Advancement of Zone Based Energy Efficient Protocol for WSN

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ABSTRACT

The Wireless Sensor Networks (WSNs) is an area of emerging technology which involves numerous number of sensor nodes/motes, a base station, processing power and storage. However, these have very limited power. The nodes exchange data and control messages with each other and towards the base station to fulfill a sensing and monitoring process. In present work, we have suggested a region based routing protocol for heterogeneous WSNs. In proposed technique, few motes forward data straight to the base station (BS) whereas other motes follow clustering method to forward data to the BS. We have employed R-SEP protocol and equated with standard Low Energy adaptive clustering hierarchy (LEACH) and SEP protocols. Experimental outcomes exhibits that R-SEP improves the lifetime of WSN and the amount of work accomplished in the network by R-SEP is much more than the conventional LEACH and SEP protocols.

KEYWORDS: Sensor networks, Stability, R-SEP, Lifespan

INTRODUCTION

As an icon of the new generation of sensor networks, the WSN is a dispersed self-forming architecture which incorporates data procurement, handling and transmission operations [1]. It has a widespread variety of applications in various significant areas, like cultivation, transport, and soldierly. Generally, the motes are operated with little battery power [2-3], thus the objective of prolonging the lifespan of the WSN may be accomplished through reduction of unnecessary power depletion [4].There is a need of an effective technique which can reduce power consumption of the network [5-6]. The clustering is a very useful procedure used in WSN for communication and energy saving purpose [7-8]. In clustering, there are mainly three stages: formation of clusters, selection of cluster heads (CHs),and data forwarding towards CHs and BS of the network. During cluster formation, the sensors form clusters of various ranges, i.e. it is not necessary that all clusters have equal number of sensors. On the basis of some threshold and probability out of all sensors, few are choose as the CHs while the residual sensors work as the member nodes in the cluster. During the data forwarding stage the member sensors are capable of gathering surrounding information.

This information is aggregated and fused and then transmitted towards the CHs which in turn forward it to the BS. Figure 1 illustrates a conventional WSN.
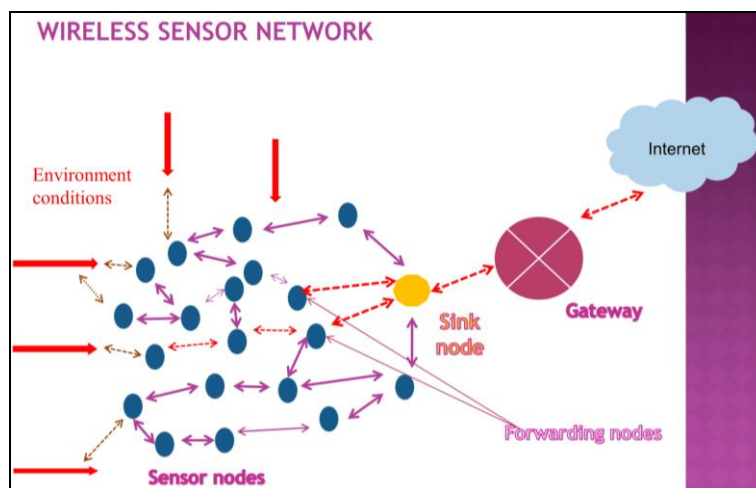

Figure 1: Wireless Sensor Network

In few past years, academicians from different area have anticipated different types of clustering mechanism for WSNs. The main issue with the WSN is that with time few of its nodes die earlier than the other nodes of the network. As these nodes functions constantly, the nodes will ultimately die owing to the endless consumption of power. When some node die and some remain alive, it is known as hot spot or energy holes problem [9-10].This issue has been resolved by authors in [11] through division of entire area into small zones and employing the gateway in each zone, the authors also have used clustering technique to mitigate the energy holes problem. The issues realized due power depletion in WSN chiefly contain two features: The unnecessary and unbalanced power depletion. The unbalanced energy depletion causes the energy holes problem whereas the excess energy depletion leads to the average power depletion of the sensors in the WSN and consequently there is deterioration in the total enactment of WSN. Procedures in [12-14] avoid excess energy consumptions in wireless body area networks through gateway node and spiral arrangements of the nodes.

