

Evolutionary Algorithm Based Clustering Protocol Design and Analysis for Wireless Sensor Network

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ABSTRACT: The major concern in design and deployment of sensor networks is the issue of maximizing network lifetime which is fundamentally rely on the network connectivity which on the other hand directly depends on battery life of sensor nodes. However, sensor nodes have limited energy supplies and making battery replacement is very difficult or even impossible. Therefore, energy should be efficiently conserved to extend sensor networks lifetime by having an energy-efficient routing protocols. Hierarchical cluster routing protocols can reduce the energy consumption requirement; but the major challenge in cluster formation is to select the appropriate cluster heads by taking into consideration various parameters such as residual energy, number of neighbours, location (position) of node, and distance from base station (sink node). Cluster formation is NP-hard problem, and evolutionary based technique is proposed to design an energy-efficient cluster to optimize lifetime of sensor networks, while ensuring energy efficient routing path construction for sensor nodes. Moreover, the proposed protocol maintain centrality of the cluster heads and let balanced energy dissipation among clusters. The protocol is implemented using OMNeT++ and the result analysis shows the protocol has good network stability period and the energy depletion of every node is smooth.

KEYWORDS: Genetic Algorithm, CHs centrality, Energy-Load balance, Network lifetime, WSN clustering

I. INTRODUCTION

Information is created through naturally occurring events in the physical world every moment, but these events go largely unnoticed and the information is lost. Sensing the physical world by embedding large collection of self organizing micro computers with appropriate sensors attached, forms the next revolutionary in information gathering and processing. On the other hand the rapid development of computer network and modem mobile communication, combining various technologies such as computer technology, communication technology, sensor technology and information processing technology together to develop a new technology gets a significant attention. An advancements in the field of wireless communications and miniature electronics have allowed the development of low-cost, low-power, multifunctional, and tiny sensor nodes which are composed of equipment responsible for sensing, data processing and communicating [2,3]. A collection of tiny sensor nodes scattered over certain area integrated with the combination of those technology can be referred to as a wireless sensor network (WSN). WSNs comprised of a large number of distributed sensor nodes with less or no infrastructure at all and a self-configuring network in which the small sensor nodes are communicating among themselves using radio signals, and deployed in quantity to sense, monitor and understand the physical world. It also provide a bridge between the real physical and virtual worlds.

A wireless sensor network generally characterized by short range radio communication, limited computational capacity, limited storage capacity and limited, irreplaceable battery power, mobility nature of nodes and no/limited central manager and inexpensive compared to traditional sensors. Unlike traditional wireless communication networks such as mobile ad hoc network (MANET) and cellular systems, wireless sensor networks have some unique features and constraints. (a) The dense node deployment and unattended nature of WSNs make it quite difficult to recharge node

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batteries. (b) Sensor nodes are usually deployed randomly in the interested field and autonomously configure themselves into a communication network. (c) Nodes are may prone to physical damages or failures due to harsh operating conditions and hostile environment. (d) Nodes have no a unique global identification. (e) Sensor network is usually designed and deployed for a specific application.

Wireless sensor network development was originally initiated by military applications such as battlefield surveillance. With advances in wireless communications, low-power electronics, embedded microprocessors and An interesting attributes of sensor nodes such as small size, low-cost, low-power, and multifunction have made WSNs available in a wide range of potential applications such as in industry, science, transportation, civil infrastructure, military and national security, environmental monitoring (biodiversity mapping and disaster relief operations), intelligent buildings (or bridges), health and medical centres and many other fields. Generally WSNs applications can be classified into two categories [4]: monitoring and tracking. Monitoring applications include indoor/outdoor environmental monitoring, health and wellness monitoring, power monitoring, inventory location monitoring, factory and process automation, and seismic and structural monitoring. Tracking applications include tracking objects, animals, humans, and vehicles.

In spite of all its advantages and wide range applications there are some factors that influence the performance of WSN. Some of these constraints/factors are limited hardware resources, massive and random node deployment, unreliable environment, communication model, diverse sensing application requirements, sensor locations, fault tolerance, scalability and energy constraint, etc. Since sensor nodes are battery powered and have limited energy capacity, energy constraint is the biggest challenge for network designers in hostile/harsh environments such as in a battlefield, where it is impossible to access the sensor nodes and recharge or replace their batteries. Moreover, when energy of a the modes reaches a certain threshold value, the nodes will become faulty/down and will not function properly, which will have a major impact on the network performance. Therefore, routing protocols designed for sensor networks should be an energy efficient to extend its network lifetime. In connection with this problem in this paper evolutionary algorithm based routing protocol is proposed to optimize the energy dissipation of sensor network.

