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Limited Cluster Technique to Enhance Wireless Sensor Network Lifespan

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Abstract

The wireless sensor networks (WSNs) are created to sense data from such environment where human face problems to collect data. A WSN consists of a number of sensor nodes with limited energy. Various routing algorithms have been proposed for WSN communication. This paper uses hybrid approach for sensor node clustering for maximum utilization of power resource. In propose method position of base station and sensor node location plays key role for clustering and data communication. This method considers some nodes for direct data transmission to base station and other advanced node with extra battery power take part for clustering using traditional Low Energy adaptive clustering hierarchy (LEACH). To show effectiveness of proposed method results are compared with existing methods as their throughput and lifetime span.

Keywords: Node position, selective clustering, minimum energy Protocol, Wireless Sensor Networks, network lifetime maximize.

INTRODUCTION

Wireless sensor network is design for collecting data from such place where human interaction is difficult as radioactive fields, deep mines, very warm or cold area etc. Sensor network can also capture required data continuously without any men interaction this improved data collection power. Any sensor network may consist numbers of sensor nodes. These sensor nodes very tiny devices with small board connected physical property sensing elements specially design to sense required data and transmit to base station. These nodes may design to sense temperature, sound, motion, moisture, pressure, pollutants, motion, vibration, radioactive material etc. WSN becomes very attractive area for researcher due to its rapid growth with low cost and advancement as technology changed. WSNs are widely using in many applications such as health monitoring systems, home security system, military deface systems etc. many improved techniques have been produce to enhance working of WSN. To work effectively with sensor nodes algorithm need to be self organizing manner and must maintain function of network as turn off any node at any time.

Sensor nodes send sensing information to base station this information sending process is based on predefine purpose of network. Apart these purpose basically three major types are use for data communication.

- **Clock Driven:** nodes continuously collecting information but transmits only once within predefine time interval.
- **Event Driven:** nodes sense data continuously but send only when any predefine activity take place.
- **Query Driven:** Nodes sense information continuously but send only when data requirement query is generated.

During design of Wireless sensor network any types of data transmission from above can take place but main concern is effective energy utilization. During all phases as planning, installation and data capturing transmission worry is increase sensing time and increase of overall network working lifetime.

Lots of algorithms have been given to improve energy efficiency for sensor network using hierarchical routing methods. Various protocols have been given for improvement of network lifetime. Low energy adaptive cluster head (LEACH) [1] is first and original cluster formation protocol apply on homogenous network. LEACH gives same possibility to become cluster head by assign equal probabilities to each node present in network for one round. But till now LEACH method unable to get its full performance. Another experiment have done by assign different energy levels to nodes and make network heterogeneous for improve energy utilization in Selective Energy Protocols (SEP) [2]. SEP increases levels as two levels of energy assign for nodes.SEP gives more change to

advanced nodes having extra energy to become cluster head. Still SEP unable to improve energy for upper level node effectively to send all sensing information by all sensor nodes till base station within less energy consumption is still challenge. To achieve this there must be a routing protocol to help each node for proper energy consumption with maximum data transmission. The conventional techniques are unable to achieve this target. This can be achieved by combined best methods approaches together as hybrid technique. This hybrid technique can be increase stability time for network, overall life time for network and also helpful to improve efficiency of sensor network by sending more data during lifetime of network.

RELATED WORK

Filter [1] could be a positioned cluster algorithmic governs for considered use of vitality inside the system. Drain utilizes sporadic revolution of the closer cluster head. Filter performs well in uniform conditions. In LEACH every hub has same opportunity to wind up plainly a cluster head. Be that as it may, LEACH isn't perfect for heterogeneous conditions. SEP could be a two level heterogeneous convention presenting two sorts of hubs, customary hubs and propel hubs. Propel hubs have a considerable measure of vitality than conventional hubs. In SEP every hubs ([2] propel hubs) have weighted opportunity to end up cluster head. Propel hubs have a great deal of probabilities to end up cluster head than conventional hubs. SEP doesn't ensure efficient establishment of hubs.

