

IMPROVE THE CONSERVATION OF ENERGY BY ADAPTIVE CLUSTERING LEACH PROTOCAOL FOR WSN

By

1st Khushboo Yadav, 2nd Mahesh Kumar Sharma

1st Rajasthan College of Engineering for Women, Jaipur, India

2nd Rajasthan College of Engineering for Women, Jaipur, India

1stkhushbu06.yd@gmail.com, 2nd Mahesh.sharma199@gmail.com

ABSTRACT

Today, in general Wireless Sensor Network (WSN) is a set of communicating sensors using wireless links. These sensors (node) are used to control an environment and transmit the captured data to the base stations. In WSN, each node serves as transmitter and router. The nodes in WSNs are usually powered by batteries with finite capacity and it is always impossible to replenish the power, and The failure of the energy sensor can significantly modify the topology of the network and impose an expensive reorganization of the network. Energy conservation has a main priority in all technology and engineering field. Hence, the wireless sensor depends on its internal battery to work its total life time, extending the life time by minimizing the consumption of power is also very important field in current researches. This research aims to optimize the energy consumption of wide scale wireless sensor networks by deploying a novel and adaptive improvement and modification on the traditional clustering of the cells of the network. In this Dissertation we work on load balancing of each cell in the network, introduce the "Potential" concept which is a measurement of node and cells overall availability and it is related to energy, distance and data transfer, deal with the nodes in between two clusters and finally make all nodes die almost at the same time by using an adaptive system for solving these problems.

Keywords

Wireless sensors networks, sensors clustering, LEACH, fuzzy logic

1. INTRODUCTION

The wireless sensor networks are an emerging field that performs a comprehensive process of sensing and measurements, measurement logging, data transfer and management via a wireless data network. The wireless sensor is a tiny small device that combines all functions in special measurements and computation. A bulk or set of sensors connected though network in mesh form perfuming a networking protocol. The hopping data of the sensors from one sensor to another is a major protocol and technique, the sensors that hopping data from one to each other is so called "NODE". The connection and cooperation of large number of nodes makes a rigid network with high capabilities and specifications [1]. The prospective and ability of any wireless sensor networks to deploy a connectivity of large number of nodes, which represents a very small "tiny" devices, represents the power of that network. This networks type is

currently deployed to be used in wide range of applications with a suitable cost with respect to its prospective [2]. The wireless sensor networks major rule is to measure specific field and logging its measurements to a host, and this is the most application that known and directly used. But also, it can be used to control some applications or actuators in that field. It also, reduces the cost of hardware installation and cabling, coming from the fact that, it doesn't need large hardware installation. From the other hand, cancellation of large hardware installations and cabling, reduces significantly the cost of maintenance, neither emergency maintenance nor proactive maintenance. Over that, the outdoor installations, especially cables, almost are subjected to be stableman. This topology of wireless sensors reduces the probability of stalling the equipment and hardware, because of no use of cables [3]. In addition to low installation cost, cheap devices, smaller sensing transducers, longer lasting, it is also, adaptive and can be reconfigured to work in different areas. For example, in a big farm, the same network that measure temperature, pressure, and humidity, also, can be configured to measure the wind speed, also, few configurations can enable that network to sense existence of specific materials in atmosphere. The single device of wireless sensor networks costs less than \$1 in most applications.

The wireless sensor nodes also, don't require communicating directly with the nearest control tower which is high power or even don't require directly communicating to the base station. But it communicates with the nodes local peers only. Thus, this connection will be a pear-to-pear connection making a mesh network. The mesh architecture implies a flexible networking of hopping branches. And the system is very adaptive for node failure substitution and compensation [4]. Each sensor node in the wireless sensors networking can perform communication over a range of 50 meters. Thus, to communicate between sensors and transfer the data, no repeaters are needed and no huge number of sensors is required.

