



Simulation & analysis of hierarchical routing in heterogeneous wireless sensor network using MATLAB

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Abstract

Wireless Sensor Networks (WSNs) are increasing to handle complex situations and functions. In these networks some of the nodes become Cluster Heads (CHs), aggregate data of cluster members and transmit it to the Base Stations (BS). However, homogeneous networks are not enough efficient in consuming energy. Hierarchical Stable Election Protocol (H-SEP) introduces heterogeneity in WSNs, consisting of two types of nodes: normal nodes and advanced nodes. HSEP is based on weighted election probabilities of each node to become CH according to remaining energy of nodes. We propose heterogeneity aware hierarchical routing protocol i.e. Stable Election Protocol. The impact of heterogeneity nodes, in terms of their energy, in wireless sensor networks are hierarchically clustered. All simulations are done in MATLAB. Different parameters are used for checking the efficacy of the considered routing protocol for H-WSN. Simulation result shows that SEP considered with parameters such as alive nodes and dead nodes etc. has better performance as compared to other protocols. MATLAB Simulation results show that H-SEP prolongs stability period and network life time with respect to number of alive nodes, percentage of dead nodes & energy consumption ratio for total number of rounds.

Keywords: MATLAB

1. Introduction

Wireless Sensor Networks (WSNs) are increasing to handle complex situations and functions. In these networks some of the nodes become Cluster Heads (CHs), aggregate data of cluster members and transmit it to the Base Stations (BS). However, homogeneous networks are not enough efficient in consuming energy. Hierarchical Stable Election Protocol (H-SEP) introduces heterogeneity in WSNs, consisting of two types of nodes: normal nodes and advanced nodes. HSEP is based on weighted election probabilities of each node to become CH according to remaining energy of nodes. We propose heterogeneity aware hierarchical routing protocol i.e. Stable Election Protocol. The impact of heterogeneity nodes, in terms of their energy, in wireless sensor networks are hierarchically clustered. All simulations are done in MATLAB. Different parameters are used for checking the efficacy of the considered routing protocol for H-WSN. Simulation result shows that SEP considered with parameters such as alive nodes and dead nodes etc. has better performance as compared to other protocols. MATLAB Simulation results show that H-SEP prolongs stability period and network life time with respect to number of alive nodes, percentage of dead nodes & energy consumption ratio for total number of rounds.

1.1 Advantages of wireless sensor networks

The WSNs has revolutionized the world around us. They are becoming integral part of our lives, more so than the present-day computers because of their numerous advantages as mentioned below:-

- Ease of deployment
- Extended range of sensing

- Improved lifetime
- Fault tolerance
- Improved accuracy
- Lower cost
- Actuation

1.2 Challenges in wireless sensor networks

In order to design good applications for wireless micro-sensor networks, it is essential to understand factors important to the sensor network applications. Although WSNs share some commonalities with existing wireless ad-hoc networks they pose a number of technical challenges different from traditional wireless ad-hoc networks. The protocols and algorithms that have been proposed for traditional wireless ad-hoc networks are therefore not well suited for the application requirements of the sensor networks.

2. Energy efficient protocols & research methodology

2.1 Various energy efficient protocol

These protocols are energy efficient communications protocol and that is utilized by the sensor to inform their sensed data to the base station (sink). Main goal of these protocols is to efficiently hold the energy consumption of sensor node with relating them in multi-hop communication inside a specific cluster and through executing data aggregation and fusion ready to reduce the number of transmitted message to the base station (sink).

3. Heterogeneous routing protocols

In a wireless sensor network, all the sensor nodes can either have the same energies or different. The network with each node

having same energy is called homogeneous wireless sensor network while the network with some nodes having energies different from others are called heterogeneous wireless sensor network.

Heterogeneous routing protocols are described as:

- a. SEP (Selection Election Protocol)
- b. DEEC (Distributed Energy-Efficient Clustering)
- c. DDEEC (Developed Distributed Energy Efficient Clustering)
- d. EDEEC (Enhanced Distributed Energy Efficient Clustering)
- e. EDDEEC (Enhanced Developed Distributed Energy Efficient Clustering)

4. Proposed Methodology

The coordinates of the sink and the dimensions of the sensor field are known. We show that the behavior of such sensor networks becomes very unstable once the first node dies, especially in the presence of node heterogeneity.