In SEP [2] conventional hubs and propel hubs region unit conveyed subjectively. On the off chance that larger part of customary hubs region unit conveyed secluded from base station it expends a considerable measure of vitality though sending data which winds up inside the shortening of solidness interim and diminish in proficiency. In this way throughput of SEP abatements. to dispose of these imperfections need to partition arrange field in areas. As corners might be most far off ranges inside the field, wherever hubs required additional vitality to transmit data till base station. Hence conventional hubs may put near the base station and they transmit their data specifically to base station. Be that as it may, propel hubs may conveyed long far from base station as they accordingly additional vitality. On the off chance that propel hubs transmit data specifically to base station additional vitality expends, subsequently for spare vitality of propel hubs cluster strategy is actualized on propel hubs alone.

An overview of clustering calculations for WSNs was given by Abbasi et al. [3]. The creators of that study given scientific categorization and order of run of the mill clustering plans, then outlined totally unique clustering calculations for WSNs upheld arrangement of variable merging time conventions and consistent joining time calculations, and highlighted their targets, highlights, unpredictability, and so forth. At last, these clustering methodologies were looked at upheld a few measurements like union rate, cluster steadiness, cluster covering, area mindfulness and support for hub quality.

Arboleda et al. [4] given a correlation overview between totally unique clustering conventions. The creators of the overview specified some essential thoughts related with the clustering strategy, similar to cluster structure, cluster assortments, clustering benefits, and in a nutshell investigated LEACH-based conventions still as proactive and receptive calculations in WSNs. the most attributes of those conventions were analyzed and furthermore the proofs wherever they'll be utilized directly were efficient.

Kumarawadu et al. [5] studied the clustering calculations offered for WSNs and arranged them upheld the cluster development parameters and CH decision criteria. The creators of the review moreover concentrated the key style challenges and specified the execution issues associated clustering conventions bolstered the order of personality based clustering calculations, neighborhood information principally based clustering calculations, probabilistic clustering calculations and naturally inspired clustering calculations.

Distinctive clustering plans square measure specified by Deosarkar et al. [6], with extraordinary weight on their CH decision ways upheld the arrangement of settled subject, accommodating topic and joined metric topic. the costs of CH decision were contrasted with connection with cluster development, dispersion of CHs and formation of clusters. Also, a craving of a considerable measure of ascendible, vitality efficient and stable clustering subject for learning gathering in WSNs was suggest.

Jiang et al. [7] said a total of three exceptional advantages of clustering procedures for WSNs, similar to a ton of quantifiability, less overheads, and basic upkeep, so present an order of WSN agglomeration plans upheld an entire of eight agglomeration qualities. The creators also broke down inside and out six standard WSN clustering calculations, similar to LEACH, PEGASIS, HEED, EEUC, and so on., and thought about these WSN clustering calculations, and also various traits.

Maimour et al. [8] considered clustering routing conventions to acknowledge vitality intensity in WSNs and given a survey on agglomeration calculations from the edge of data routing. a simple arrangement of clustering routing conventions is arranged inside the survey. Completely nine average clustering conventions and also two classes, pre-set up clustering routing calculations and on-request clustering routing calculations, square measure condensed in severally. Also, some future investigation bearings square measure given inside the audit.

The operations of some clustering conventions were said inside the study given in [9], and furthermore the advantages and constraints of each one in every one of these calculations were investigated quickly. The creators of the review assigned

exclusively seven standard clustering calculations for WSNs, similar to LEACH, TL-LEACH, EECS, TEEN, APTEEN, and so on to boot the overview thought about these clustering conventions regarding vitality utilization and system life expectancy.

A review on clustering calculations for WSNs was given by Boyinbode et al. [10]. The most difficulties for agglomeration calculations were specified and inside and out nine normal clustering calculations for WSNs like LEACH, TL-LEACH, EECS, HEED, EEUC, and so forth were simply abridged inside the study. The creators moreover thought about these clustering calculations bolstered measurements like lingering vitality, consistency of CH appropriation, cluster estimate, delay, jump separation and cluster development system.

A study of dynamic routing methods for WSNs was given in [11], whose creators made open the clustering plan in WSNs and given a simple grouping upheld exclusively three qualities, i.e., parameters utilized for CH decision, regardless of whether there exists an incorporated administration all through clustering, and bounces amongst hubs and CH in intra-cluster correspondence. Also, the overview highlighted the difficulties in clustering WSNs and in a nutshell presented a few clustering routing strategies.

Xu et al. [12] have made a simple review of clustering routing conventions, and in addition exclusively six normal clustering calculations. The creators of the review simply thought about these clustering routing calculations upheld some execution parameters, and in addition vitality protection, arrange life expectancy, information conglomeration, heartiness, quantifiability, security, and so forth.