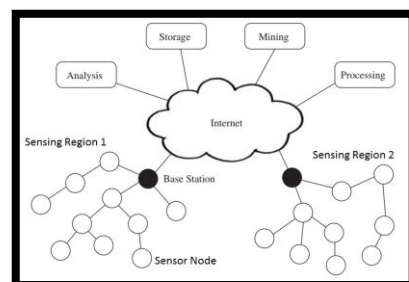


Fig 1: wireless sensor networks topology

(eg. Figure 1) shows an example of wireless sensor networks applied to a farm. It has a big important in agriculture fields, and such fields are active area for researchers and developers. It's clear that, large number of nodes are distributed throughout the field and connected together. That is establishing what so called "Routing Topology" or "Network Topology". The mount of sensors can be extended from tenth or hundreds to thousands in some cases [5]. This paper concerns in proposing and developing a new topology.

MAC: The MAC protocol of wireless sensor networks coordinates and manages the access of the sensors node to the communication field or area. The efficient MAC protocol for efficient power management is important methodology for life time extend.

LEACH: LEACH is acronym regards "Low Energy Adaptive Clustering Hierarchy". The hierarchal clustering was introduced by Heinzelman. It clusters all nodes of the network into clusters (cells) where each cell has center called "head of cluster".

Applications of WSN: The applications of data connection of canonical environments are a main field that software engineers and scientist researchers are interested in Security, surveillance, and monitoring, object tracing in such, the researchers need to collect the readings of several sensors from sets of environmental points in a specific timer interval, to detect the physical interdependencies and trends.

2. LITRATURE REVIEW

This section deals with the study of the field of study and looks for issues that have been resolved and unresolved in this area.

[Jianpo Li et al 2017] proposed the fuzzy power optimized clustering routing algorithm (FPCRA). FPCRA categorize the nodes according to node degree by optimizing the iteration radius before electing the cluster head to avoid the delay caused by excessive iteration. As a hierarchical routing process it works on round basis where each round has four stages: broadcast, cluster head election, cluster formation and data dissemination. For dynamically adjusting the power of cluster nodes, fuzzy control has been used during each stage of routing process. The proposed scheme is divided into four sub tasks i.e optimizing the broadcast power and iteration radius, cluster head election, check for uneven clusters formation and the applying the power optimal method. On comparison with predefined algorithms such as LEACH, LEACH-E and UCRA, FCA prolongs the network lifetime by 42.2% with 40.1% increase in amount of data packets. The total energy consumption rate is less in FPCRA by approx 7%.

[Karthika Sundaran et al, 2017] proposed the algorithm named as Energy Conserved Unequal Clusters with Fuzzy logic (ECUCF) as an enhancement of fuzzy based unequal clustering. ECUCF first divides the network and then select the cluster head using probability function. For energy consumption model free-space and multi-path fading channel models are used. The sensing field is divided into three sectors namely closest, middle and outside sector. Nodes carry the neighbor information table that helps in recognizing the nodes with less remaining energy and the CH on comparison

with threshold value puts those nodes to sleep state that have less remaining energy value than threshold value. The performances obtained are compared with the performances of other clustering schemes like LEACH and FBUC that based on respectively the equal and unequal clustering. On comparison with the unequal and equal clustering based algorithms the proposed algorithm ECUFC provides the improved performance by maximizing the number of clusters, increasing the number of live nodes and extending the nodes lifetime on each round of operation.

[Dr. V. Natarajan et al, 2016] proposed Fuzzy Based Dynamic Clustering (FDC) algorithm. Two major problems are discussed and new algorithm is proposed to solve these problems by using particle swarm optimization (PSO) algorithm and FIS. to overcome the problems mainly faced by the WSN in a non-distributed clustering. FDC uses three parameters: node density, position and remaining energy of nodes for determining cluster heads. Cluster formation task has to come across three stages: election stage, radius optimizing stage and cluster formation stage. FDC ensures that no node over exploits its energy or uses it continuously. Nodes on the basis of three parameters give a fitness value from which the first node is selected as cluster head after arranging in descending order. Cluster radius is directly proportional to the distance to the cluster head and residual energy but in inverse proportion with cluster head density. Results shows that the starting point of node depletion starts after all other algorithms with which FDC is compared that ensures enhanced network lifetime. Advantage of FDC algorithm is that it can eliminate the hotspot problem by using the fuzzy logic.

