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Distance Based Approach to Improve Consistency WSNs

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***Abstract*— Wireless Sensor Networks (WSNs) are includes large number of sensor nodes, within limited energy, to facilitate cooperation to achieve any sensing duty. a range of routing methods are deliberate for data communication in WSNs. This paper, gives a hybrid routing scheme, Distance based-Stable Election Protocol (DBSEP) for heterogeneous WSNs which consider distance of node from base station than decide data transmission method. This method consider some nodes for directly send information to base station whereas some node have to apply clustering technique to transmit information to base station as in Stable Election Protocol (SEP) mechanism. We implemented distance based election and compared it with traditional Low Energy adaptive clustering hierarchy (LEACH) and SEP. Simulation modeling outcomes confirms effectiveness of distance based protocol which improved the permanence period and throughput in comparison of presented methods like LEACH and SEP**

***Index Terms*— Distance based Stable, Election, Protocol, Wireless, Sensor, Networks.**

I. INTRODUCTION

WSNs are network consists of lots of nodes as sensor elements which are spread randomly for purpose of monitoring various parameters as require fulfilling different applications. Parameters to be measure may be temperature, sound, vibrations, pressure, motion or pollutants from different geographical locations where human can't reach for measurements. As technology improves in field of wireless communication it help lot to developed WSN network as provide low cost various application support such as home security, health monitoring military services etc. lots of research till now going for overcome various technical issues in mentions application on different levels. Sensor nodes having mechanism those are capable sensing facts, processing information and also contact components to further spread or accept data. The procedures and algorithms of this type of networks have to hold self-organizing ability to guarantee precise and proficient functioning of network.

- Data transmission within WSNs takes place by various methods which absolutely depends lying on the purpose. Usually, three major types of communication used:
- Clock Driven: Sensors sense and collect information at continuously and once in a while transmit.
- Event Driven: Transmission is activated by a individual result.
- Query Driven: Transmission take place by generation of a desire query.

In mention all types of data transmission, resourceful utilization of energy is worry during learning, planning or installations of this type networks to extend the sensing time and the whole life span of the network.

Hierarchical routing methods have been establishing additional energy proficient routing methods. Numerous protocols are deliberate for standardized networks. LEACH [1] is original grouped supported routing algorithm applied on homogeneous type network. LEACH allocates equivalent possibility for every node to be performed as cluster head of current group. Still, LEACH does not achieve best performance in heterogeneous situation. Heterogeneity of nodes through value to their battery energy point has as well showed additional lifetime for WSNs. For enhance energy effectiveness of WSNs, SEP [2] was given on WSNs. SEP has more levels such as two levels for maintain energy of nodes in heterogeneous situations. SEP allocates different chance to be any node cluster head on the according to their energy level. Yet, SEP not implies additional energy of upper level nodes proficiently.

For sending information to base it perform within minimum use of energy. To do this there is need to good routing protocol algorithm. Such protocol must help to proper energy utilization for each node in WSN. Traditional methods are not capable to complete this task. So here is need of hybrid approach which can perform efficient energy utilization by combining more than one method together for improvement of stability period, network lifespan and also efficiency of the network.

II. RELATED WORK

A survey of clustering algorithms for WSNs was given by Abbasi et al. [3]. The authors of that survey given taxonomy and classification of typical clustering schemes, then summarized completely different clustering algorithms for WSNs supported classification of variable convergence time protocols and constant convergence time algorithms, and highlighted their objectives, features, complexity, etc. Finally, these clustering approaches were compared supported a couple of metrics like convergence rate, cluster stability, cluster overlapping, location-awareness and support for node quality.

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Arboleda et al. [4] given a comparison survey between completely different clustering protocols. The authors of the survey mentioned some basic ideas associated with the clustering method, like cluster structure, cluster varieties, clustering benefits, and in brief analyzed LEACH-based protocols still as proactive and reactive algorithms in WSNs. the most characteristics of those protocols were compared and also the evidences wherever they'll be used presently were systematic.

Kumarawadu et al. [5] surveyed the clustering algorithms offered for WSNs and classified them supported the cluster formation parameters and CH election criteria. The authors of the survey additionally studied the key style challenges and mentioned the performance problems connected clustering protocols supported the classification of identity-based clustering algorithms, neighborhood data primarily based clustering algorithms, probabilistic clustering algorithms and biologically impressed clustering algorithms.