Keeping in consideration the perception of effectual and balanced power consumption, we hereby designed a power proficient clustering routing protocol for WSN. The elementary ground is as follows: To curtail the overall power depletion of the WSN, we suggest an innovative network organization pro to type and originate the optimum number of clusters conferring to the previous standard power consumption paradigm [15].

The clusters for me din conventional clustering mechanism are of numerous sizes, as a result, there is unbalanced power depletion (the power depletion of CHs in big size clusters is generally very higher than that in small clusters.). To lessen this issue, gateway can be employed to lessen the distance among the sensors inside the clusters during the cluster formation stage.

Related work:
There are numerous popular protocols, like LEACH [15], SEP (Stable Election Protocol) [16], DEEC (Distributed Energy-Efficient Clustering) [17], and HEED (Hybrid Energy Efficient Distribution) [18].

The LEACH [15] is a hierarchical clustering method which tries to ensure stable usages of available power in the WSN. It makes arbitrary alternation of the native CH. Although it works fine in homogeneous atmosphere and here all sensors have equal probability of becoming a CH but it does not work fine for heterogeneous atmosphere.

The SEP [16] is a heterogeneous protocol which performs at two level. It has two kinds of sensors, normal and advance sensors. The advance ones have extra energy than normal ones. Both types of sensors have equal weighted probability to turn out to be a CH. Advance sensors have additional probabilities to be a CH than the normal sensors. It does not ensure effective placement of sensors.

The DEEC [17] illustrates manifold heterogeneity. The CH configuration is conferred to remaining power of sensors and average power of the WSN. The sufficient power based sensor has extra possibility to become a CH than small power sensor. In case of SEP normal sensor and advance

sensor are positioned arbitrarily. If bulk of normal sensors are positioned far-off from BS, it utilizes extra power where as communicating data that leads to the restraining of constancy epoch and reduction in throughput. Hence forth competence of SEP declines over times. To eliminate these defects we have partitioned the network area into more than one region. The junctions of the remote areas need extra power to transfer data to the BS. Consequently normal sensors are positioned near the BS and they can transfer the data straight to the BS. Though advance sensors are positioned far-off from the BS since they contain extra power. If advance sensors transfer data straight to the BS, they also consume extra energy. Therefore clustering technique is applied to save their energy.

Authors in [19] have described that to extend the lifespan of WSN; peoples of different nations have projected numerous clustering based protocols. Though, the energy consumption of the entire network in most of the protocols is not properly reduced and stabilized. To lessen this issue, the authors have proposed a power proficient clustering based routing protocol for WSNs. They have introduced a novel network structure prototype and combined the standard power consumption paradigm to make a new technique to decide the optimum number of clusters for minimization of complete power depletion. On the basis of stable power depletion, they have optimized the Agglomerative NESting (AGNES) technique which involves initiation of distance variance, Twin CHs, partition of the balanced power technique, and the sensor in activity method. They have also decided the priority function for CHs according to remaining power and location of the sensors. Conclusively, they have tested the proposed protocol in homogeneous as well as in heterogeneous networks.

PROPOSED R-SEP:
Our proposed protocol have a mixed strategy, it transmit data directly as well as through CHs towards the BS. There are some terms which are used in the proposed protocols as follows:

Permanence Phase: It the interval between the beginnings of network starts functioning and till the expiry of first sensor.

Impermanence Phase: It the interval between the expiry of first sensor and the expiry of last sensor.

Throughput: Amount of whole data transferred in the WSN during its operation like transfer of data from sensors to CHs or from CHs to the BS or from sensors to straight BS.

Lifespan: Duration of functioning of WSN.

Aggregation of Data: In order to reduce energy consumption, similar type of data is aggregated and transmitted further.

Network configuration: The network area has been divided into regions as shown in figure 2. The area has been partitioned into 3 regions (Region 0, Region 1and Region 2). The BS is situated at the middle point (center) of the network filed. All the nodes' data should reach at the base station. Other than BS, there are two types of sensors: advanced (shown by blue colored circle) and normal (shown

by green colored circle). Let p be the number of advanced nodes and q be the total number of nodes. These p nodes are equipped with β times more energy than the normal nodes.