[Mohd Nasir Taib et al, 2015] proposed Energy Source Saving Approach Using Multi-Tier Network Design Technique. Author's aim is to minimize the energy usage of sensor nodes resulting in extended network lifetime. Protocol works as Initialization phase, Node distribution phase, Primary node selection phase, Cluster head selection phase, Cluster formation phase, Data transmission phase. At early stage of data transmission nodes are used evenly until they start to deplete. For efficient data transmission two-tier network design is followed. Each tier has its own cluster head for data transmission control between node and sink. The cluster head will collect data from cluster member nodes and pass to primary nodes before it reaches sink. From the proposed work author concluded that the implementation of Fuzzy Logic uses all nodes evenly and the nodes died sequentially as the data was increased causes nodes to use the energy efficiently and prolonging network lifetime.

[Kishor kolhe et al, 2015] proposed a Fuzzy manage based General Self-Organized Tree-Based Energy-Balance directing convention (FGSTEB) [6] which depends on the GSTEB, in this work creator manufactures a steering tree for information transmission by choosing the fitting steering way and hand-off hub utilizing fluffy standards. The principle objective of the work is to enhance the execution of GSTEB convention by adjusting vitality utilization which delaying the lifetime of WSN. Work is isolating into four stages i.e. Starting Phase, Tree Construction Phase, Self-Organized Data Collection and Transmitting Phase, and Information Exchange Phase. Nodes keep up table about neighbor of neighbors. Root ID and root directions to all sensor nodes is conveyed by the base station. Using TDMA and FHSS techniques data is collected and sent towards base station. Nodes before going to sleep state inform

its neighbor node to update their table and continue with the routing process. Results are compared using different parameters like throughput, end to end delay, energy, Routing load, PDR and network lifetime. FGSTEB is capable of finding the optimal route to BS with minimum energy used with 10-15% less energy consumption compared with other method under the same network scenario like HEED and GSTEB.

[Prasenjit Chanak et al,2013] Author proposed a technique based on distributed and load balancing scheme in which nodes decide multi-hop data transmission path according to their efficiency distributing the routing load throughout the network. The scheme Fuzzy-based Dynamic Load Management Policy for wireless sensor network (FDLMP) [7] reduces cluster head as well as cluster members' load to elongate network lifetime and improved network performance. FDLMP frequently reduces the energy holes within the network formed due to unbalanced traffic in multi-hop data transmission. Policy is to divide the task in three phases viz: Nodes classification through fuzzy logic inference system, cluster formation and traffic node selection, and the Data routing phase. BS classified the nodes as strong, moderate and weak nodes with strong ones being the cluster head. Membership functions Triangle and Trapezoid shape are used to reduce the complexity of computing. Results show that with FDLMP, network life span is better when compared to LEACH, CHEF and HEED protocols by 51.21%, 46.34% and 56.09% respectively due to minimum global energy dissipation.

[Zhang Baihai et al ,2011] [4] proposed an algorithm considering a factor of region density that is not mainly used by the existing algorithms. Cluster head selection is on the basis of inter and intra-communication distances and the residual energy. The transmission model consists of energy consumption of the transceiver circuitry and the power amplification circuit consumption that depends on the distance between the transmitting and receiving nodes. Proposed technique can achieve an increment in network lifetime and total packets delivered to BS by 40% and 90% as compared with normal LEACH-C.

3. PROPOSED METHODOLOGY

3.1 Clustering

Clustering provisions network scalability, resource sharing, efficient use of constrained resources and lengthens network lifetime of wireless sensor networks. Clustering is used to group similar nodes into disjoint sets designated as the cluster. The ("Figure 2") shows two dimensional distributed nodes, then, it classified into different clusters. Each cluster is colored with unique color.

