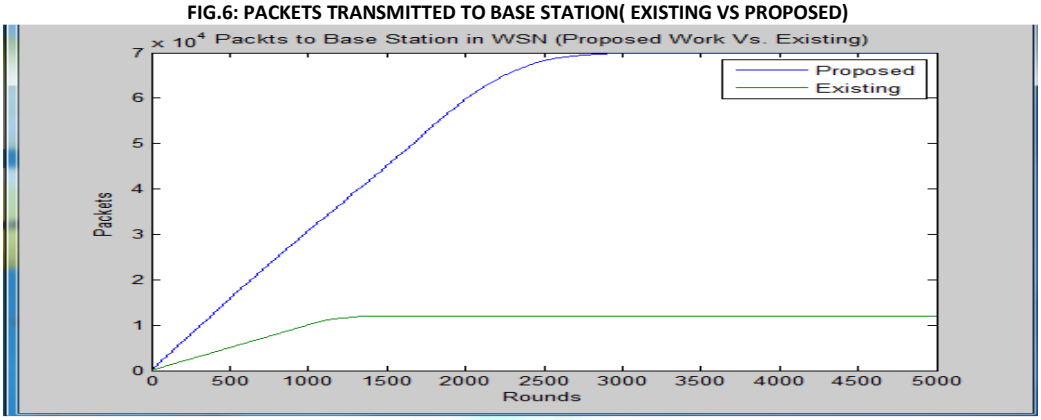
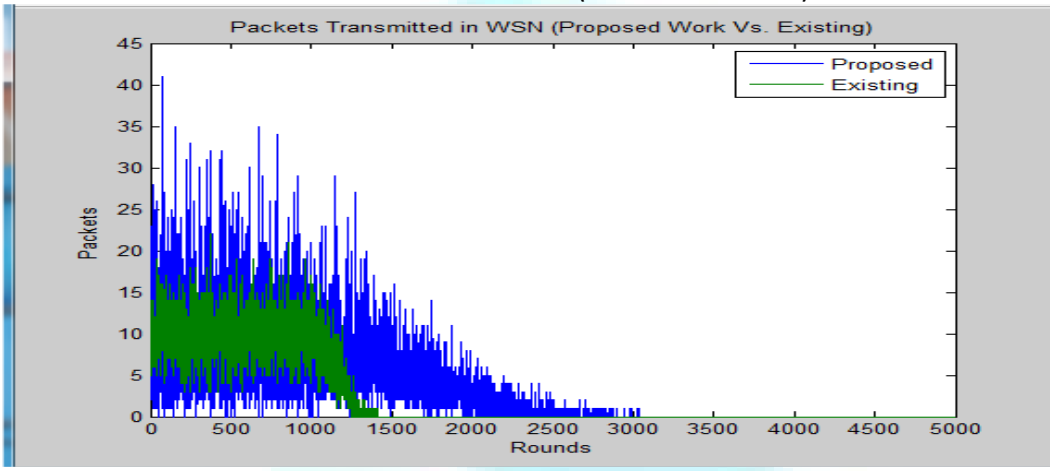


FIG. 7: PACKET TRAMSMITTED IN WSN(EXISTING VS PROPOSED)



6. CONCLUSION

The core operation of a WSN is to gather and convey the collected data to a distant BS for further processing and analysis. Gathering information from a WSN in an energy effective manner is of supreme importance in order to prolong its life span. This calls for use of an appropriate routing protocol to ensure efficient data transmission through the network. In this thesis, we have proposed an architecture modified V-LEACH which extends the V-LEACH clustering routing algorithm. The result of simulations conducted indicates that the proposed clustering approach is more energy efficient and hence effective in prolonging the network life time compared to LEACH. In existing system data transmission depends on current energy of nodes and distance between nodes. Modified-LEACH algorithm works on two additional parameter residual energy of node and time stamp of packet transmission from. Modified-LEACH affords to conserve energy through multilevel clustering. If each node were to transmit its sensed data directly to the BS, it will deplete its energy reserves rapidly. So Next Node directly communicates with base station and approach to minimizing energy consumption which reduces transmission costs.

7. SCOPE FOR FUTURE WORK

A good exploitation of the system parameters i.e. transmission range and node density to find the best possible optimal setting could also be researched further. Another interesting observable fact that can be studied further is the relationship between the number of hops and the spatial uniformity of energy distribution in a WSN. Knowing this relationship can help to choose the right parameters in a WSN for different kinds of topology. Further work can be done in direction of control the number of nodes in every cluster. The idea is to create a relative load balanced clusters such that no cluster-head is heavily burdened. This load balancing technique could ensure a balanced number of nodes in each clusters formed. This can further extend the network life-time by ensuring a uniform energy pattern.

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