Deployment of nodes: The normal nodes are dispersed arbitrarily into the entire network whereas the advanced nodes are placed in a planned manner. E.g., in Region one and two the advance nodes are placed in corners and in the center of the regions. Since the nodes in corners are very far from the BS station, they need extra power to convey their data up to the BS. The middle node acts as a CH or gateway to transmit the data of the reaming normal nodes to the BS.

In case of Region 0, the advanced nodes are placed near the BS, so that energy holes do not create near the BS. Since in a multi-hop routing technology, the nodes near the BS transmit their own data as well as the data of other nodes, they deplete their power quicker as compared to remaining nodes of the network. Consequently, the network needs extra power nodes to transmit the entire data to the BS. Therefore in Region zero, the advanced nodes are positioned near the BS. In region zero, no clustering is required, nodes can transmit their data directly to the BS through multi hop routing i.e. via advanced node if any or direct to the BS.

Energy Model:
The model used in LEACH protocol has been followed in our method using equation 1 and 2:

$$E_{TX}(k,d) = \begin{cases} k*E_{elec} + k*\varepsilon_{friss-amp}*d^2, d < d_0 \\ k*E_{elec} + k*\varepsilon_{two-ray-amp}*d^4, d \geq d_0 \end{cases} \quad (1)$$

$$E_{RX}(k) = E_{elec} \times k \quad (2)$$

The E_{Tx} and E_{Rx} are powers disbursed during transmission and acceptance of a data packet correspondingly.

➢ Data rate of every single sensor node is given by k (in bits/sec). When the distance d is relatively far-away, the multiple-path fading channel model (d^4 power loss) is used otherwise free space model (d^2 power loss) is used.

➢ E_{elec} is the radio energy dissipation, used to activate the transmitter and receiver circuit board.

➢ ε_{fs} and ε_{amp} are amplifier energies, the energy required by power amplification to achieve an acceptable bit error rate in the two models.

Cluster Head selection in Region one and two:
The advanced sensor select themselves as CHs in altered rounds through a definite probability P_i, that decides the predictable number of CHs in present round r. Let k be the number of CHs in a round and N be the complete number of sensors in the network area. The probability of a node Ni to be picked up as a CH at round r is given by equation 3:

$$P(N_i) = \begin{cases} \frac{k}{N-k*(r \bmod N/k)} : & 1 \text{ if } N_i \in S \\ 0 : & \text{otherwise} \end{cases} \quad (3)$$