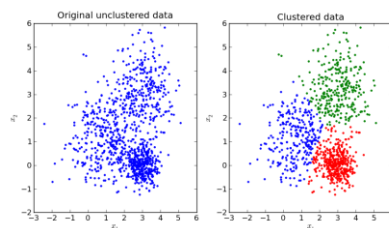
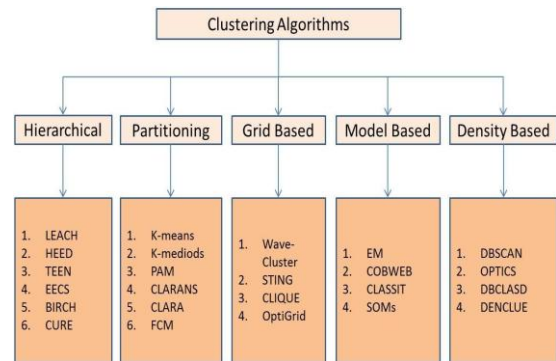


Fig 2: Data clustering

3.2 Classification of Different Clustering Algorithms

There are various types of clustering techniques are diverse approaches in the literature. A number of clustering algorithms can be arranged as partitioning, hierarchical, model-based, grid-based and density-based methods as shown



in (Eg. "Figure 3").

Fig 3: Types of Clustering Algorithms

3.3 Energy Efficient Clustering Algorithm (EECA)

(Eg. Figure 4) shows the general mode of the Energy Efficient Clustering Algorithm "EECA" adaptive software system. Starting by network data collection, it includes the calculation, determining the energy of each sensor and the initial nodes clustering (distributing on the cells) over the measurement space and initialization.

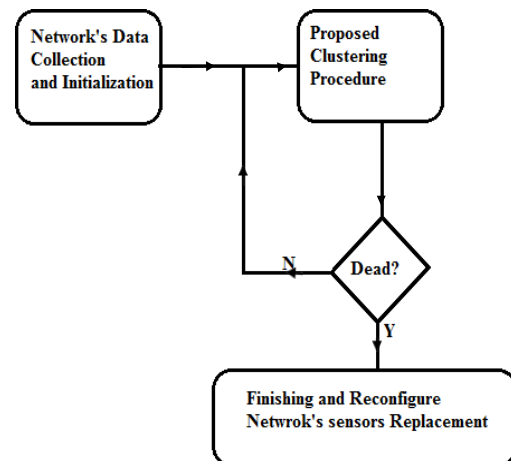


Fig 4: The EECA system's initial diagram

3.4 Proposed Clustering Algorithm

The EECA is an adaptive developed structural algorithm that locates the head of cluster by cluster centroid localization of data set that consists of geometric distribution of sensor-nodes in x-y plan or even capable to be used in 3-D space of sensing. EECA is based on the original Fuzzy C-mean algorithm of clustering data in 2-D plan, and improving it that by the use of "Potential" concept of the networks nodes and clusters. When calculating the overall sensor-nodes potential to the centroid that is being obtained from FCM, the nodes will be distributed into clusters easily by the mean of its potential not Euclidean

distance. In the contributed EECA algorithm, once the potential of each node is calculated, the head of cluster (CH) will be localized via the traditional FCM algorithm. The clustering process will follow the last centroid (head of cluster) determination phase. This will be determined and localized using

$$P = \frac{1}{E_q} + \frac{1}{E_r} - d \times T_q - K$$

the current suggested

modification (addition) to the fuzzy approach of clustering.

Where: P is the Potential, E_q is the Euclidian distance, E_r is the total remaining energy in the sensors battery, D is the transmission data cost function, T_q is the energy slop of transmission data, and K is the battery self-leakage.

This above equation calculates the potential of the node, and it represents a non-linear relation between the Euclidean distance, and the sensor's current working energy (which is the maximum initial energy minus the running cost energy), in addition to the energy cost (assumption) of each data bit; the energy consumption is known as (energy slope). When the potential is taken into consideration, the specification of internal battery surely has leakage. Its leakage is represented by the Equation below equation.

$$d(p, q) = d(q, p) = \sqrt{\sum_{i=1}^n (q_i - p_i)^2}$$

The above equation illustrates how to calculate the E_q Dist between target point "q" and destination pint "p". Here the distance is "d". The destination point may be the head of cluster or normal node .

The proposed methodology of the thesis consists of three phases. The bulk network of sensors should be divided into clusters and that process is so called "Clustering". The thesis assumed to use the fuzzy logic approach of clustering by what is called C-mean. The phase one distribute the sensor points into separate clusters, each cluster has its own head.