Evolutionary algorithms(EAs) are population based meta-heuristic optimization algorithms that use biology-inspired mechanisms and survival of the fittest theory in order to refine a set of solution iteratively. EAs are the solution for optimization of hard problems quickly, reliably and accurately. As cluster formation in sensor networks is NP-hard problem, in this paper a subclass of EAs algorithms called genetic algorithm (the elements of the search space are binary strings or arrays of other elementary types) is used to organize the sensor nodes into clusters. The proposed protocol uses genetic algorithm (GA) to find the optimal Cluster Heads (CH) while maintaining the energy load balance among the cluster and ensuring centrality of the CHs for their member nodes in order to reduce the total energy consumption of sensor nodes in routing packet and extending the network lifetime

II. RELATED WORK

Hierarchical clustering is an energy-efficient communication protocol which explored from several perspective by many researchers. In clustering protocols the sensor nodes are grouped into clusters with a cluster head that is in charge of routing data from the corresponding cluster to the sink.

Heinzelman et al. [5] proposed the first energy efficient hierarchical clustering protocol called low-energy adaptive clustering hierarchy (LEACH) to extend the network lifetime of sensor networks by reducing power dissipation. LEACH protocol is self-organized hierarchical, cluster-based approach in which the sensor nodes in the target network field or area randomly grouped into number of clusters, where the numbers of clusters are pre-determined. LEACH has setup phase and steady state phase. In setup phase CHs are selected and the nodes are initiated to join their corresponding clusters while in steady state phase, based on TDMA slot the sensor nodes transmit data to CHs which are responsible to aggregate and forward the data to the sink. CHs uses direct communication to transmit data to base station. After specific period of time the clusters are reconstructed by setting new CHs. A node can be re-elected only if all the remaining nodes have been elected and the clustering task is rotate among all nodes based on duration.

Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN) [7] is a hierarchical clustering protocol, which proposed for time critical applications. IN TEEN, nodes sense the environment continuously and data transmission is done less frequently. The CHs send to its member nodes hard threshold and soft threshold value. A hard threshold is threshold value of sensed data which reduces the number of transmission by allowing nodes to transmit the data only if the sensed attribute is in the range of interest. On the other hand soft threshold used to reduce the number of transmission that will occur when there is small or no change in the sensed attribute. This protocol has a big advantages

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for applications where the users are in need of controlling a balance between energy efficiency, and response time dynamically.

Hybrid, Energy-Efficient Distributed Clustering (HEED) [8] which operates in multi-hop networks, extends the basic LEACH schema to achieve power balancing. In HEED algorithm CHs are selected periodically by using residual energy and node degree (the intra-cluster communication cost) as metric. Residual energy of the sensor nodes are used to compute their probability of becoming CH and to choose an initial set of CHs probabilistically. In addition to maximizing the network lifetime, HEED was proposed (i) to reduce control overhead, (2) terminating the clustering process within a constant number of round, and (3) producing well-distributed CHs. According to the simulation result analysis, HEED clustering prolong network lifetime over LEACH protocol.

ECHSSDA (Efficient Cluster Head Selection Scheme for Data Aggregation) protocol designed by Maraiya et al. [6] has set-up phase and steady phase like that of LEACH. The algorithm maximize the network lifetime by improving the cluster head selection methods. The BS compares the residual energy of current CHs with average energy of regular nodes when the round is completed. If the residual energy of cluster head's is less than the average energy of regular nodes, BS chooses new CH from regular nodes based on energy level the node has. After new CHs are selected, all the current cluster setups are destroyed and new set-up phase and steady state phase are perform. The results of this work prove that how this method is more efficient than LEACH and LEACH-C.

Hussain et al. [1] uses genetic algorithm to improve the hierarchical cluster-based routing (HCR) protocol to find number of cluster heads and cluster members as well to determine the transmission schedules. Since the GA is running on base station it gives an energy efficient solution and the ability to find the best clusters which reduce energy computation during run time of the algorithm. Every round GA is applied by base station after analysing the current network condition. The fitness function of proposed approach depends on several parameters such as cluster size, distance from base station, cluster distance and energy consumption. The optimizer modifies its decision method based on feedback received from the network.

S. Jin [9], describe an efficient genetic algorithm based method to solve energy optimization problem of sensor networks. Depend on network size each chromosome is divided into a number of genes which used to form the chromosomes. The fitness function depends on distance (d) which refers to the summation of distance between regular nodes and the CHs as well as the distance from CHs to BS. It also rely on number of CHs exists in the network. The genetic algorithm should find the fittest chromosome that has small number of CHs and shortest distance.