The S is the set of non-cluster heads in recent (r mod N/k) rounds. $P(N_i)$ is 1 if node N_i is not selected as a CH in recent rounds otherwise $P(N_i)$ is zero.
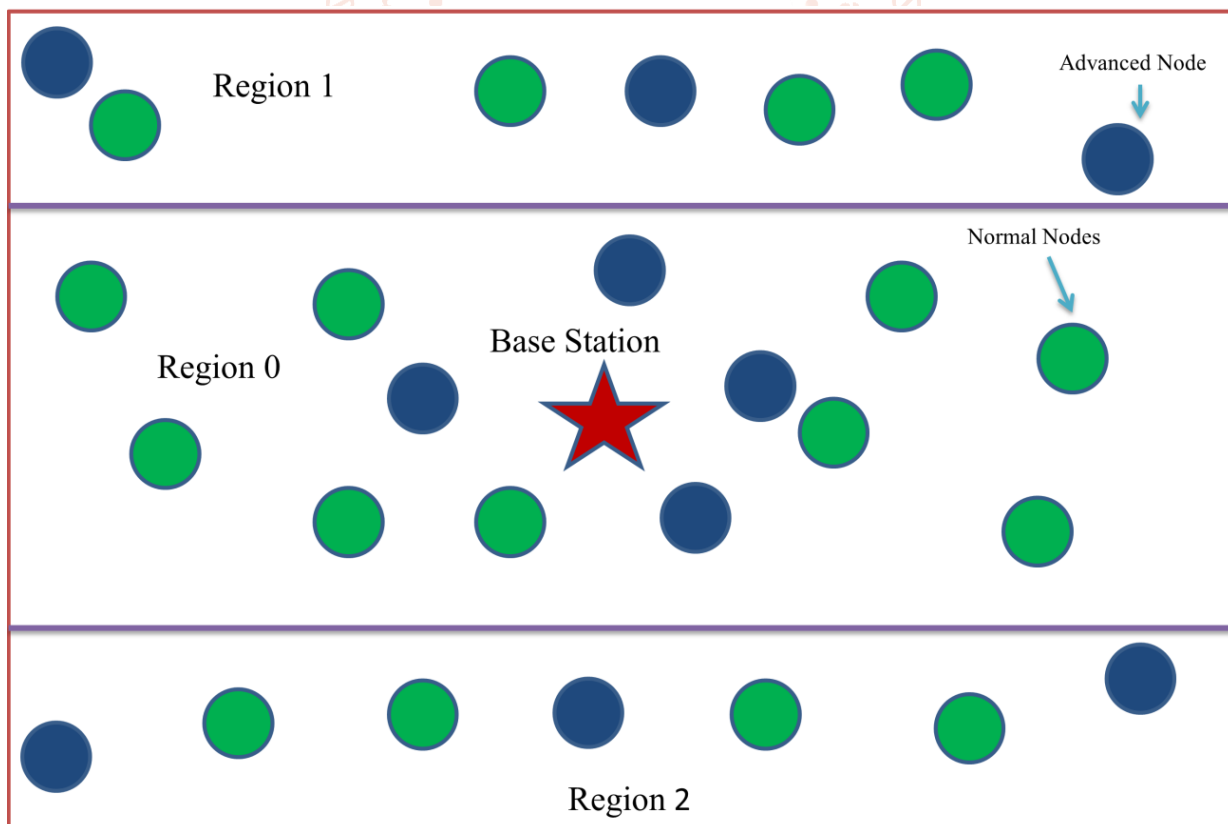

Figure 2: Division of Network area into three regions

Experiment Results:
We have considered a 100 X 100 m² area of WSN which is needed to be monitored. Total 100 number of nodes have been disseminated in the field. We have carried out the experiments in a MATLAB bases environment. Table 1 show the parameters used in experiments.

Table 1: Parameters and their values

Parameters	Value
E_{init}	0.5 J
E_{elec}	5 nJ/bit
E_{fs}	10 pJ/bits m^2
E_{mp}	0.0013 pJ/bit/m^4
E_{DA}	5 pJ/bit
Initial energy of advanced nodes	E_{init} (1+β)