Another simple review on clustering routing calculations was given by Joshi [13]. Exclusively eight standard clustering routing conventions square measure covered amid this study, similar to LEACH, PEGASIS, TEEN, APTEEN, and so on. The creators of the study to sum things up thought about this clustering routing moved toward bolstered vitality protection and furthermore the system life expectancy.

An outline of Haneef and Deng [14] concentrates on style difficulties and relative examination of WSN clustering routing calculations for raising the system life expectancy. The creators of the synopsis broke down a few troublesome elements that impacted style of routing conventions in WSNs, and given a simple order of routing conventions. Additionally, a few viable clustering essentially based traditional WSN routing conventions with near investigation were specified inside the rundown.

In paper, [15] authors gives an adjusted clustering calculation with dispersed self-association for WSNs of non-uniform conveyance, considering ideal design of clusters. Contrasted and conventional clustering calculations, the master postured calculation can frame more steady and sensible cluster structure, and furthermore enhance the system life cycle altogether. The reproduction result demonstrates that the calculation is practical and has prevalent execution. What's more, the situation we propose is adaptable and works for various system sizes.

Terminologies Used

Major terminologies used in this paper can be describe as follows

- **Stability Period:** this period is calculated as time difference between network starts and the time at which first sensor node dead due to out of power.
- **Constancy Period:** This time period defines as time difference between first node dead and the time of last sensor node dead in network.
- **Throughput:** Throughput can be measure as data rate for information transmission within network. This can be define as rate of data sent by cluster head to base station along with data transmission by normal sensor node to base station.
- **Network Lifespan:** This is time interval between network starting time and the time at last sensor node dead within network.
- **Phase:** this is time interval cycle at which nodes are capable to choose new cluster head for network according to predefine scheme.
- **Data Collection:** some nodes are deployed very near to each other due to random nodes distribution topology. These nodes sense same data and transmit to base station thus redundancy of data occurs. So there is need to handle such redundancy to utilize network resources effectively during data aggregation. If data collection have redundant in unusual Collection having contains redundancy in unusual information during communication, this redundancy result to loss of few signal processing systems, this process is known as data fusion.

Proposed Distance Based Protocol

Proposed method uses base station and nodes position very well for effective utilization of energy resource. This method usage heterogeneous wireless sensor network with normal nodes having single battery power and advance node having multiple batteries like SEP scheme as require for improve network lifetime. The base station and node placement is very important here. Base station is placed at the center of network area and all normal node with less energy power are deploy near to base station where all advance nodes are place to network boundary. This unique arrangement helps to improve energy utilization effectively. Data transmission depends on type of node if node is normal then it sense data in each round and transmit to base station directly without clustering, if node

is advance node then it takes part for clustering first then send sense data via cluster head.

Network Architecture

Normally all schemes are design for random node deployment method in WSNs this is major issue to utilize node energy properly in wireless network. So some modifications are needful for making most of energy uses for data transmission in network apart than setup signals communication. This work divides network area in two major regions for optimum energy utilization. These regions are region 0 and head region 1 according to distance from base station and base station place at the center of network. All nodes are deploy according to their energy level some node are with more energy power compare to other nodes known as advance nodes as SEP method, these advance nodes are placed within region 1.

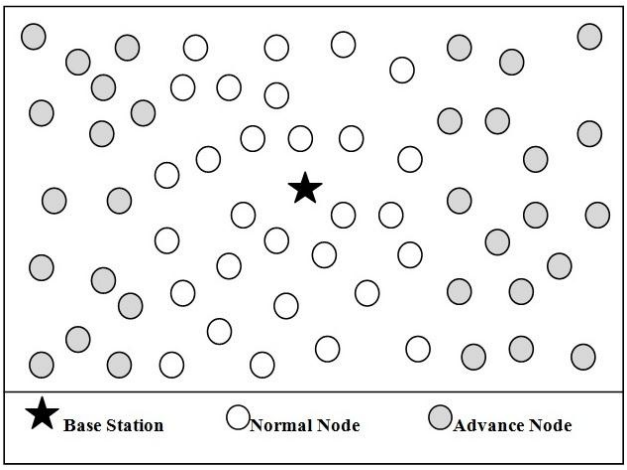

Figure 1: Network Architecture

Suppose m is ratio of total nodes n, having α time more energy power than other nodes. Let these nodes called advance nodes, hence (1-m) ×n is quantity of normal nodes.