Different clustering schemes square measure mentioned by Deosarkar et al. [6], with special stress on their CH choice ways supported the classification of settled theme, reconciling theme and combined metric theme. the prices of CH choice were compared with relation to cluster formation, distribution of CHs and creation of clusters. Besides, a desire of a lot of ascendible, energy economical and stable clustering theme for knowledge gathering in WSNs was recommend.

Jiang et al. [7] mentioned a complete of three outstanding benefits of clustering strategies for WSNs, like a lot of measurability, less overheads, and simple maintenance, so current a classification of WSN agglomeration schemes supported a complete of eight agglomeration attributes. The authors additionally analyzed altogether six standard WSN clustering algorithms, like LEACH, PEGASIS, HEED, EEUC, and etc., and compared these WSN clustering algorithms, as well as numerous attributes.

Maimour et al. [8] thought of clustering routing protocols to realize energy potency in WSNs and given a review on agglomeration algorithms from the angle of information routing. an easy classification of clustering routing protocols is planned within the review. Wholly nine typical clustering protocols as well as two categories, pre-established clustering routing algorithms and on-demand clustering routing algorithms, square measure summarized in severally. Besides, some future analysis directions square measure given within the review.

The operations of some clustering protocols were mentioned within the survey given in [9], and also the benefits and limitations of every one in all these algorithms were analyzed briefly. The authors of the survey designated solely seven standard clustering algorithms for WSNs, like LEACH, TL-LEACH, EECS, TEEN, APTEEN, and etc. to boot the survey compared these clustering protocols in terms of energy consumption and network lifespan.

A survey on clustering algorithms for WSNs was given by Boyinbode et al. [10]. The most challenges for agglomeration algorithms were mentioned and altogether nine common clustering algorithms for WSNs like LEACH, TL-LEACH, EECS, HEED, EEUC, etc. were merely summarized within the survey. The authors additionally compared these clustering algorithms supported metrics like residual energy, uniformity of CH distribution, cluster size, delay, hop distance and cluster formation methodology.

A survey of progressive routing techniques for WSNs was given in [11], whose authors made public the clustering design in WSNs and given an easy classification supported solely three attributes, i.e., parameters used for CH election, whether or not there exist a centralized management throughout clustering, and hops between nodes and CH in intra-cluster communication. Moreover, the survey highlighted the challenges in clustering WSNs and in brief introduced a couple of clustering routing techniques.

Xu et al. [12] have created an easy survey of clustering routing protocols, as well as solely six typical clustering algorithms. The authors of the survey merely compared these clustering routing algorithms supported some performance parameters, as well as energy conservation, network lifespan, knowledge aggregation, robustness, measurability, security, and etc.

Another easy survey on clustering routing algorithms was given by Joshi [13]. Solely eight standard clustering routing protocols square measure coated during this survey, like LEACH, PEGASIS, TEEN, APTEEN, etc. The authors of the survey in brief compared this clustering routing approached supported energy conservation and also the network lifespan.

An overview of Haneef and Deng [14] focuses on style challenges and comparative analysis of WSN clustering routing algorithms for raising the network lifespan. The authors of the summary analyzed several difficult factors that influenced style of routing protocols in WSNs, and given an easy classification of routing protocols. Besides, several effective clustering primarily based classical WSN routing protocols with comparative analysis were mentioned within the summary.

LEACH [1] could be a ranked cluster algorithmic rule for considered usage of energy within the network. LEACH uses irregular rotation of the nearer cluster head. LEACH performs well in uniform conditions. In LEACH each node has same chance to become a cluster head. However, LEACH isn't compatible for heterogeneous conditions. SEP could be a two level heterogeneous protocol introducing two kinds of nodes, traditional nodes and advance nodes. Advance nodes have a lot of energy than traditional nodes. In SEP each nodes ([2] advance nodes) have weighted chance to become cluster head. Advance nodes have a lot of probabilities to become cluster head than traditional nodes. SEP doesn't guarantee economical installation of nodes.