To reduce the long-distance communication among sensor nodes Heideri et al. [10] uses a genetic algorithm and achieve good power preservation in the network. The major fitness function parameter used is transfer energy (E) which reflects the energy dissipated by CHs to transmit aggregated data to the base station. The proposed approach can be used both in non-uniform and uniform distribution network. Also it can be used in network where nodes are mobile. Generally the protocol minimize the long distance communications efficiently which on the other hand reduces the total energy dissipation

III. PROPOSED STRATEGIES AND ALGORITHMS

The objective of this paper is to prolong the network lifetime of sensor networks by reducing the total energy consumption needed for delivering data to base station. An adaptive heuristic method is used to construct an energy efficient clusters. In clustering, the sensor nodes are partitioned into different clusters and each cluster is managed by a node referred as cluster head (CH). Non cluster head nodes do not communicate directly with the sink node rather they pass the collected data to the cluster head. Cluster head will aggregate the data it received from cluster nodes and transmits it to the base station. Thus minimizes the energy consumption and number of messages communicated to base station. The main advantages of clustering are reducing number of nodes taking part in transmission, making useful energy consumption, creating scalability for large number of nodes, reduces communication overhead, and an efficient usage of resources in WSNs. For justification of energy efficiency of the proposed protocol some important features of the model is discussed in the following consecutive subtopics.

Network Model

In the proposed protocol, the following assumptions about the network model are considered.

- The Base Station (BS) is resource-rich stationary device and located far away from the sensor nodes at fixed position.

- All nodes are stationary, once deployed randomly in the area of interest and they are left unattended.
- Nodes are battery operated, energy constrained and homogeneous with uniform initial energy allocation. The battery could not be rechargeable.
- Each sensor node periodically senses the monitored environment, and has a perpetual desire to send the sensed data to the BS. Sensor nodes are probed with power control capabilities to change their transmitted power.
- All sensors have GPS or other location determination devices.
- Nodes located close to each other have correlated data.
- All nodes should be roughly time synchronized on the order of seconds.
- The nodes are considered to die only when their residual energy raise below the threshold level.

Radio Model

Sensor nodes consumes energy, when transmitting and receiving data packets and the energy consumption is correlated to the data packet size and the distance between the two sensor nodes. Extensive research has been conducted in the area of low-energy radios. Different assumptions about the radio characteristics, including energy dissipation in the transmission and receive modes, will change the advantages of different protocols. For our experiments, both the free space (d^2 power loss) and the multipath fading (d^4 power loss) channel models of first order radio model [5] were used, depending on the distance between the transmitter and receiver. Thus, the energy dissipate by node in transmitting a k-bit packet to another node located at distance d, is given by:

$$E_{Tx}(k, d) = \begin{cases} k * E_{elec} + k * E_{fs} * d^2, & \text{if } d < d_0 \\ k * E_{elec} + k * E_{amp} * d^4, & \text{if } d \geq d_0 \end{cases} \quad (1)$$

and to receive this packet, the radio expends;

$$E_{Rx}(k) = E_{elec} * k \quad (2)$$

here d refers the transmission distance, d_0 is threshold distance; E_{elec} the energy consumption per bit in the transmitter and receiver circuitry by a node that depends on factors such as the digital coding, modulation, filtering, and spreading of the signal [37] when $d < d_0$ and $d \geq d_0$, where $d_0 = \sqrt{E_{fs} / E_{amp}}$. On the other side E_{fs} and E_{amp} are the energy consumption coefficient of the amplifier.

The Proposed Approach Description

Genetic algorithm (GA) is an adaptive stochastic particular class of evolutionary algorithms that use techniques inspired by evolutionary biology and it is a good solution for optimization of hard problem with irregular search space where global optimum is required. The aim of GA is to find global optimum solution and to avoid danger in any optimization problem which is being trapped in local Min and Max. Genetic algorithms (GAs) use operators named selection, crossover, and mutation which plays a very significant roles in proper selection of optimized value. The selection of proper crossover and mutation technique depends upon the encoding method and as per the requirement of the problem. Basically crossover and mutation provide exploration, compared with the exploitation provided by selection. The effectiveness of GA depends on the trade-off between exploitation and exploration [11].