Region 0: Normal nodes are placed in random manner in Region 0 near area of base station, lying between 30<X<80.

Head region 1: Half of advance nodes are deployed randomly in this region, lying between 0<X<=20 and 80<X<=100.

This placement is important because advance nodes having more energy levels than normal nodes and sides are most far away distance from centre position of base station so if any nodes wants to send information to base station it have to spend more energy. Hence more energy level nodes placed such area Head Region 1.

Distance Based Protocol function

Proposed Distance based protocol uses two different communications is used for data transmission to base station.

- Direct transmission.
- Transmission via Cluster head.

Direct Transmission

Any node resides within region 0 are near to base station and transmission energy cost using clustering is higher than direct data transmission. So such node does not take part in clustering process and send data directly to base station. This process helps to save energy for normal nodes.

Transmission via Cluster head

The nodes are far away from base station usage more energy to transmit data over long distance so Nodes in Head region 1 send information to base station by applying clustering technique. This clustering method saves energy for member nodes by transmitting data only to cluster head place short distance. Cluster head is chosen between nodes in Head region 1. Cluster head collect information from its all member nodes, aggregate them into single message and then transmit it to base station. Base station extracts information for each node from received message. Cluster head election is main task and important function this selection is done by LEACH cluster head election algorithm. Fig. 1 illustrates complete architecture for WSN network node placement for normal and advance nodes. Here advanced nodes are represented in dark color and normal nodes are shown in white color. Advance nodes are deployed within head region 1 to make proper use of their battery remaining energy and normal nodes are deployed nearby base station to save their battery energy this arrangement improves network operation life time. Clustering process is done only for advance nodes communication to base station.

Here consider that most favorable number of clusters Kopt and n is the number of advance nodes to minimize over heads. As mention in SEP optimal probability for cluster formation to decide cluster head by following formula using Kopt and n can given as

$$P_{opt} = \frac{K_{opt}}{n} \quad (1)$$

Each node chooses whether to be converted into cluster head within ongoing phase or not. Any random number among 0 and 1 is produced for node de. If generated random no. is a smaller than or equivalent to threshold T(n) for a node then this node is selected as cluster head of current cluster. Threshold T(n) can be express by following equation

$$T(n) = \begin{cases} \dfrac{P_{opt}}{1 - P_{opt}\left(r \times mod \frac{1}{P_{opt}}\right)} & if\ n \in G \\ 0 & otherwise \end{cases} \quad (2)$$

Where G is the group of all nodes could not be cluster heads during last 1/Popt phases. Probability that any advance node to selected as cluster head as given in [2] can be express as

$$P_{adv} = \frac{P_{opt}}{1 + (\alpha . m)} \times (1 + \alpha) \quad (3)$$

By above equation threshold value for advance nodes can be given as

$$T(n) = \begin{cases} \dfrac{P_{adv}}{1 - P_{adv}\left(r \times mod \frac{1}{P_{adv}}\right)} & if\ adv \in G' \\ 0 & otherwise \end{cases} \quad (4)$$

G' is the group of all advance nodes could not be cluster heads during last 1/Popt phases.

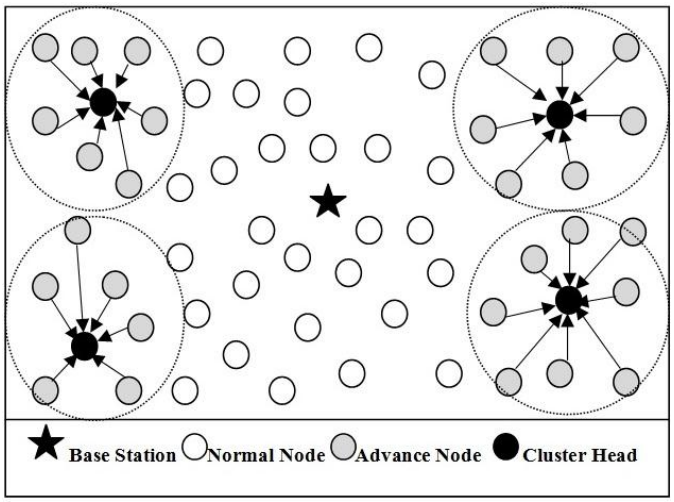

Figure 2: Nodes sending data to cluster head

Whenever cluster head is selected then cluster head inform all other nodes by broadcast a message. All nodes under CH transmission range receive message and store information about cluster head for current phase. Thus cluster formation is completed. All member nodes response to CH and connect as member to CH for current phase data transmission. CH usage TDMA slot as predefine scheduling algorithm for member nodes, all member send its data to cluster head. Fig. 2 demonstrates this overall process in detail. After completion of clustering process all member nodes send data to CH and CH send this combined information to base station, this process is called as transmission phase as Fig.3 highlight this process.

