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Research Paper

Zonal stable election protocol for heterogeneous wireless sensor networks

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Abstract

Wireless sensor networks play a key role in communication. They are comprised of hundreds sensor nodes with limited energy. So energy utilization major issue in WSN for performing the given task. So most of the protocols are concentrate on energy consumption .Zonal mechanism is one popular WSN routing technique. In this work we are mostly concentrating on optimization of stable election protocol for heterogeneous wireless sensor networks and compare the performance with LEACH and SEP. Most of the work to find stability period, alive nodes and dead nodes, throughput in LEACH, SEP, ZSEP. We are stimulated in MATLAB tool. Stimulation results prove that improvement in stability period and through put is better in ZSEP when compared to LEACH and SEP.

Keywords: *LEACH, SEP ZSEP, MATLAB, alive nodes, dead nodes.*

1. Introduction

Large number of sensor nodes is randomly arranged in wireless networks with a base station at the center of network region. These sensors detect information from environment and transmit to the base station for processing. The network in which each sensor having different levels of energy then the network is so called heterogeneous WSN. Different types of protocols are designed to guide the nodes. In heterogeneous WSN, there are different protocols like Low Energy adaptive clustering hierarchy (LEACH), Stable Election Protocol (SEP), Threshold sensitive Energy Efficient sensor Network protocol (TEEN), Distributed Energy-Efficient Clustering Protocol (DEEC) etc. Using these protocols we can transmit data to the base station. The main aim of these protocols is to send data more effectively. So we should design a protocol which uses energy most efficiently[5].

LEACH is one among the protocols which is based on Clustering process. Gathering group of nearby sensor nodes and selecting a cluster head to gather data of all the nodes of cluster and send to base station. By forming the clusters in network field we can use energy effectively. SEP is stable election protocol developed from LEACH[1]. SEP is having more energy efficiency compared to LEACH. In LEACH, every node has the possibility to become a cluster head. In SEP, the nodes are separated into normal nodes and advanced nodes based on their energy levels. Normal nodes are the nodes with low energy and advanced nodes are the nodes with high energies. Most of the advanced nodes are placed away from base station uses more energy for transmission leading to reduction in life span of node. So, to overcome this problem we perform clustering process in advanced nodes. By this we can improve life span of nodes. Thus network life time increases.

2. Vision Aided Movement Estimation

Base station: A base station is a radio receiver/transmitter that is used as the hub for the local wireless network.
Network lifespan: It is the time gap from the beginning of operation up to the death of the first alive sensor node.
Number of cluster heads per round: This is instant measure that displays the number of nodes which transmit data directly to the base station, information aggregated from their cluster members.
Number of alive nodes for each round: This instant measure that display the whole number of nodes and that of each type that has not yet expended all of their energy.
Network throughput: This is the rate of successful message delivery over a communication channel.
Advanced nodes: Nodes with high energy in the network region
Normal nodes: Nodes with low energy in the network region
Intermediate nodes: energy of the node that is ranges between advanced nodes and normal nodes[2].

3. Proposed ZSEP Method

Our proposed protocol is the modified method of stable election protocol, in order to utilize energy effectively. SEP and Z-SEP are similar. In both cases, the entire network contains advanced nodes and normal nodes with base station at the center.
Network Design:
There are several types of routing protocols designed, where nodes are random in network region and node's energy is not used effectively.
In this protocol we alter this method: the region of network is partitioned into three zones: 0th zone, 1st Head zone, 2nd Head zone. All nodes in the network region are distributed among these

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three zones depending on their energy. We considered some portion of total nodes is supplied with high energy.
Let Nh be the high energy nodes among total number of nodes Nt, which are supplied with 'x' time extra energy than the energy of other existing nodes. We represent these nodes as 'advanced nodes' and (1-Nh)*Nt are represented as 'normal nodes'
Distributing nodes among the zones based on energy levels:
0th zone: Normal nodes are placed indiscriminately in this 0th zone,
1st Head zone: Half of the advanced nodes are placed indiscriminately in this zone.
2nd Head zone: Another half of the advanced nodes are placed indiscriminately in this zone.
This type of allotment of nodes to these zones is to achieve high efficiency. As the advanced nodes are having extra energy than the normal nodes.
The nodes which are far away from the base station require more energy for transmission. So we designed the network in such a way that nodes having high energy i.e., advanced nodes are away from the base station and nodes which is having low energy are kept near to base station.