Basically, crossover and mutation is the process which enables the solution to the problem to be found. New solutions are found from old solutions by the process of crossover and mutation, much like what happens in nature with chromosomes. Crossover is a convergence operation which is intended to pull the population towards a local minimum or maximum. Mutation is a divergence operation. It is intended to occasionally break one or more members of a population out of a local minimum or maximum space and potentially discover a better minimum/maximum space. Mutation maintains genetic diversity in the subsequent generations which means that you avoid premature convergence on a local maximum or minimum. Too high a mutation probability means that convergence is slow or it does not occur. Since the end goal is to bring the population to convergence, selection/crossover happen more frequently (typically every generation). Mutation should happen less frequently, and typically only effects a few members of a population (if any) in any given generation.

The proposed protocols are centralized clustering protocols where the BS has to determine the clustering configuration for the currently non-dead sensor nodes. Thus, the BS uses genetic algorithm as a tool for creating an energy efficient clusters for a given number of alive sensor nodes to optimize lifetime of WSN, while ensuring energy efficient routing

path construction for sensor nodes that cannot directly reach the base station. The operation of the proposed protocols is broken into rounds; the clusters are re-established in each round and new cluster heads are elected. Each round consists of two phases; a set-up phase and a steady-state phase. In the set-up phase, the sensor nodes are organized into clusters. while in steady-state stage, several data frames are transmitted from the worker nodes to their cluster-heads.

Set-up Phase

In first round, the BS broadcasts a short message to wake up nodes and to request the IDs, position (location information), energy levels of all sensor nodes in the sensor network field. Based on the feedback information from sensor nodes, the BS run the GA to created energy efficient clusters. At the first step by using binary encoding techniques, WSN nodes are represented as bits of a chromosome. The head and member nodes are represented as 1s and 0s respectively. The base station assigns member nodes to each cluster head using the minimum distance strategy and then broadcasts the complete network details to the sensor nodes. The broadcast message includes; the ID number of cluster heads, the members associated with each cluster head, and the number of transmissions for this configuration. All the sensor nodes receive these packets transmitted by the base station and clusters are configured accordingly.

Fitness Function Evaluation

In any evolutionary computation algorithm, a metric is needed to compare and evaluate the fittest candidate from a generation of candidates. During the design of the fitness function it is essentially significant to consider various fitness parameters. A few fitness parameters that are take into consideration while designing the objective function of proposed approach are Direct Distance to Sink (the sum of all distances from sensor nodes to BS), Cluster Distance (sun of the distances from sensor nodes to cluster head and distance from cluster head to BS), Transfer Energy (Energy consumed to transfer aggregated message), Residual energy.

1) *Cluster Distance (CD)*: The cluster distance, CD is the sum of the distances from the nodes to the cluster head. For a cluster with k member nodes, the cluster distance C is defined as follows:

$$CD = \sum_{i=1}^k d_{ih} \quad (3)$$

where d_{ih} is the distance from node i to the cluster head h and k is the number of sensor nodes in a given cluster. For a cluster that has large number of widely-spaced nodes, the cluster distance will be higher and thus the energy consumption will be higher.

2) *Cluster Distance - Standard Deviation (SD)*: For uniform spatial distribution of sensor nodes, where nodes are uniformly placed, the variation in the cluster distances should be small. However, for non-uniform spatial distribution, where nodes are randomly placed, the cluster distances must not be necessarily the same. The variation in cluster distances should be tuned according to the deployment information and the variation in cluster distances is acceptable. The cluster distances-SD, can be computed as follows:

$$\mu = \frac{\sum_{i=1}^N d_{clusteri}}{N} \quad (4)$$

$$SD = \sqrt{\frac{\sum_{i=1}^N (\mu - d_{clusteri})^2}{N}} \quad (5)$$

In the above two equation μ stand for mean (average), where N and $d_{clusteri}$ represent the number of sensor nodes in the cluster and the clusters in the network respectively. Equation 5 used to compute the average distance of members nodes from its' CH while equation 4.6 design to find the standard deviation of cluster distance.

3) *Transmission Energy (E_{Tx})*: The transfer energy represents the summation of energy consumed to transmit the sensed data form sensor nodes to BS and to transfer the aggregated message from the cluster to the BS. For a cluster with k member nodes, cluster transmission energy is defined as follows:

$$E = \sum_{i=1}^k E_{TxSi} + k * E_{Rx} + \check{k} * E_{Txhs} \quad (6)$$

The first term of Equation 6 shows the energy consumed to transmit messages from k member nodes to the cluster head. The second term shows the energy consumed by the cluster head to receive k messages from the member nodes. Finally, the third term represents the energy needed to transmit \check{k} packets from the cluster head to the BS

Fitness function is the core part of a GAs and establishes the basis for selecting chromosomes that will be mutated. In the proposed approach the fitness is designed to minimize the energy consumption and to extend the network life time. Therefore, GA is used to find energy optimal clusters by minimizing the following objective function $F(x)$.

$$F(x) = w * E_{disp} + (w/2) * E_{vavg} + (1 - w) * D_{sdavg} \quad (7)$$

where E_{disp} is the total dissipated energy of all alive nodes in the sensor field and E_{vavg} is the average of energy consumed by all cluster while D_{sdavg} is the average of distance variance in every cluster.