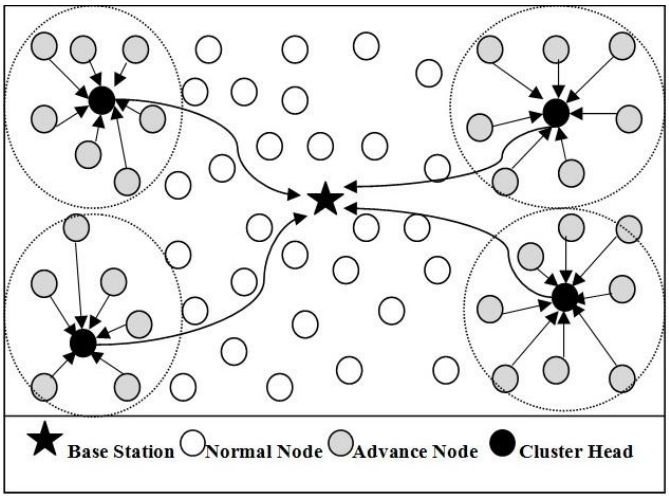

Figure 3: Cluster head transmitting data to base station.

The normal nodes (placed in Region 0) are no need to form cluster because they have lesser energy compare to advance nodes energy and if any normal node become cluster head then it require more energy to schedule and transmit all members' data to base station. If any normal nodes become cluster head it will dead very soon and this leads to shortening of consistency period. Overall network lifetime will be very short. Fig.4 consist proposed work operation in flowchart form.

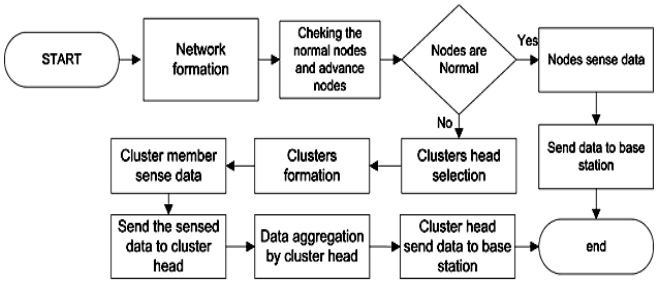

Figure 4: Flow chart of Distance Based procedure

SIMULATIONS

This proposed work performed within a network area having dimensions 100m height and 100m width, 100 nodes are placed in predefine regions according to their energy level. It is assumed that the Base station is situated at center of the network area. This work employs the first order radio model same as mentioned in traditional SEP scheme. For result analysis and graph comparison MATLAB is used to implement proposed work as simulator. Some predefine settings are considered for WSNs network as following. Here 20% of nodes are form as advance nodes and they are placed in Head region 0. While Popt is set to 0.1 hence there should be 2 cluster heads per round. One cluster head selected from

left side area and other cluster head is selected from right side area during each phase. All Other necessary parameters are given in Table 1.

Table 1: Simulation parameters

Parameters	Value
Initial energy Eo	0.5 J
Initial energy of advance nodes	Eo(1+α)
Energy for data aggregation EDA	5 nJ/bit/signal
Transmitting and receiving energy Eelec	5 nJ/bit
Amplification energy for short distance Efs	10 Pj/bit/m2
Amplification energy for long distance Eamp	0.013 pJ/bit/m4
Probability Popt	0.1

RESULT AND DISCUSSION

This section gives result comparison of proposed method with traditional SEP and LEACH. This work involved heterogeneity in LEACH, as all parameters are considered same to SEP algorithm. The goals of this work are as follow to check the constancy time of LEACH, SEP and proposed work. This work also inspects the throughput of LEACH, SEP and proposed work.

Fig.5 and Fig.6 illustrate outcome for the case while m=0.2 and α=1. According to this setting network have 20 advance nodes from total 100 nodes and remaining 80 nodes are normal nodes who do not participate in clustering method. As proposed work these 20 advance nodes place in random manner within Head region 0. Fig.5 explains the total alive nodes against total phases completed. Fig.5 obviously gives result that proposed work improved as compare to SEP and LEACH methods in requisites of constancy.