In SEP [2] traditional nodes and advance nodes area unit deployed arbitrarily. If majority of traditional nodes area unit deployed isolated from base station it consumes a lot of energy whereas sending information which ends up within the shortening of stability interval and reduce in efficiency. Therefore throughput of SEP decreases. to get rid of these flaws need to divide network field in regions. As corners may be most distant areas within the field, wherever nodes required extra energy to transmit information till base station. thus traditional nodes may placed close to the base station and they transmit their information directly to base station. but advance nodes may deployed long far away from base station as they thus extra energy. If advance nodes transmit information directly to base station extra energy consumes,

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hence for save energy of advance nodes cluster technique is implemented on advance nodes alone.

III. Terminologies Used

Few terms are used in this work these are explain here

- **Stability Period:** this is just Time interval of time at which network start and the time at which first sensor node dead.
- **Constancy Period:** difference of Time between death of first sensor node and time at last sensor node dead.
- Throughput: Throughput is just total data rate of at which information sent within network, it is rate of data transmitted from cluster heads till base station along with rate of data transmitted to base from normal sensor nodes.
- **Network Lifespan:** Time difference between time start of the network and time at which death of the last alive node.
- **Phase:** integer amount of cycles after which a node are capable to choose as cluster head.
- **Data Collection:** nodes within a nearer distance generally share almost same data to base station. So there should be restriction in such situations for reduce energy expenditure is data aggregation. Collection having contains redundancy in unusual information communication. While the redundancy is accomplished by a few signal processing systems, this procedure is known as data fusion.

IV. Proposed Distance Based Proptocol

The proposed method is advancement of SEP scheme. This proposed work pursues hybrid mechanism i.e. direct data communication and data communication using cluster head. Here detail discussion is given with the functioning of proposed work.

A. Network Architecture:

Most of the routing protocols nodes are place in random manner within the network area thus overall energy of nodes can't be utilized properly. This work modified such existing method and considers network area as two regions: region 0, Head region 1, by energy levels of nodes and X co-ordinate of network field. This is assumed that some ratio of node from all nodes having more energy level to compare with others. 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 center 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.

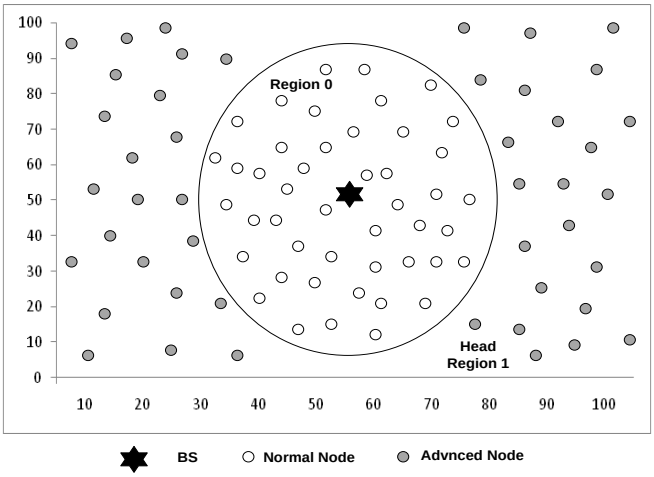

Fig. 1. Network Architecture

B. Distance Based Protocol function

Distance based protocol employ two methods to send information to base station. methods are:

- Direct transmission.
- Communication using Cluster head.

a) Direct Transmission

Nodes in Region 0 transmit information directly to base station. Normal nodes sense atmosphere, collected information of concern and transmit this data directly to base station.

b) Transmission via Cluster head

Nodes in Head region 1 send information to base station by applying clustering technique. Cluster head is chosen between nodes in Head region 1. Cluster head gather information from member nodes, comprehensive it and then sends it to base station. Cluster head election is main task and important function. Fig. 1 give all detail regarding WSN network node placement here advanced node are represented in dark color and normal node are shown in white color. Advance nodes are placed in head region 1 to utilize their battery power properly and normal nodes are placed nearby base station to save their battery power for increase network life span. Always Cluster is created only for advance nodes communication for 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