Termination Criteria

The algorithms terminates when the objective function does not change for certain number of generation or when the specified number of generations is reached. In the last generation the network with the best fitness value is selected to ensure that the total energy dissipation in the network decreases and the best individual among the individuals in the population is considered as the clustering solution.

Steady-state phase

The final phase is also called *data transmission* phase. During this phase, the sensor nodes are wake up and start sensing data. Then each node sends the sensed data to its CHs according to the TDM schedule. The CH node must keep its receiver on to receive all the data from the nodes in the cluster. When all the data have been received, the CH node performs signal processing tasks to aggregate the data in to a single signal. The aggregated signal is sent to the BS. After a certain time, which is determined priori, the network again goes back into the setup phase and a new CHs are determined using GA.

Working principle of evolutionary based routing protocol description

Step 1 [Setup setting parameters] First set the initial value of all parameters, the playground or network dimensions (X_{max} , Y_{max}), number of sensors (N), sensor's coordinates ($S_{x,y}$), energy of sensors (E), initial energy (E_0), amplifier energy (E_{fs} , E_{amp}), Transceiver circuit energy (Eelec), Transmitting energy (E_{Tx}), Receiving energy (E_{Rx}), Data aggregation energy (E_{DA}), and BS location ($BS_{x,y}$). Also, set the evolutionary algorithm parameters, including population size (n), probability of recombination (P_c), probability of mutation (P_m), number of generations.

Step 2 [Cluster Head election]

Step 2.1 [Initialize] generate an initial EA population. In each chromosome, a non-dead sensor may be a CH, otherwise it will be a worker node.

Step 2.2 [Evaluate] calculate the fitness function of each individual in the population.

Step 2.3 [Generate] create a new population of chromosomes by select individual mates from old population to form the mating pool. Then make offspring between two consecutive mates from the mating pool. and mutate each generated offspring.

Step 2.4 [Replace] use the new population instead of the old one for further run of the Cluster Head election algorithm.

Step 2.5 [Evaluate] calculate the fitness function of each individual in the new population.

Step 2.6 [Stop] test if the stopping condition of the EA is satisfied. If such, get the best individual found in the current population based on its fitness. If not, go to step c.

Step 2.7 [Decode] decode the genotype of the best individual into its phenotype

Step 3 [Association phase] Base station associates each non CH node to the nearest CH to form clusters.

Step 4 [Data transmission phase] the nodes transmit message packets to their associated CHs and the CHs transmit the aggregated message packets to the BS.

Step 5 [Stop] If all sensor nodes die, then end the protocol, otherwise go to step 2 to perform the next round of the protocol.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

Performance Measure Metrics

The performance of proposed energy efficient protocol has been analysed by using the following metrics

- *Network Lifetime*: This metrics reflects the time interval from the start of operation (of the sensor network) until the death of the first node which is the stability period of the network with full sensor nodes under operation.
- *Instability Period*: The instability period of network reflects the total time interval from the death of the first node to the death of the last sensor node.
- *Residual Energy of Nodes per Round*: This measurement shows with how much amount of energy the nodes have at every round of reclustering
- *Number of Cluster Heads per Round*: This measure refers to the total number of cluster heads selected per round which collect information from associated non CH nodes and aggregate them to make it compact and forward to the base station.
- *Number of alive nodes per round*: This instance reflect the total number of nodes which are able to sense the environment and able to transmit data to either CH or BS.

Simulation Settings

The proposed algorithm simulated on clustered wireless sensor network in the network field of 100m X 100m dimensions. There are a total number of 100 sensor nodes which are randomly (uniformly) deployed over the field. The Base station is located at the top right corner of the sensing field. Initial energy of a normal node is set to $E_0 = 0.1$ Joules, and this value is arbitrary for the purpose of this study that does not affect the behaviour of EABRP protocol. The radio characteristics and other parameters used in the simulations are summarized in the table 1 below.

