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Improved Stability with Improved Energy Efficient Stable Election Method for Wireless Sensor Networks

Nibedita Priyadarshini Mohapatra [1], Monalisa Jena[2], Dr. Sushant Ku Dash[3]
[1] National Institute of Science and Technology ,Dept. of Computer Science and Engineering, India, mohapatranibedita10@gmail.com
[2] National Institute of Science and Technology Dept. of Computer Science and Engineering, Berhampur,Odisha India
[3]Berhampur University, Department of Computer Science and Application, Berhampur,Odisha India

ABSTRACT
The modern era believe in Technology and application point of view. Wireless Sensor Networks (WSNs) set the new platform for researchers to work with it for innovative creations and set the new trends in this field for research community and achieve valuable goals to set new parameters. So we are excited to do some work in this field. We analyze the works regarding low energy adaption clustering, stable election and heterogeneity. Here, we proposed an improved energy efficient stable election (I_SEP) model for Wireless Sensor Networks. Clustering model like LEACH the overall energy loss is more due to same energy level for all sensor nodes; energy depletion is fast after the first dead node. So to solve this problem, to make the network more stable, more flexible and at the same time decrease the overall energy loss and thereby increase the network life time, we use two different energy levels, one for sensor nodes and other for advance sensor nodes. Here we also use double cluster head selection (ID-SEP) to make the network more secure with same energy budget as I-SEP. In our model we achieve more energy efficient, more stable wireless sensor network with increased level of fault tolerance capability.

Key words: Advance sensor, Energy depletion, heterogeneity, Stable election, Wireless Sensor Network.

1. INTRODUCTION

Highlight Wireless Sensor Networks provide huge range of application in almost every field and more shiner promising technology. Still it requires additional research to an optimum extent for final mature technologic view. Application ranges start from simple chemical reaction in particular temperature level, monitoring particular area to industry level application and complex application like battle field surveillance and complex medical equipment application. Different types of models are designed to give better performance in WSN. Some models design to provide routing application best. Some provides data transmission with better speed. Some of the model design to give better application level performance i.e. they are application oriented only. Some provides better stability to the network and some provide desired level of fault tolerance. Some of the complex model is design to give better accuracy with time critical application. In traffic application energy consumption should be less for sensing application. i.e. energy budget should be optimized. The energy cost for 1 KB data transmission in 100 m area is same as 3 million instruction execution by using general purpose processor. Markovision traffic model improved by using demand distance vector routing (AODV) , because it specify the relations among different kinds of routing messages and such relations can be depicted by an FSM. MTPR (minimum total transmission power routing also used for better performance. In medical application WSN proves its capability to an optimum level. Medical information collected by sensors on patient's body (WPAN) is displayed on a monitor. RFID reading improves automatic data gathering, radio frequency identification possible, localization possible. WPAN (802.15.4), WPAN (802.15.1), WLAN (802.11b), CSMA, TDMA, CSMA/CA technologies are used respectively. GSM, GPRS, EDGE, 3G/UTMS provides good platform in this regard. But every model must concern about stability of the network with desired level of performance. At the same time maintain economic power budget and better life time of the network with improved energy efficiency. Our proposed model design to give better stability by stable election with improved performance due to advance sensor nodes; secure and efficient data delivery with the presence of assistant cluster head.

2. RELATED WORKS

Low Energy Adaptive Clustering Hierarchical routing protocol (LEACH) proposed by W.Hiezelman etal. in the year 2000. It sets the new horizon for most of the clustering and routing models.

Manjeshwar and his group came with an innovative idea of Threshold sensitive Energy efficient for WSN in 2001 [1, 2, 3 and 13]. This model has two different flavors, one is Soft threshold designed for time critical events with no duplicate data. Another one is hard threshold which is suitable for more complex time critical real time applications where job is done completely within specific time interval or job not done.

Stable Election protocol (SEP) for heterogeneous WSNs proposed by G. Smaragdakis et el. In 2004[4,5,6] is the improved version of LEACH. The main difference between two models is the energy level. It uses two energy levels for two different kinds of nodes (normal sensor nodes and advance sensor nodes). This method increases stability of the network.

The Wireless sensor nodes are low cost and having less power and deployed in large geographical area in more numbers for more network coverage area. The energy depletion rate is faster after first dead node in the WSN. So here we want to decrease the energy depletion by increasing the life time of the node by improving the stability. In our proposed model the first dead node energy depletion time was maximized to a greater extent. So the overall energy loss was minimized and there by network lifetime increased. Due to two different energy levels advance nodes are works for more time and provide stability to the network. For maintaining the efficient balanced energy budget the number of advance nodes is minimized and normal sensor nodes are maximized. So that it becomes more energy efficient at the same time we have to care for secure data delivery so here we choose assistant cluster heads those are responsible for secure and timely data delivery in the absence of main cluster head. The number of Assistant cluster head also equal to number of clusters to maintain the efficient data delivery.