That clustering is potential based as illustrated in this chapter above. The below equation is being used to calculate the contributed potential. This research is a novel clustering algorithm for improving the conservation of energy in WSN's. Hence, the asymmetry of clusters (cells), the nodes will consume asymmetrical power, due to the asymmetrical structure, design, and pocket data transfer. While, it can be managed to balance the cluster's load by introducing a specific variable or concept that can express the overall load of the cluster and also node. Whereas this variable or concept should be mathematically and physically meaningful for all conditions and variables that affect the sensors battery and cluster communication transfer. This variable or concept is so called in this thesis "POTENTIAL".

This, Dissertation introduces the "POTENTIAL" concept of the wireless sensors network. The potential of the node represents the availability of that node (sensor) to transfer data and for how long a time. The POTENTIAL of the cell is the availability of the cluster of sensors to measure and send data for a how long time. In thesis, the symmetry of all clusters (Cells) enables all clusters to work in the same time long.

Thus, all clusters will start to die at the same time. This ensures that, no cluster work and other die. The LEACH

$$P_c = \min(P_{co} \sum (P_{co} - 1) + (P_{co} + 1))$$

algorithm extensions (either M or L) aim to make the life time of the nodes to be maximum, but in both, once the first node is dead, a problem occurs.

The problem is that, the dead sensors will not be able to measure the physical data and cannot transfer any data to the head of cluster node. So, it should be imagined that, one of the two scenarios may happen once the first node is dead.

The first scenario is that, the network still working as it is, thus, one node cannot log the measured data. While the process continues, more nodes will start dead and thus, a non-negligible data will be loosed, and the network becomes un-useful. The second scenario is that, the network sensor nodes are being replaced in the start time of nodes death, thus, a high cost will be achieved. Then, the contributed EECA aims to minimize the period between the first and last node death. This will keep the network running in balance measurements and data collection, and also, it saves more power. Many researchers performed experiments and researches to save network energy, specially the energy between the first and final node death. This thesis, implements a very effective and adaptive approach, that minimizes significantly the energy lose and cost.

The best algorithm that saves the energy in interval of nodes death is LEACH-L before testing the EECA approach. It increases the balancing in the nodes, thus, the use of low power nodes converted to high power nodes. This contributed thesis increase the efficiency to 90% rather than LEACH-L. In this thesis, the key point in the developed EECA is making all nodes died in the same time (that means the interval becomes near to zero) that why it is an efficient clustering procedure for cells.

The adaptation means that, the cluster head will not be fixed – even it is still has large power in the cell -. It will be changed to keep on the balancing of the cluster. Thus, the nodes distribution will be balanced with respect to its potential, and it results the balance energy slope and power consumption of all nodes. The generated clusters will be symmetrical along the overall running period. Furthermore over that, the head of cluster should be kept as it is the larger potential node over all running time. This requires re-clustering all of the data at each round.

This makes a benefit of decreasing the power consumption of the leave nodes where that is considered to be head in the traditional LEACH procedure or its extensions. The wrong cell center (Head of clusters) is almost leaks a big value of energy. On the other hand, the contributed Energy Efficient Clustering Algorithm "EECA" contributes intelligent solutions for that problem, and thus, saves an interesting value of the cell's power. The best algorithm that saves the energy in interval of nodes death is LEACH-L before testing the EECA approach. It increases the balancing in the nodes, thus, the use of low power nodes converted to high power nodes.

4. RESULT ANALYSIS

PExperimental results of the proposed method are presented and discussed in this section. This dissertation developed MATLAB program to experiment and simulate EECA algorithm and getting the results. In such, two assumed areas

are used for testing the protocol. The wireless sensor networks are distributed in the two scope areas individually and both are tested, and the parameters measured individually. The “round” concept represents a complete transmission process over running of the wireless sensors network. There are already several techniques that address the trouble of distance, but the existing method serves to decrease the distance with a variety of the cluster head next to base station, this brings returned the death of the node which is far from CH, which we note inside the simulation achieved in the previous part.