Notation	Description	Value
E_{TX}/E_{RX}	Electronics energy	50nJ/bit
E_{DA}	Energy of data aggregation	5nJ/bit
ϵ_{fs}	Amplified transmitting energy using free space	10pJ/bit/m ²
ϵ_{amp}	Amplified transmitting energy using multipath fading	0.0013pJ/bit/m ⁴
L_{Data}	Data packet size	500 bytes
L_{Broad}	Broadcast packet size	25 bytes
n	Population Size	100
P_c	Crossover rate	0.75
P_m	Mutation rate	0.1
P_s	Tournament Selection size	5
w	Weight factors	0.6

Table 1. Simulation Parameters

Results and Discussion

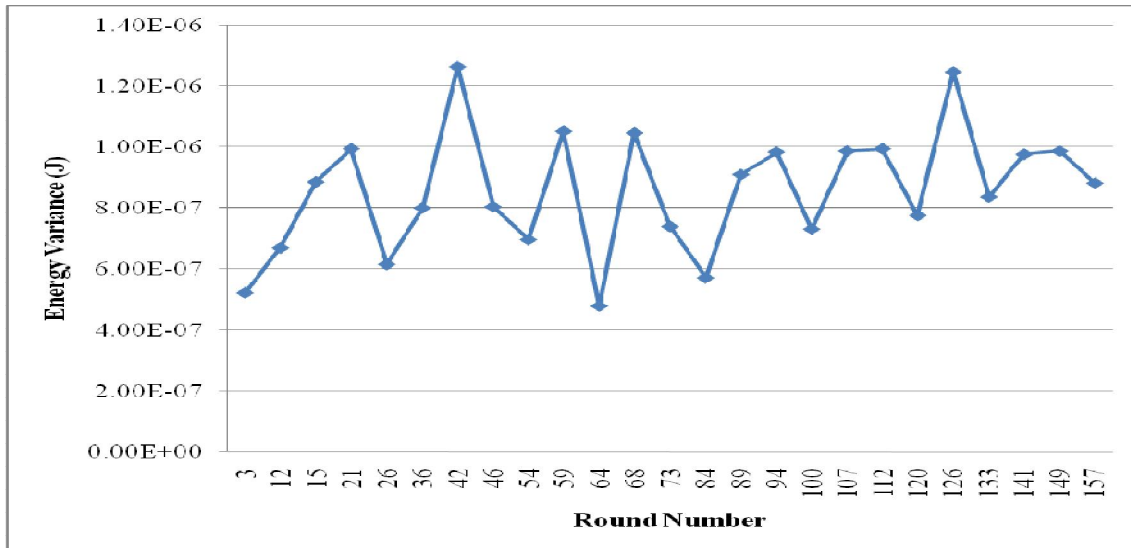


Figure 1. Energy dissipation variance among clusters in the network

Figure 1 shows the energy dissipation variance among clusters in the network. If the total energy dissipation variance among the clusters are high it will shorten the network life time. When one cluster is dissipating too much energy than the rest of the clusters, it will resulted with unbalanced network in which the whole nodes or some nodes which belongs to that cluster running out of energy earlier, this in turn cause some part of the network to be down in the early stage and shorten the network life. The EABRP protocol significantly maintain the balance of energy consumption among the clusters in the network.