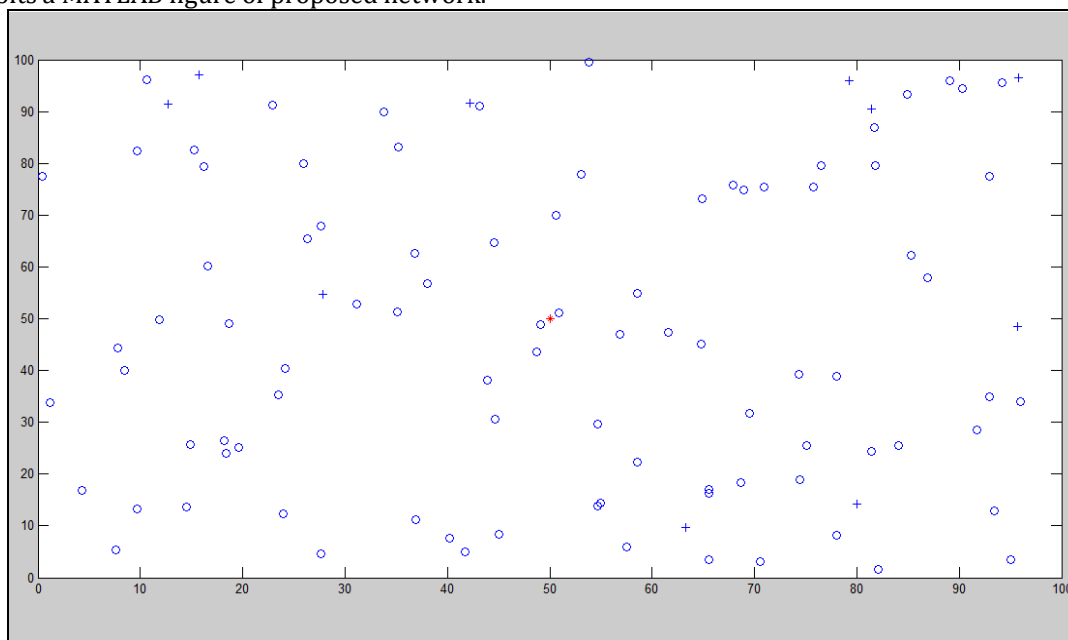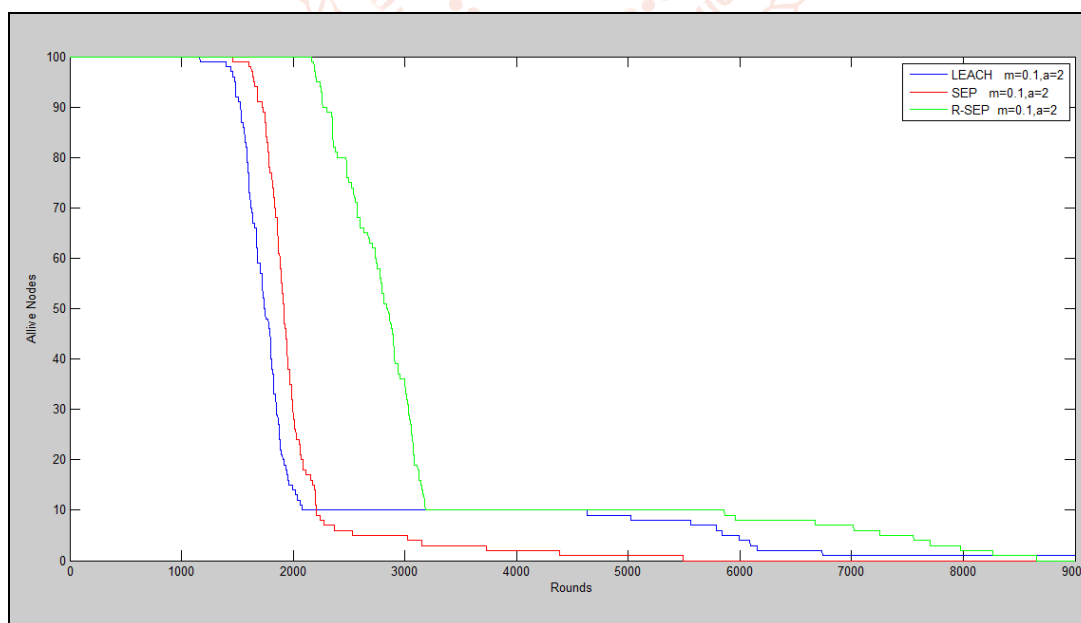Figure 3 exhibits a MATLAB figure of proposed network.