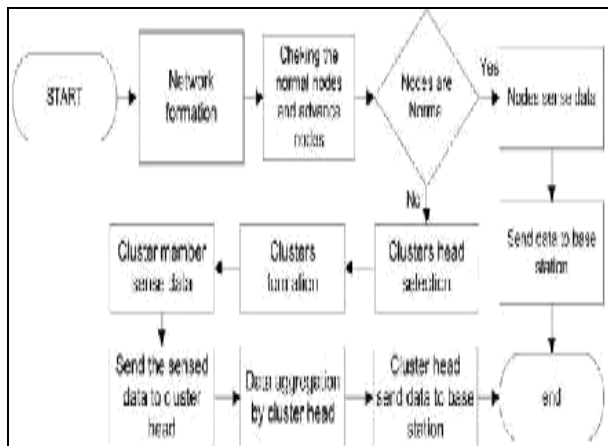


Fig 1: Flow Chart of H-SEP Operation

Classical clustering protocols assume that all the nodes are equipped with the same amount of energy and as a result, they can not take full advantage of the presence of node heterogeneity. We propose an advance H-SEP, a

heterogeneous protocol to prolong the time interval before the death of the first node, which is crucial for many applications where the feedback from the sensor network must be reliable.

4.1 Network Model and Simulation Parameters

The simulation is carried out using MATLAB R2008a. Let us consider a square sensing field with each side (X, Y) measuring 500 meters. The coordinates of the field are as shown in Figure 2, where crosses represent overlay sensors/cluster heads, and circles represent normal sensors. All data collected by the sensors is to be sent to a receiver/sink located inside the sensing field. The location of sink is assumed to be fixed. We assume all sensors are aware of the location of the receiver via some type of pre-configuration or self configuration. There are a total of 400 sensor nodes in the field which are assumed to be uniformly distributed within the field.

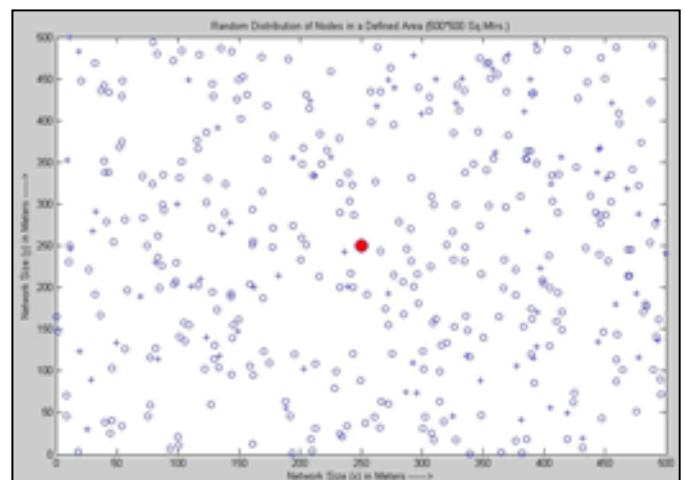


Fig 2: Random Distribution of 400 Nodes in 500*500 Sq. Mtrs. Area

The base station is situated at the center (250, 250). We have set the minimum probability for becoming a cluster head (pmin) to 0.0005 and primarily the cluster head probability for all the nodes is 0.05. The parameters used in our simulation are as shown in the Table 1.