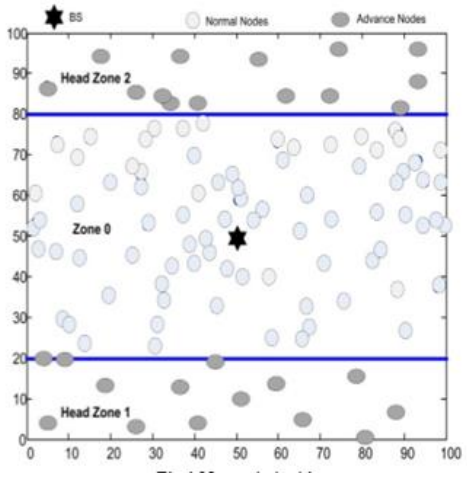


Figure 1. Zones Arrangement

Transmission in Z-SEP:

Z-SEP follows two methods for transmission of data from nodes to the base station. The methods are:

- Direct transmission.
- Communication through cluster head.

Direct transmission:

The normal nodes in 0th zone transmit data to the base station without forming cluster head or any media. This low energy nodes sense surroundings, collects data and transmit them to the base base station directly[4].

Communication through cluster head:

Advanced nodes in 1st Head zone and 2nd Head zone send data to base station via cluster head. By using clustering technique, a node is selected as cluster head in 1st Head zone and 2nd Head zone. This cluster head gather information from the nodes and transfer to the base station. Thus data is transmitted by using clustering algorithm. Formation of clusters is only applicable for advanced nodes.
Let us consider optimum number of clusters as N_{opt} and N_h is number of advanced nodes. Based on SEP optimum cluster head probability C_{opt} is [1]

$$c_{opt} = \frac{N_{opt}}{N_h} \quad (1)$$

Each advanced node has to determine whether to be as a cluster head in present round or not. A indiscriminate number from 0 to 1 is generated for advanced node.if that number is less or equal to threshold Th(x) for nodes then it can be considered to be a cluster head.

$$Th(Ad) = \begin{cases} \dfrac{c_{opt}}{\left(1 - c_{opt}\left(r \times \mathrm{mod}\left(\dfrac{1}{c_{opt}}\right)\right)\right)} & if \ \mathrm{x} \in \mathrm{A} \\ 0 & \text{otherwise} \end{cases}$$

Where A is group of nodes which are not considered as cluster head in last $\dfrac{1}{c_{opt}}$ rounds.
Probability for high energy nodes to become cluster head is

$$c_{adv} = \frac{c_{opt} \times (1+n)}{1 + (n.N_h)}$$

Threshold for high energy nodes is

$$Th(Ad) = \begin{cases} \dfrac{c_{adv}}{1 - c_{adv}\left(r \times \mathrm{mod}\left(\dfrac{1}{c_{adv}}\right)\right)} & if \ Ad \in \mathrm{A} \\ 0 \end{cases}$$

A' is the group of high energy nodes that have not been considered as cluster head in the last

$\dfrac{1}{c_{adv}}$ Rounds[3].
As the cluster head is identified the cluster head broadcasts a message to the nodes. The nodes collect the information and determine which cluster head it comes under for present round. This period is called as 'cluster formation phase'.
Based on strength of reception signal, node reply to cluster head and join as a member in that particular cluster head. Cluster head then allocate a time division multiple access scheme for nodes during which nodes can transmit information to cluster head. After formation of cluster, each node data is sent to cluster head in particular time allotted to node by cluster head[6-14]. This period is shown in fig

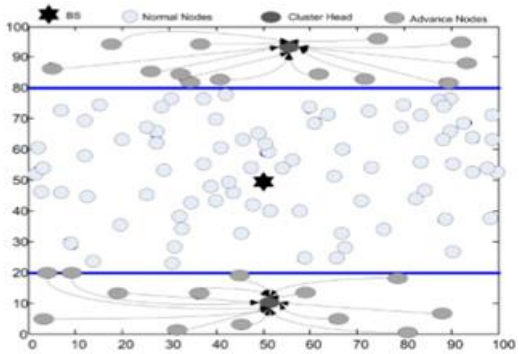


Figure 2. Sensor sends the information cluster heads

The cluster head receives data from the nodes and transmit them to base station. This period is known as 'transmission phase'. The cluster head requires more energy during transmission of data to the base station.