The first scope is 300 by 300 m, where the second is 500 by 500 m. Initial conditions and the test will consider almost on the energy optimization measurements with respect to a LEACH, LEACH-M, and LEACH- L protocols. The overall nodes death displays the performance of the network optimization. The testing of EECA is done in two topological scenes; the first is over 500 by 500 meters, while the other comprises 300 by 300 meters. The result will be compared and discussed in this section. Table 1 below illustrated the assumed parameters that have been implemented in simulation for testing purpose.

Table 1 Simulation Parameters [9]

Parameter	Test conditions 1	Test conditions2
Network validity scope “m”	300 by 300	500 by 500
No of wireless sensors	900	2500
Energy at Starting	0.5 J	0.5 J
E (J)energy parameter	1	1
Transmission packet length “bits”	4000	4000
$E_{(DA)}$ (Energy required for data aggregation)	5×10^{-9}	5×10^{-9}
P(cluster-head section probability used during cluster creation)	0.1	0.1
M (Multipath-Fading)	0.1	0.1
D (distance between transmitter and receiver)	70 m	70 m
Transmission-Distance(m)	30	70

4.1 Experimental Results

In this section, we present the results of our evaluation, comparing our approach with several state of the art methods. The cycle across the total running time of the network of 300X300 m and 500X500 m results are displayed in (Eg. “Figure 5”, “Figure 6”).

Fig 5: Nodes Death over 300 x 300 round in different protocols

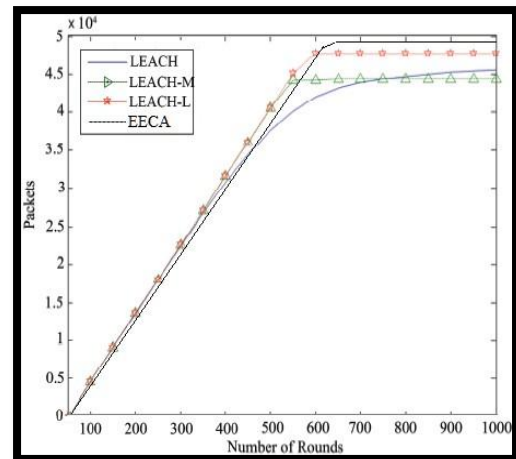
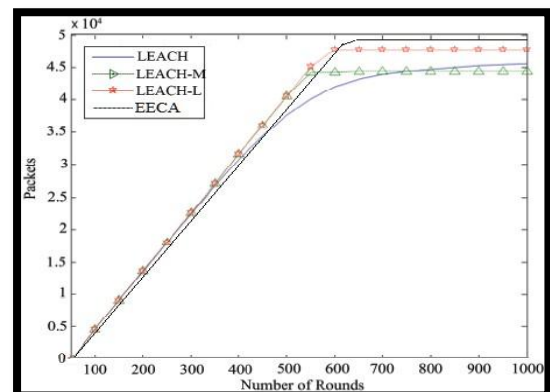


Fig 6: Dead Nodes over a round of 500 x 500 in different protocols

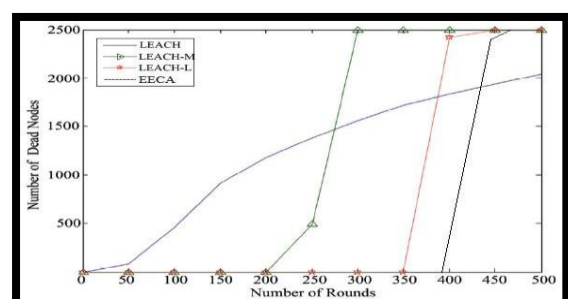
The next two Figures show the received packet number in time interval of all LEACH protocols in addition to the EECA protocol tested in 300x300m WSN space, and 500x500m WSN space respectively. (Eg. “Figure 7” and “Figure 8”) displays the relation of the amount of sent packets during their