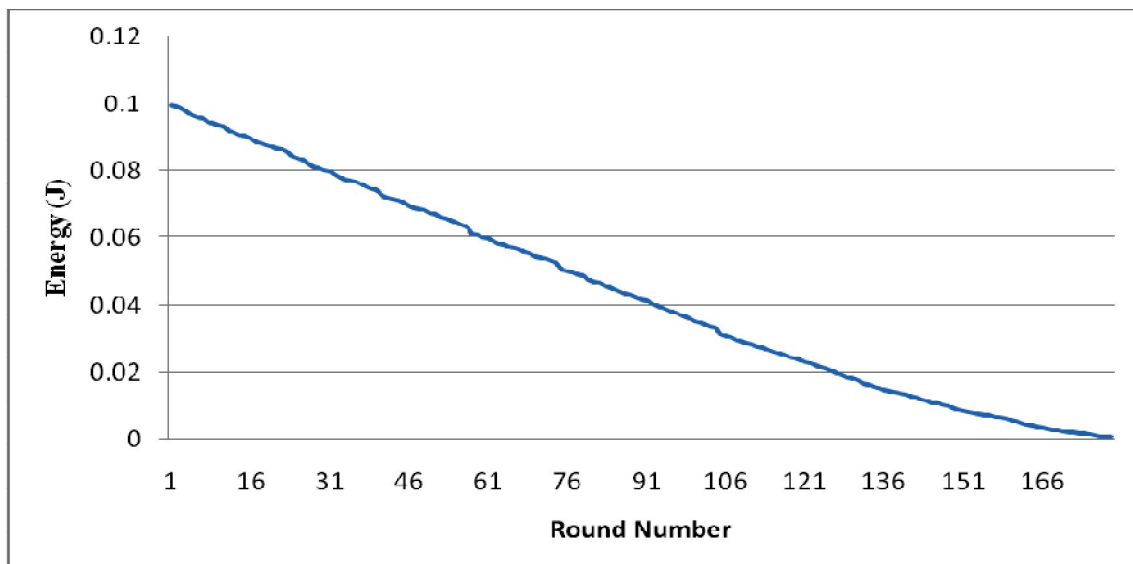


Figure 2. Average residual energy of nodes per round

Figure 2 shows that how the average residual energy of nodes per round decrease smoothly. Reclustering is initiated by BS based on the feedback it would get from CHs nodes. At every round the residual energy of alive node is recorded and the average of the residual energy is computed. As we can see from the chart there is no sudden extreme reduction or fall down of the graph. This reflects how the algorithm is work efficiently.

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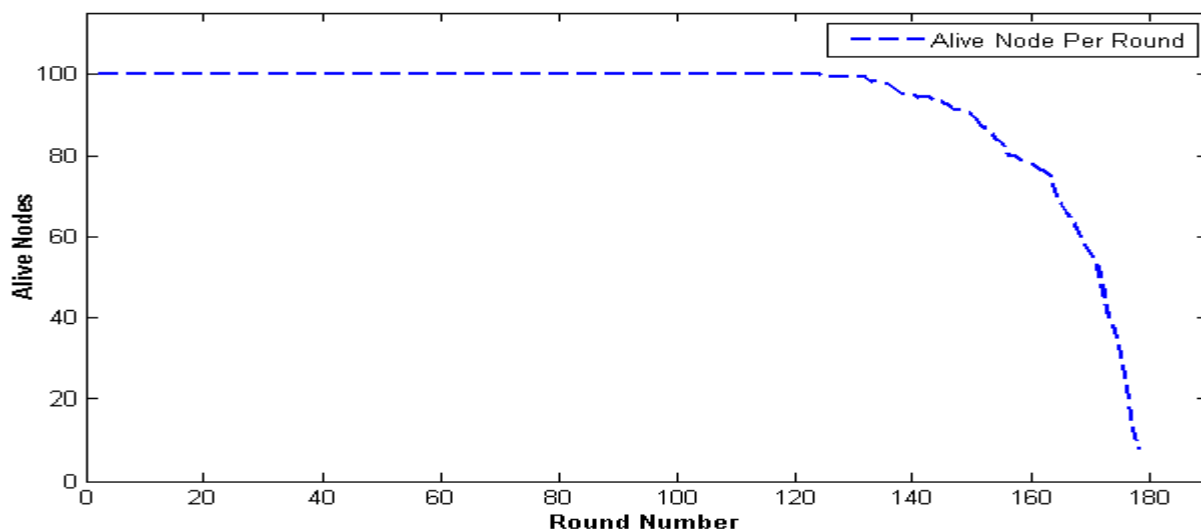


Figure 3. Alive Nodes per round

The stability period of sensor networks are directly dependent on the lifetime of sensor nodes. The network to be said stable all the nodes must be under full operation. As clearly seen from figure 3 stability period of the network is greater than instability period. The figure shows that all nodes are under full operation for 130 rounds out of the total 180 rounds