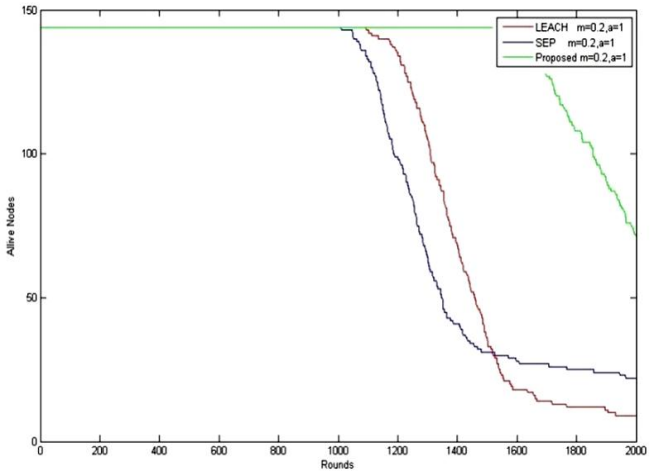

Figure 5: Alive nodes in LEACH, SEP and proposed method

The known that LEACH is not good for heterogeneity conditions so nodes are dead at a higher dead rate. SEP achieve good results compared to LEACH for network heterogenic in nature, apart this SEP consist weighted probability scheme for selecting cluster head and it form cluster for both normal nodes and also for advance nodes. Proposed scheme shows improved results in compare to all other techniques LEACH and SEP, since nodes in Region 0 (normal nodes) transmit information directly to base station on other hand advance nodes in head region 1 transmit data using clustering method till base station using cluster head.

Cluster head uses additional energy for information collection and as well via getting information from member nodes in the current cluster. But this method saves energy of member nodes and normal nodes because they do not need to collect information and getting information from further nodes, hence energy is not exhausted as spend as cluster head, this leads to improves constancy time of network. Fig 5 clears that network lifespan is increase with help of advance nodes. Advance node contains time large energy than ordinary nodes hence advance nodes can survive longer duration as compare to normal nodes. This help to increase overall network life time and stability period of network.

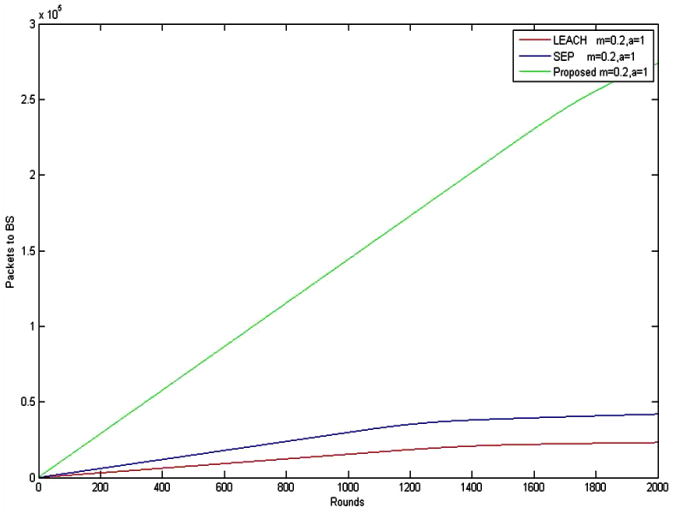

Figure 6: Throughput of LEACH, SEP and proposed scheme

Fig.6 shows the throughput of proposed scheme it is more improved than LEACH and SEP for the reason that each normal node directly transmit information to base station. Throughput of other methods as LEACH and SEP is a lesser amount in compare to propose scheme reason of simply cluster head transmits information base station apart any node.

Fig.7 and Fig.8 explains effectiveness of proposed method for the value of m=0.1 and α=2. In the experiment total 10 advance nodes in the network area within Head region 1. Yet present energy is improved i.e. α=2.