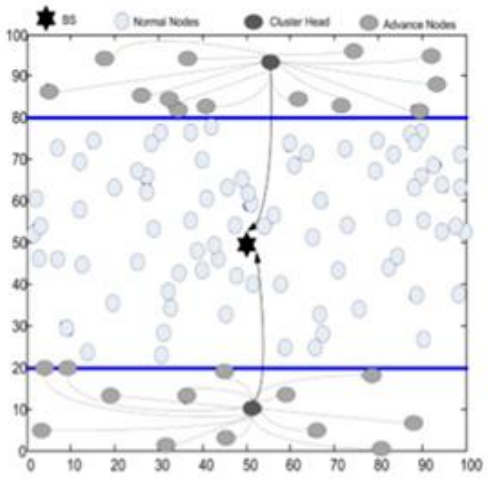
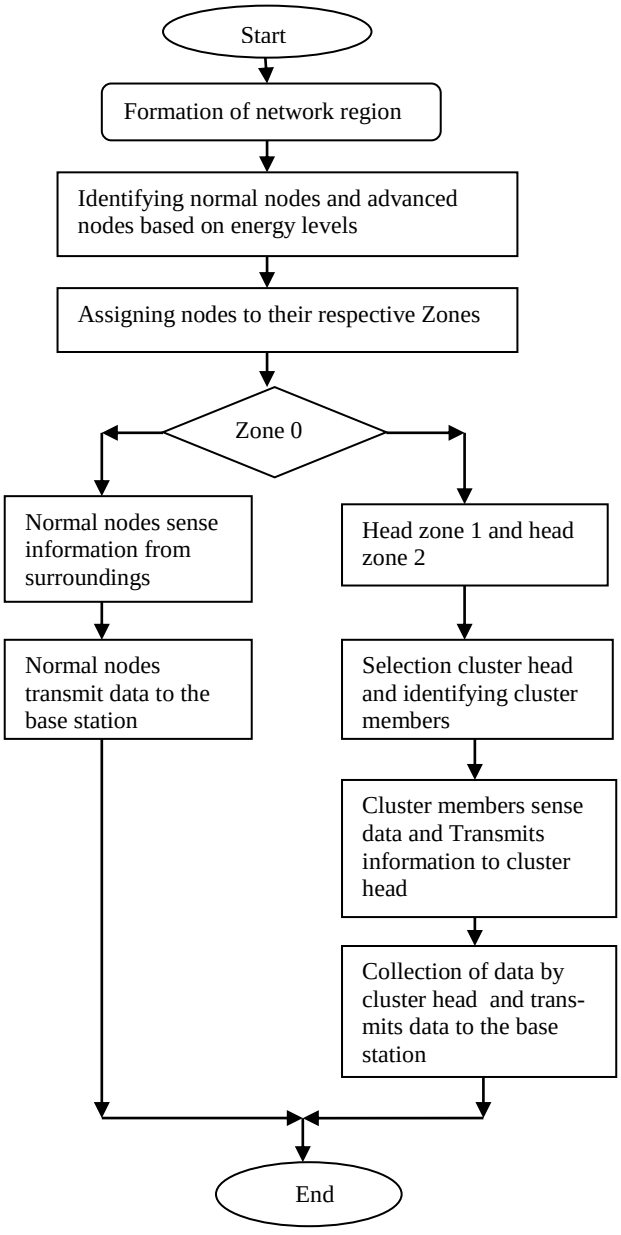


Figure 3. Cluster head sending information to base station

The cluster head is selected only from advanced nodes which are of high energy. Normal nodes are not capable to become a cluster head as they are with low energies. So normal nodes are placed near to the base station, can transmit directly using less energy. Hence the energy is effectively used and we can improve life span of each node

FLOW CHART:



4. Simulation

In this section analyses the implementation of proposed method ZSEP and compares with SEP and LEACH. In comparison, we consider 200 nodes and placed in 150*150 areas. We situated the base station in Centre of the ZONE 0. In this operation we consider some input parameters mention in table 1. We mainly concentrate on throughput, stability period alive nodes for SEP, LEACH, ZSEP.

Table 1: Parameters Consider For Simulation

INPUT PARAMETERS	VALUE
Size of the network field	200*200
Nuber of nodes	200
Energy of node	2J
Data in terms of bits	7000bits
Threshold energy	1J
Advanced nodes	50
Zone 1 nodes	25
Zone 2 nodes	25
Zone 0 nodes	150
Advanced node energy	E(1+a)

5. Results and Discussion

In this section we got results by using MATLAB tool for LEACH ,SEP and ZSEP for the 10-20 percentage of advanced nodes and having the enery 2-3 times then normal nodes.