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

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

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

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

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

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

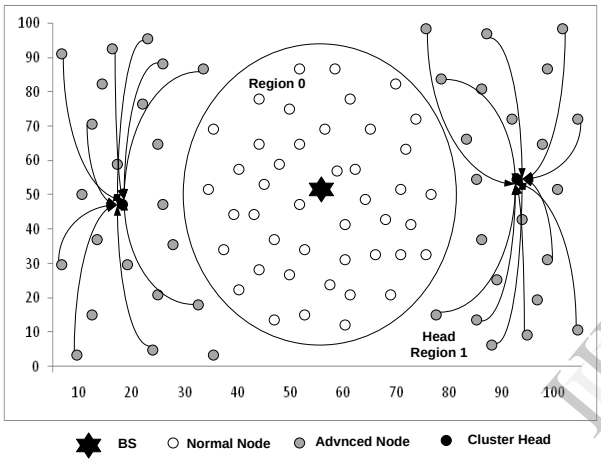

Fig. 2. Nodes sending data to cluster head

When cluster head is identified then it broadcasts a message to inform all nodes. All nodes within range of cluster head received information message and decide to which cluster node is head for current phase. This process is known as cluster formation phase. Nodes respond to cluster head for which get maximum signal strength and connect as cluster member of cluster head. Cluster head allocate TDMA slot as per scheduling algorithm for member nodes with help to these slots member send its data to cluster head. As cluster formation process is finished each member node gather information and transmitted it to cluster head within time slot allocated by cluster head. This detail process is given in fig. 2.

After receiving sensed information from all member nodes, Cluster head combined this data and then transmit this data to the base station this process is called as transmission phase. Fig.3 demonstrates this process.

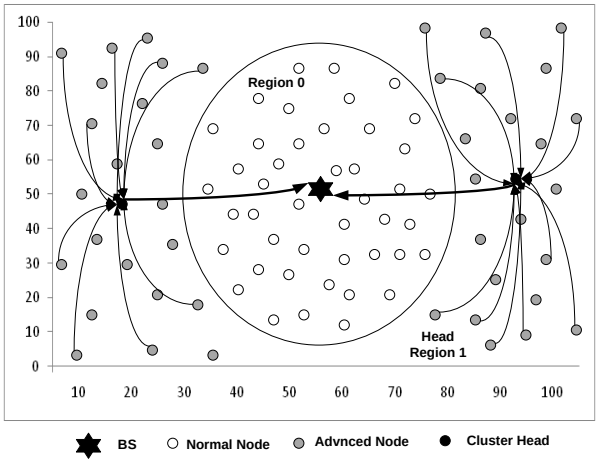

Fig. 3. Cluster head transmitting data to base station

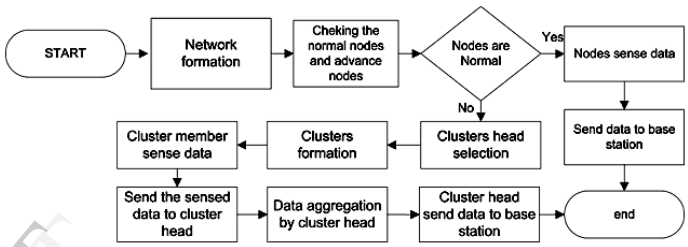

Fig. 4. Flow chart of Distance Based procedure

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.

V. 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.

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TABLE I. 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

VI. 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.

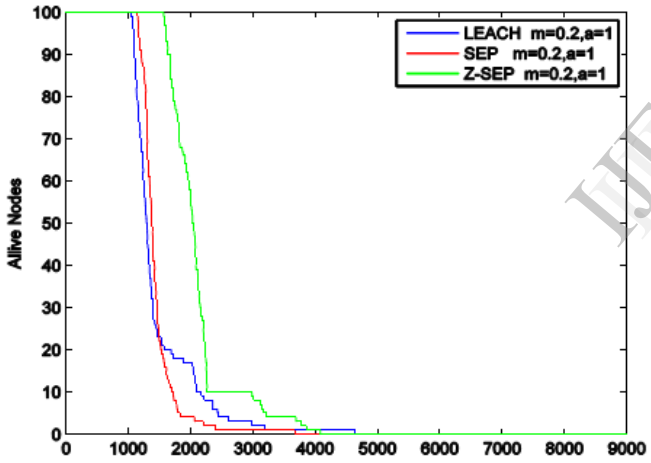

Fig. 5. Alive nodes in LEACH, SEP and proposed method

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.