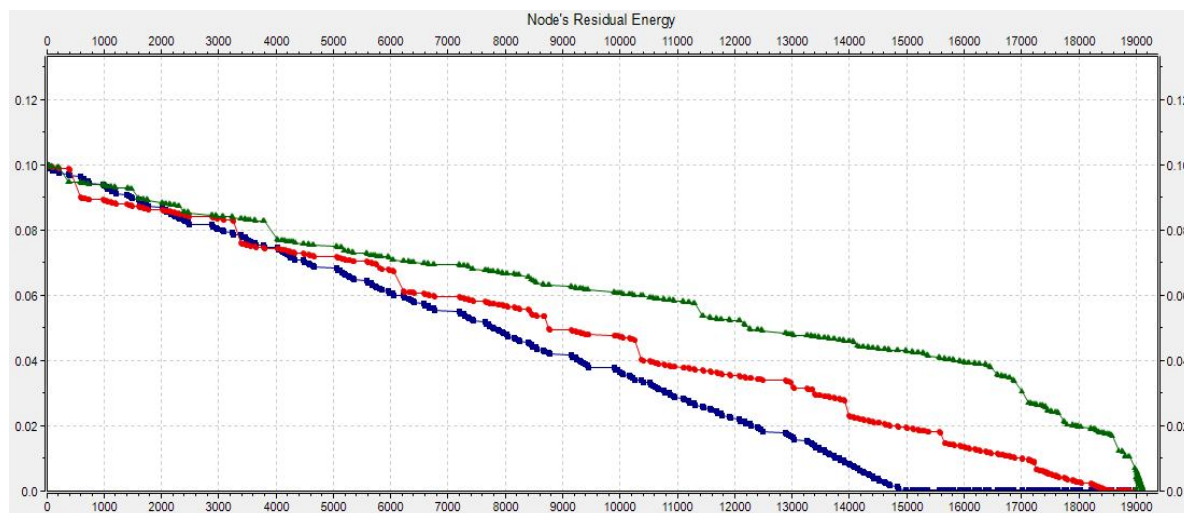


Figure 4.1 Residual energy of nodes

In figure 4 the X-axis represents the simulation time while Y-axis represent residual energy of nodes in joule. The graph represents the residual energy of first dead node and last dead node. And it is clearly depict that the instability period of the network is short. Additionally, it shows how smooth the nodes energy is decreasing. From this I conclude that the EABRP protocol significantly prolong the network life.

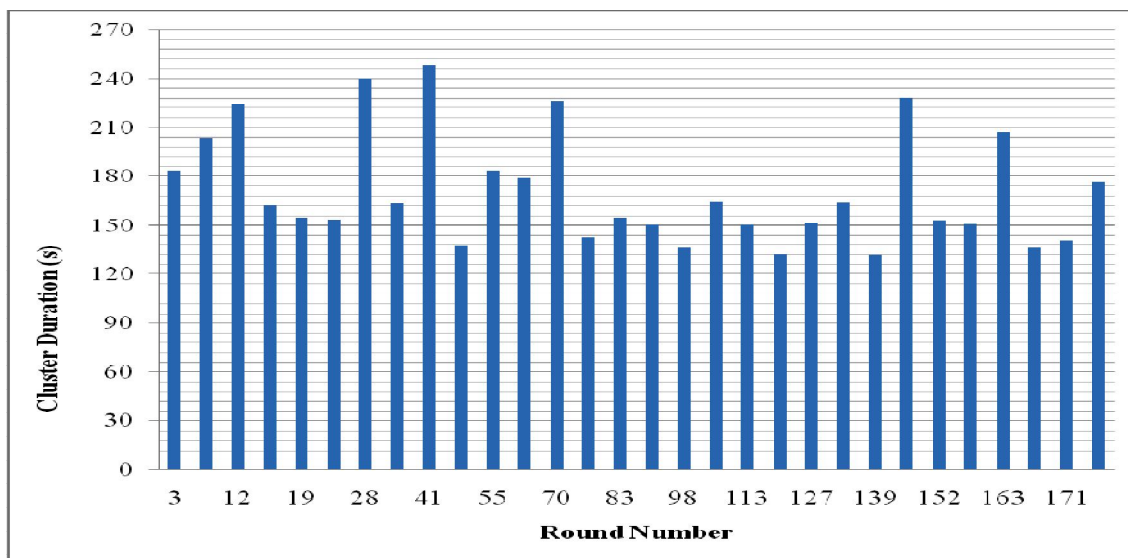


Figure 5. Cluster duration as per simulation timer

Figure 5 represents how long the clusters are operational before it need reclustering. Even the cluster formation is done centrally at the BS, during reclustering the nodes need to communicate directly with the BS to send about their current status. If reclustering is regularly within very short time it will reduce the network life time as the nodes far away from the BS dissipating more energy every reclustering time which may results some nodes die earlier because of long distance communication. The graph clearly shows that most of the clusters are operating for significant period of time before reclustering has been initiated.

V. CONCLUSION

In this paper a protocol that utilize an optimal energy which thereby increasing the network life time is presented. EABRP protocol tries to distribute the network energy evenly among all the network nodes and proposes a specialized approach for selecting the cluster heads. After every round, the base station computes the average energy of all the nodes and compares it with a certain threshold energy level. The nodes whose energy level is greater than the threshold value become eligible to become cluster heads. Then, using a cluster splitting genetic algorithm, it divides the network into several clusters, ensuring that the CHs are uniformly placed throughout the network area. Due to the fact that it can find the solution very quickly without complex computations needed, clustering using genetic algorithm is an efficient method to cluster the networks. Simulation results illustrate that the hierarchical clustering using genetic algorithm decreases the long-distance communication very well and nodes energy depletion is smooth. Further it uses a balanced clustering technique to ensure that all clusters have approximately equal energy dissipation and cluster heads are appear at central position of their member nodes.

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