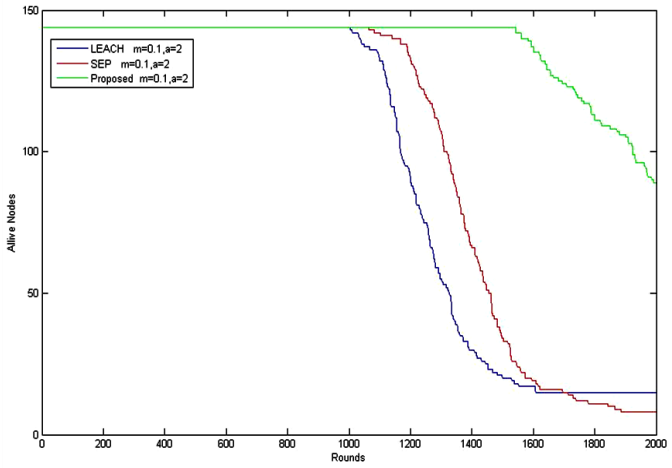

Figure 7: Alive nodes in LEACH, SEP and proposed method

From Fig.7, we can see that stability time of proposed technique is roughly similar for both cases i.e. (m=0.2, α=1 and m=0.1, α=2). The cause following is that normal nodes contain equal quantity of energy, they utilize equal quantity of energy and they expire about at the equal time as earlier, still network life span is better for the reason of the additional energy of advance nodes contains. Constancy period of LEACH is reduced the reason that LEACH is very responsive to heterogeneity. LEACH does not have weighted scheme as in SEP in favor of even placement of extra energy nodes. In LEACH each node has equivalent possibility of becoming cluster head thus normal nodes dead earlier than advance nodes. Fig. 8 demonstrates throughput for LEACH, SEP and Distance Based method. Throughput of proposed method is better in compare to LEACH and SEP even though energy of advance node has been enlarged.

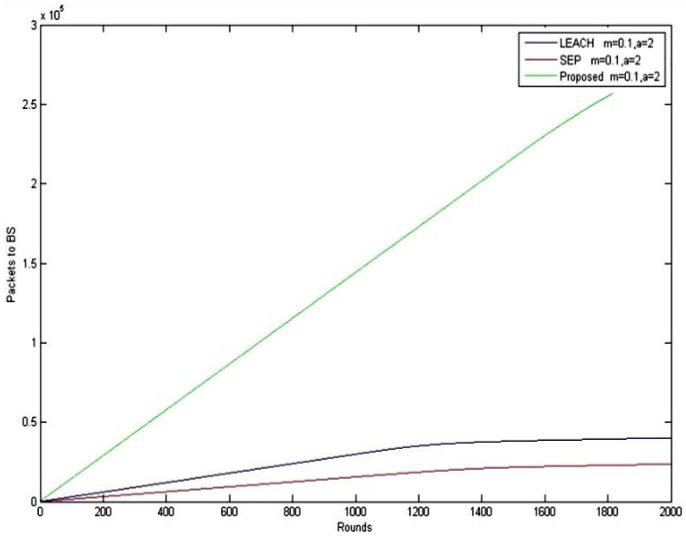

Figure 8: Throughput of LEACH, SEP and proposed method.

Table 2: Comparison Table When m=0.2 and α=1

Protocol	Stability Period (Rounds)	Network Lifetime (Rounds)	Throughput (Packets)
LEACH	1018	4685	1.99×10^4
SEP	1089	3005	3.43×10^4
proposed method	**1531**	**4119**	**2.21×10^5**

Table 3: Comparison Table When m=0.1 and α=2

Protocol	Stability Period (Rounds)	Network Lifetime (Rounds)	Throughput (Packets)
LEACH	899	5583	2.44×10^4
SEP	1150	5078	4.02×10^4
proposed method	**1584**	**5966**	**2.26×10^5**

The Table 2 and Table 3, compare the standard results for LEACH, SEP and Distance Based SEP method. Roughly 50% permanence time of proposed method is improved from LEACH and SEP, still network life span is reduced with compared to LEACH. While in match up to SEP, proposed method network life span is improved reason of advance nodes which are dead in low rate compare to normal nodes. Network life span of SEP is small since of the weighted possibility for normal and advance nodes in the network area.

CONCLUSION

This work, gives system for heterogeneous circumstances as two phase heterogeneity. The system range isolated into two areas: Region 0, Head Region 1. Typical less vitality hubs are just sorted out in district 0 for limiting the vitality usage and they convey information direct to base station. All of cutting edge hubs are conveyed in Head area 1 and they just apply clustering plan to send data to base station. Vitality and life time charts have demonstrated that the steadiness time is enhanced about half, by means of just moving the situation of the divergent hubs in various areas in system range on premise of their vitality imperative. Throughput of given plan too enhanced as measure with LEACH and unique SEP.

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