Figure 3: Sensors and Base station in 100 X 100 WSN

Figure 4 exhibits the Permanence Phase in terms of alive nodes till the end of the network. More the number of alive nodes, more is the permanence phase. Figure 5 shows Impermanence Phase of the network. Figure 6 shows the throughput of the WSN.
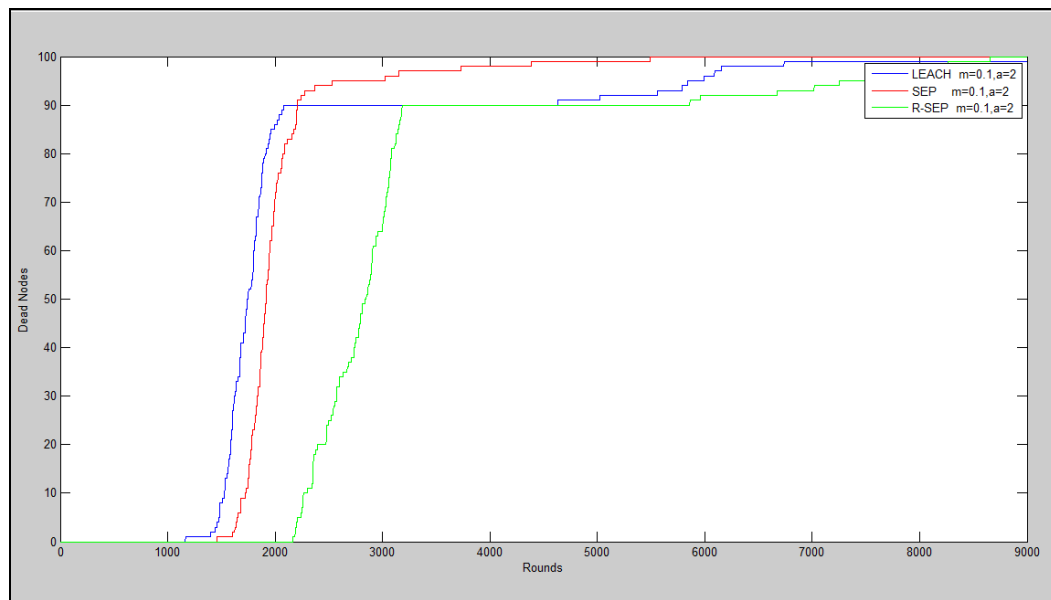

Figure 4: permanence Phase
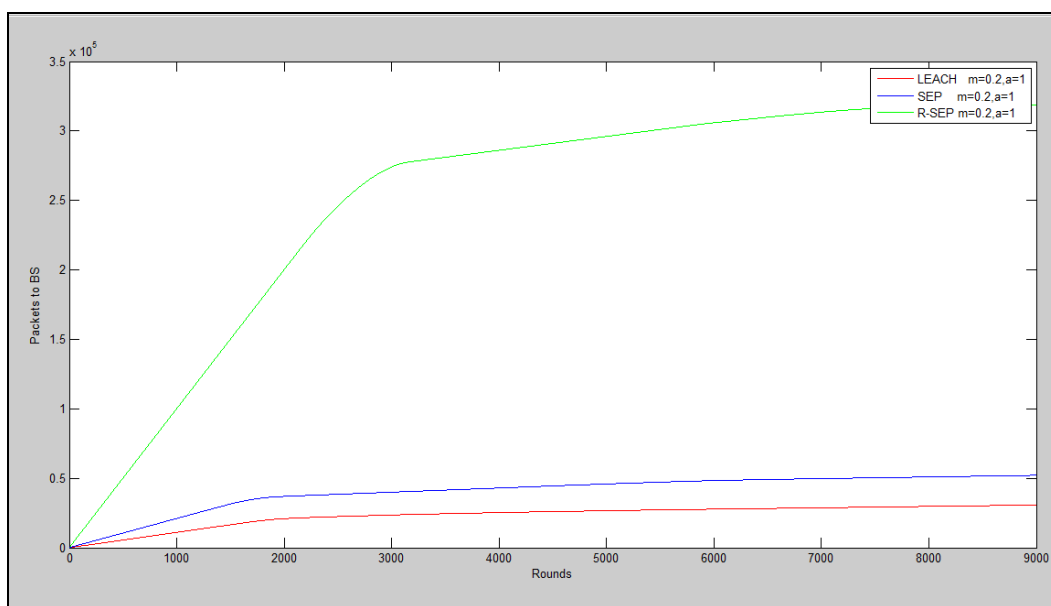
Figure 5: Impermanence Phase

Figure 6: Throughput of WSN

CONCLUSIONS

In the present work, we have suggested the R-SEP protocol for heterogeneous atmosphere with two-fold heterogeneity. The area of WSN has been partitioned into three regions: region zero, region 1 and region 2. Normal and nodes are disseminated arbitrarily throughout the filed while advanced nodes are position in a planned manner. Nodes in Region one and two transmit their data using advanced nodes and clustering process whereas nodes in region 0 can transmit data straight or though the advanced nodes. The experiments show that the permanence phase is amplified around 50%, only by modifying the positioning of the dissimilar kinds of sensors in diverse regions rendering to their power prerequisite. Through put of R-SEP has also been amplified as compared to LEACH and SEP.

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