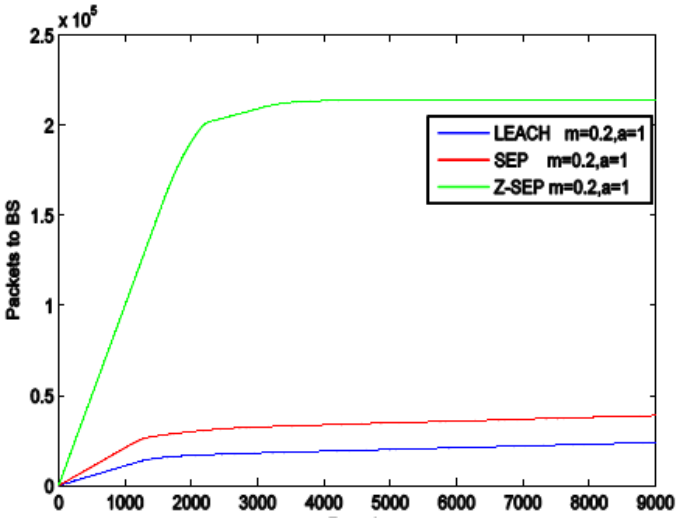

Fig. 6. Throughput of LEACH, SEP and proposed scheme

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.

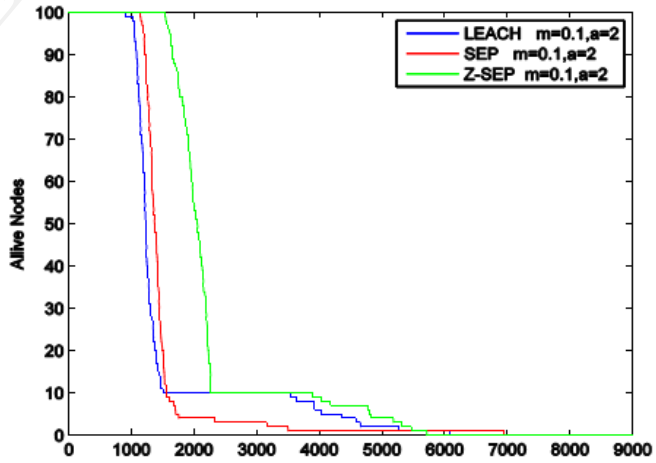

Fig. 7. Alive nodes in LEACH, SEP and proposed method

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.

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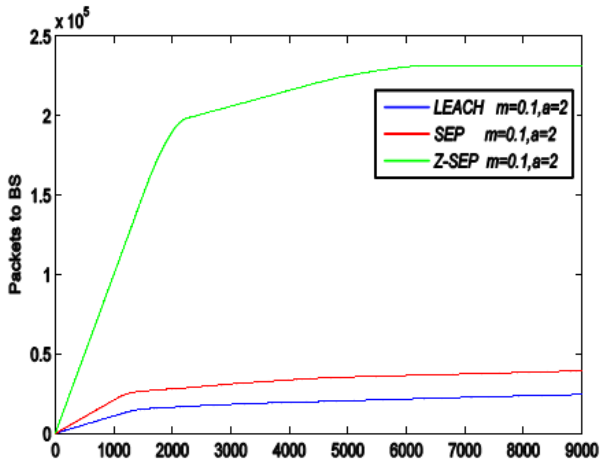

Fig. 8. Throughput of LEACH, SEP and proposed method

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.

TABLE II. COMPARISON TABLE WHEN M=0.2 AND A=1

Protocol	Stability Period (Rounds)	Network Lifetime (Rounds)	Throughput (Packets)
LEACH	1018	4685	1.99×104
SEP	1089	3005	3.43×104
proposed method	1531	4119	2.21×105

TABLE III. COMPARISON TABLE WHEN M=0.1 AND A=2

Protocol	Stability Period (Rounds)	Network Lifetime (Rounds)	Throughput (Packets)
LEACH	899	5583	2.44×104
SEP	1150	5078	4.02×104
proposed method	1584	5966	2.26×105

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.

VII. CONCLUSION

This work, gives technique for heterogeneous situations as two stage heterogeneity. The network area separated in to two regions: Region 0, Head Region 1. Normal less energy nodes are only organized in region 0 for minimizing the energy utilization and they send out data straightforward to base station. All of advanced nodes are deployed in Head region 1 and they only apply clustering scheme to send information to base station. Energy and life time graphs have proved that the constancy time is improved roughly 50%, via only shifting the placement of the dissimilar nodes in different locations in network area on basis of their energy constraint. Throughput of given scheme as well improved as measure with LEACH and original SEP.

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