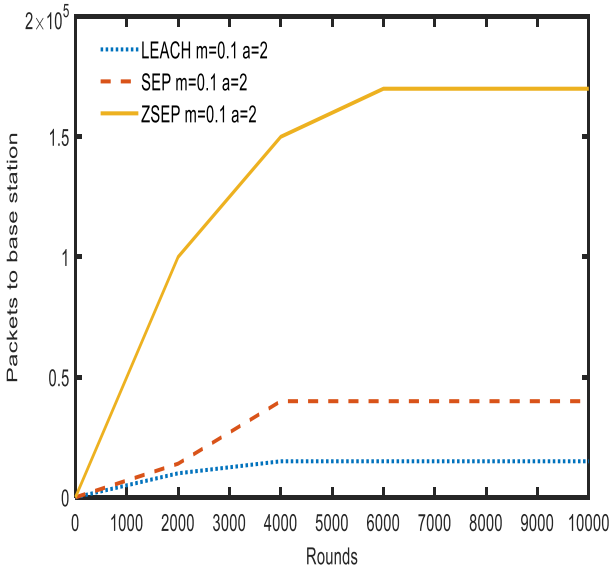


Figure 4. Total throughput per no of rounds

In fig 4 we considering 10% nodes as advanced nodes having the energy three times the normal nodes after MATLAB simulation LEACH and SEP protocols consuming more power for information bits to the base station when comparing with ZSEP. We can observe performance table 3.

Table 2: Performance Analysis for m=0.1 and a=2

PARAMETERS	Stability period(in terms of no of rounds)	Throughput(data in terms of packets
LEACH	2000	0.1x10^5
SEP	4000	0.4x10^5
ZSEP	7000	1.7x10^5

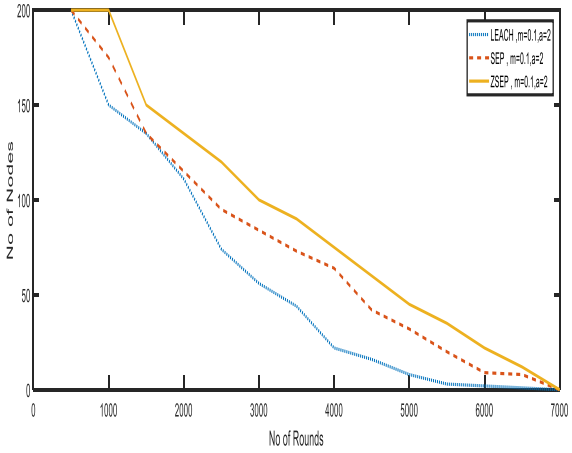


Figure 5. No of alive nodes per rounds for m=0.1 and a=2

In fig 5 we considering 200 nodes , in that we assuming 10% nodes means 20 nodes are advanced nodes having the double the energy then normal nodes . In this simulation we are trying to find no alive nodes LEACH , SEP and ZSEP protocol , from the we we can conclude that ZSEP performs better then LEACH and SEP.

Table 3: Performance Analysis for m=0.1 and a=2

PARAMETERS	No of rounds	No of nodes
LEACH	5000	12
SEP	5000	34
ZSEP	7000	51

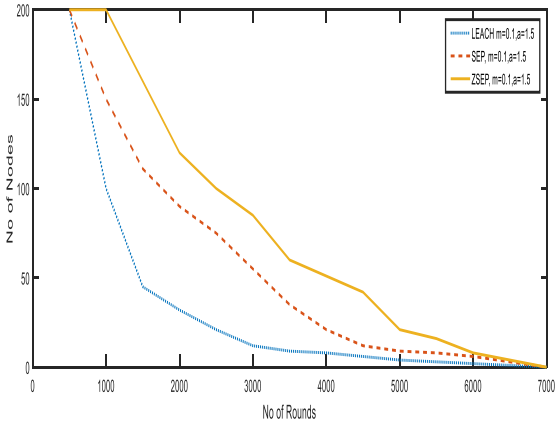


Figure 6. No of alive nodes per rounds for m=0.1 and a=1.5

In fig 6 we considering 200 nodes , in that we assuming 10% nodes means 20 nodes are advanced nodes having the 3 times the energy then normal nodes . In this simulation we are trying to find no alive nodes LEACH , SEP and ZSEP protocol , from the we we can conclude that ZSEP performs better then LEACH and SEP

Table 4: Performance Analysis for m=0.1 and a=1.5

PARAMETERS	Stability period(in terms of no of rounds)	Throughput(data in terms of packets
LEACH	5000	8
SEP	5000	18
ZSEP	5000	27

6. Conclusion

Proposed zonal stable election protocol shows better simulation results then LEACH and SEP in the form of alive nodes and through put. If we observe the through put graphs ZSEP protocol gives better throughput almost 4 times then SEP. If we observe the alive nodes simulation results ZSEP protocol will make the nodes to operated for long time 50% of the nodes will alive more the 5000 rounds

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