Table 1: Simulation Parameters

S. No	Parameter	Values
1	Network Size	500*500 Sq. Mtrs.
2	Location of Sink	250 * 250
3	Number of Nodes in the Field	400
4	Max. Number of Simulation Rounds	1000
5	Initial Energy	Eo (0.5)
6	Initial energy of advance nodes	3 j
7	Distance threshold	2 mm
8	Multi root distance from higher e.ad	10 mm
9	Energy for data aggregation (Eda)	5 nJ/bit/signal
10	Transmitter/Receiver Energy (Etx/Erec)	50 nJ/bit
11	Amplification energy for short distance (Efs)	12 Pj/bit/m2
12	Amplification energy for long distance (Eamp)	0.0013pJ/bit/m4
13	Hirerichal factor	(infinity)
14	Probability (Popt)	0.3

4.2 Simulation Results

The heterogeneous network with various types of sensors and sink nodes (static or mobile ones) has been simulated which consists of 400 sensors which are randomly deployed in a 500 X 500 Sq. Meters region. Base station is located in the middle of the sensor field. Nodes endlessly sense the region and have the data to send to base station. Nodes do not have any information about their location. Some percentage of the nodes has high energy than the other nodes. Figure 2 shows the heterogeneous network after completion of maximum predefined 1000 rounds.

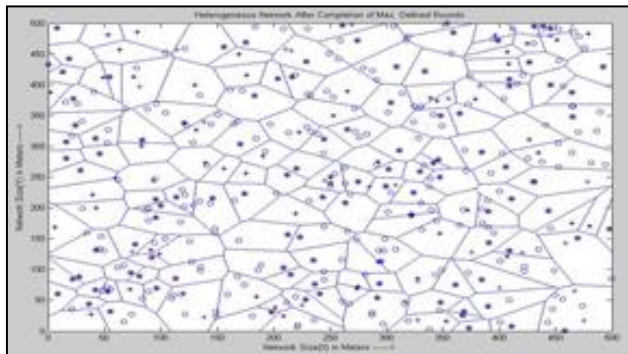


Fig 3: Heterogeneous network after completion the 1000 rounds

The simulated graph between the alive nodes vs round numbers is shown in Figure 4 and the corresponding parameters used are shown in Table 3. The simulated graph between the dead node v/s round number is shown in Figure 5 and the corresponding parameters used are shown in Table 4.

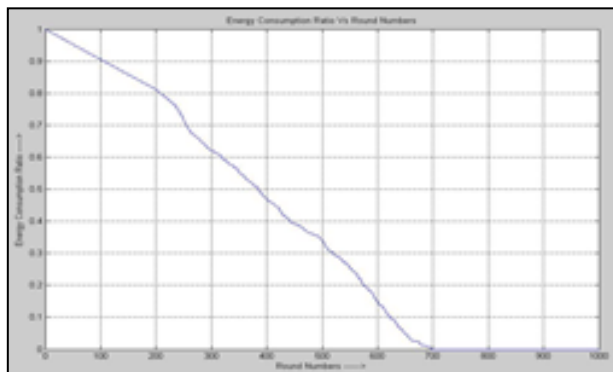


Fig 4: Simulated graph between energy consumption ratio vs round numbers

Table 2: Parameters used for simulation

Sl. No.	Field Area (Sq. Mtrs)	No. of Rounds	Energy Consumption Ratio
1	500*500	100	0.904
2	500*500	200	0.811
3	500*500	300	0.616
4	500*500	400	0.466
5	500*500	500	0.339
6	500*500	600	0.149
7	500*500	700	0.000
8	500*500	800	0.000
9	500*500	900	0.000
10	500*500	1000	0.000

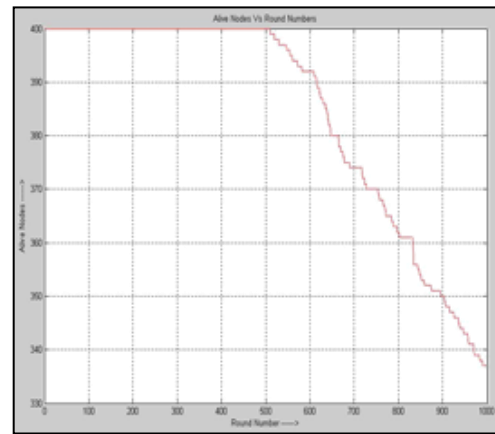


Fig 5: Shows the results for the alive nodes with 1000 number of rounds

Table 3: Parameters used for Simulation

Sl. No.	Field Area (Sq. Mtrs)	No. of Rounds	No. of Alive Nodes
1	500*500	100	400
2	500*500	200	400
3	500*500	300	400
4	500*500	400	400
5	500*500	500	400
6	500*500	600	392
7	500*500	700	374
8	500*500	800	362
9	500*500	900	350
10	500*500	1000	337