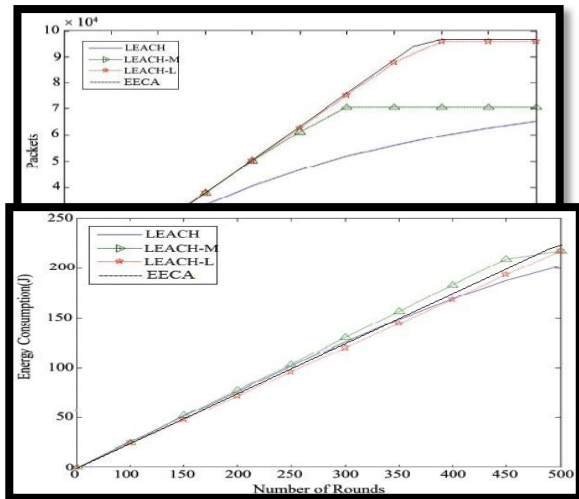


life interval in an area of 300 by 300m and 500X500 m respectively.

Fig 7: Received packets over round of 300 x 300 in different protocols

Fig 8: Received packets over round of 500 x 500 in different protocols





The next two Figures show the direct relation between the power consumption with the number of cycles for an area of 300 by 300m and 500 by 500 m respectively. So, the capacity of the battery is enough to run the sensors in normal operation rather than old methodology.

Fig 9: Energy Consumption over und of 300 x 300 in different protocol

Fig10: Energy Consumption over round of 500 x 500 in different protocols

Table 2 Energy Optimization of Different Clustering Algorithms

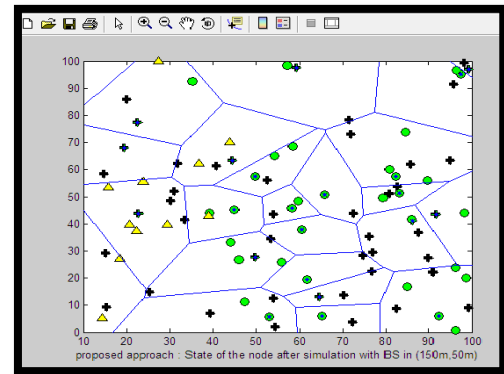
Algorithm	Energy Optimization Percent
EECA	93%
LEACH-M	80%
LEACH-L	65%

4.2 Simulation Improvement Approach AndDiscuss

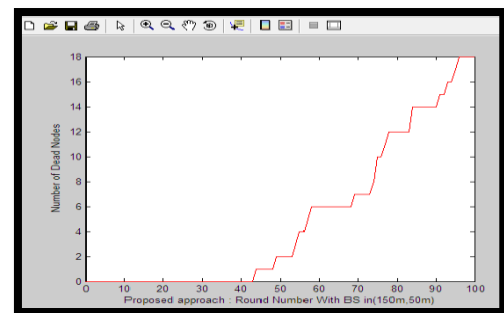
To make the comparison between our improved method and the results existing method, we choose the same parameters presented in table 1 to simulate our approach improvement.

4.2.1 Results simulation Proposed approach with BS in C1 (150m,50m)

Thebothfigurebellow (Figure12andfigure13)showsthe



simulation results of our approach method representing respectively the state of the nodes after simulation and the number of node dead after number of rounds with BS in location (150m,50m).The yellow triangle in “figure 12”



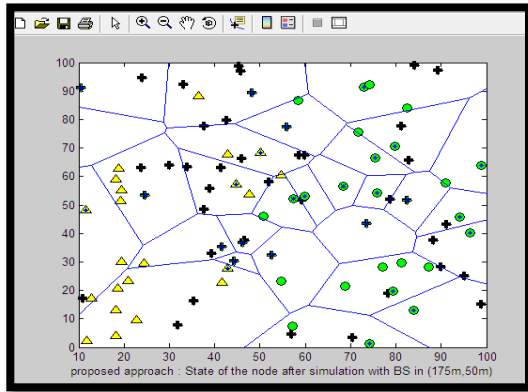
represents the dead node after finally simulation with BS in location (150m, 50m).