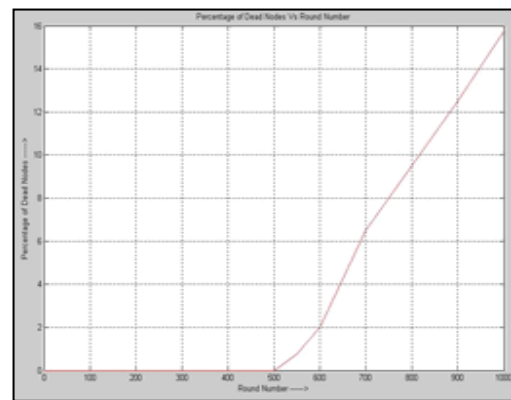


Fig 6: Shows the results for the Dead Nodes with 1000 Number of Rounds

Table 4: Dead Nodes Comparison between H-SEP and I-SEP

Sl. No.	Field Area (Sq. Mtrs)	No. of Rounds	% of Dead Nodes
1	500*500	100	0.00
2	500*500	200	0.00
3	500*500	300	0.00
4	500*500	400	0.00
5	500*500	500	0.00
6	500*500	600	2.00
7	500*500	700	6.50
8	500*500	800	9.50
9	500*500	900	12.5
10	500*500	1000	15.75

4.3 Result Analysis

In figures presented above, we showed how our analysis can be used to determine the appropriate number of heads in the network. In summary, regardless of whether the network is homogeneous or heterogeneous, under the considered parameters, the optimal number of alive and dead nodes are calculated. The Simulation of proposed protocol in a field with dimensions 500m×500m and 400 nodes has been deployed in specific levels with respect to their energy. Base station is placed in the center of the network field. We are using the radio model as used in SEP. MATLAB is used to implement the simulations. Simulation is carried out by modifying H-SEP protocol.

5. References

1. Ahlawat A, Malik V. An Extended Vice-Cluster Selection Approach to Improve V-LEACH Protocol in WSN, IEEE 3rdconference on Advance Computing and Communication Technology, 2013, pp. 236-240.
2. Babaie S, Amaalizadeh S, Golsorkhtabar M. The Novel Threshold Based Hierarchical Clustering Method for Wireless Sensor Network, IEEE International Conference on Electronics and Information Engineering (ICEIE), 2010, pp. 191-195.
3. Bakr BA, Leszek L. Extending Wireless Sensor Network Lifetime in the LEACH-SM Protocol by Spare Selection, IEEE 5th Conference on Innovative Mobile and Internet Services in Ubiquitous Computing, 2011, pp. 277-282.
4. Beiranvand Z, Patooghy A, Fazeli M. I-LEACH: An Efficient Routing Algorithm to Improve Performance & to Reduce Energy Consumption in Wireless Sensor Networks, IEEE 5th International Conference on Information and Knowledge Technology, 2013, pp. 13-18.
5. Chen G, Zhang X, Yu J, Wang M. An improved LEACH algorithm based on heterogeneous energy of nodes in wireless sensor networks, IEEE International Conference on Computing, Measurement, Control and Sensor Network. 2012, pp. 101-104.
6. Elbhiri B, Fkihi SE, Saadane A, Lasaad N, Jorio A, Driss Aboutajdine, Morocco ER. A New Spectral Classification for Robust Clustering in Wireless Sensor Networks, IEEE Conference on Wireless and Mobile Networking (WMNC), 2013, pp. 1-10.
7. Heinzelman W, Chandrakasan A, Balakrishnan H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks IEEE Proceedings of the 33rd Hawaii International Conference on System Sciences, 2000, pp. 3005-3014.