Fig 12: State of the nodes after 100 rounds with BS in location (150m, 50m) Using Proposed Approach

Fig. 13: Number of node dead after 100 rounds with BS in location (150m,50m) Using Proposed Approach

4.2.2 Results simulation Proposed Approach with BS in C2 (175m, 50m)

The both figure bellow(“Figure 14” and “Figure 15”) shows the simulation results of our approach method representing the



state of the nodes after simulation and the number of node dead after number of rounds with BS in location (175m, 50m). The yellow triangle in (“figure 14”) represents the dead node after finally simulation with BS in location (175m, 50m).

Fig. 14: State of the nodes after 100 rounds with BS in location (175m, 50m)Using Proposed Approach

Fig. 15: Number of node dead after 100 rounds with BS in location (175m,50m)Using Proposed Approach

4.2.3 Discuss Results Improvement Approach LeachProtocols

Simulation Result

The (“table 3) and figure 16”) below gives a comparison between the simulation results between the existing approach and our improvement approach for each base station position.

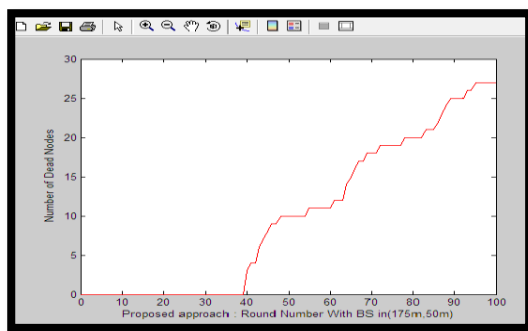


Table 3Number Dead Node in Existing Approach and Improvement Approach

Position of base station	Existing Approach for LEACH	Our Improvement Approach For LEACH
BS (150m,50m)	40	18
BS (175m,50m)	58	28

Decrease the number of dead nodes from 40 to 18 in the case where the base station is located at a distance of (150m, 50m). Decrease the number of dead nodes from 58 to 28 in the case where the base station is located at a distance of (175m, 50m).

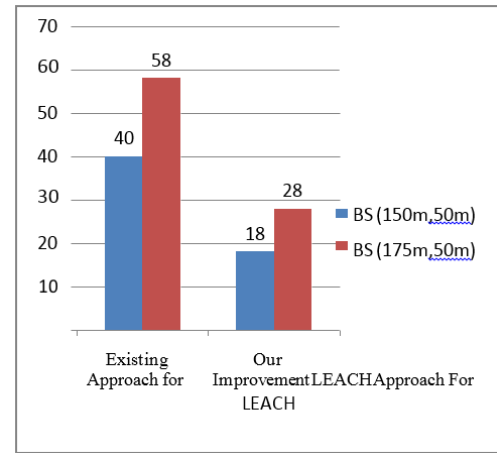


Fig. 16: Number node dead in each approach for each position BS

The results of the simulation shown in the “table 3” and “figure 16” clearly show that there is an extension of the network lifetime, by applying our approach.

We decrease the number of dead nodes from 40 to 18 in the case where the base station is located at a distance of (150m, 50m).

We decrease the number of dead nodes from 58 to 28 in the case where the base station is located at a distance of (175m, 50m).

Finally in our approach we have succeeded in extending the network lifetime by 45%.

5. CONCLUSION AND FUTURE WORK

This research concerns to implement a new methodology for wireless sensors adaptive clustering in order to optimize energy and power consumption in the network. The past researches on clustering of wireless sensor networks got a result of saving an interesting amount of energy and sensor’s life. This research added a value of saving more energy and power, and building adaptive algorithm. This research is a novel clustering algorithm for improving the conservation of energy in WSN’s. Hence, the asymmetry of clusters (cells), the nodes will consume asymmetrical power, due to the asymmetrical structure, design, and pocket data transfer. In this paper we have presented and detailed our new improvement approach of clustering LEACH protocols, simulation results show that our approach ensures the low energy consumption and improves the network lifetime, so we have succeeded to maximizing the lifetime of networks up to 45%, As perspective this work can be improved in different directions in future to increase more the lifetime of Wireless Sensor Network. The future work that is closely related to this thesis is concerns in two axes. Those axes should be implemented and developed to complete the full system optimization. Those are adapting management protocol that manages both, the data transfer and clustering algorithm.

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