Satvir Singh and Meenaxi do an excellent review on the different energy efficient routing protocols in the year 2013. Which motivate most of the researchers to do some valuable work in this field; [10, 15]We analyze from this paper that how different factors like Sensor Location, end to end delay, Node Deployment, Fault Tolerance, Scalability are very crucial factors when the WSN models are designed. Thus it is very clear that according the design specification and application criteria of WSN model, the above factors needs to be upgraded. The interest in sensor networks has led to a number of routing schemes that use the limited resources available at sensor nodes more efficiently. These schemes typically try to find the minimum energy path to optimize energy usage at a node. In this paper we take the view that always using lowest energy paths may not be optimal from the point of view of network lifetime and long term connectivity. [8, 9To optimize these measures, we propose a new scheme called Energy aware routing that uses sub optimal paths occasionally to provide substantial gains. Simulation results are also presented that show increase in network lifetimes of up to 40% over comparable schemes like directed diffusion routing. Nodes also burn energy in a more equitable way across the network ensuring a more graceful degradation of service with time.

In this paper, [12, 15] they propose PEACH protocol, which is a power-efficient and adaptive clustering hierarchy protocol for wireless sensor networks. PEACH forms clusters without additional overhead and supports adaptive multi-level clustering. In addition, PEACH can be used for both location-unaware and location-aware wireless sensor networks. The performance of PEACH is less affected by the distribution of sensor nodes than other clustering protocols.

Knowledge of the routing zone topology is leveraged by the ZRP to improve the efficiency of a globally reactive route query/reply mechanism. The proactive maintenance of routing zones also helps improve the quality of discovered routes, by making them more robust to changes in network topology. [13, 14 and 17].The ZRP can be configured for a particular network by proper selection of a single parameter, the routing zone radius. Multi-hop routing is utilized for inter-cluster communication between cluster heads and the base station, instead of direct transmission in order to minimize transmission energy. Besides, this protocol adds some mechanisms to CSMA/CD (Carrier Sense Multiple Access with Collision Detection) so as to avoid collisions, instead of using other more complicated MAC protocols during the period of cluster formation.

3. PROPOSED WORKS

As we know the wireless sensor network consist of low power and low cost sensor nodes and the number of deployed nodes is more in the network. In clustering model like LEACH the network is energy constraint, flexible and also having fault tolerance capability. But the overall energy loss is more here due to same energy level for all sensor nodes and energy depletion is fast after the first dead node of a particular sensor node in the WSN. So to solve this problem, to make the network more stable, more flexible and at the same time decrease the overall energy loss and thereby increase the network life time.

Here we propose an improved energy efficient heterogeneous clustering model. Here we use multiple energy levels. One energy level for sensor node and other one for advance sensor nodes having more energy than normal sensor nodes. Here we also use double cluster head selection to make the network more secure. In this we achieve more energy efficient, more stable wireless sensor network with improved fault tolerance capability.

Dynamic Cluster Head Selection with SEP:

1. Distribute all the sensor nodes of network; energy level is send to the base station.
2. Apply SEP to maintain K clusters in each round
3. Nodes with highest residual energy level are selected as cluster heads for the network in each round.
4. Cluster heads status is broadcasted and the number of cluster heads is found out.
5. Received signal strength indication (RSSI) is checked.
6. Join request is sent by the nodes to their desired cluster head and response message is sent by each cluster head to its requested sensor nodes, advance nodes to inform them that they are members of associated cluster.
7. RSSI value calculated.
8. If energy of a node is zero it is dead.
9. The energy spent for choosing new cluster head is calculated.

10. The amount of data transmitted between the nodes is calculated according to the number of nodes present in the network.

Dynamic Double Cluster Head Selection with I-SEP:

1. Distribute all the sensor nodes of network; energy level is send to the base station.
2. Geographically group data about the sensor nodes
3. Nodes with second height residual energy level selected are assistant cluster head (ACH) for the network or backup node for the cluster. ACH sent the join request to cluster head (CH) after the selection.
4. The criteria for more secure network satisfy by multilevel cluster head selection and multi hop communication between cluster head is enhanced. By choosing cluster heads two times based on residual energy.
5. CH and ACH status is broadcasted and number of CHs found out.
6. Received signal strength indication (RSSI) is checked.
7. Join request is sent by the nodes to their desired CH & ACH and response message is sent by each CH to its requested sensor nodes, advance nodes to inform them that they are members of associated cluster.
8. RSSI value calculated.
9. If energy of a node is zero it is dead.
10. Before a sensor node or advance node becomes faulty or dead node the node sends all the useful sensed data to ACH of the cluster to which it belongs. Therefore information lose is controlled to a greater extent.
11. The energy spent for choosing new cluster head is calculated.
12. The amount of data transmitted between the nodes is calculated according to the number of nodes present in the network.
13. Stability improved due to advance nodes.
14. First node die late as comparison to existing models. So lifetime and stability of network improved a lot.

We propose I-SEP model an improved heterogeneous energy aware protocol to increase the time period of the first dead node, (i.e. Stability period). Here another constraint we add to make the network more stable by placing the advanced nodes in more distance places from the base station i.e. equally distributed in the network corner region. Again we modify the I-SEP to improved double cluster heterogeneous energy aware protocol (ID-SEP). Here it provides more security to data transmission

Heterogeneity impacts on WSN

- Reduction in processing latency: Due to computational heterogeneity in energy level, it can reduce the processing latency in closest nodes and heterogeneity communication link can decrease the transmission waiting time.
- Increasing Network Life time: The energy consumption for data transmission between normal sensor nodes to the base station in these sensor networks will be very less than the energy consumption in homogeneous sensor networks.
- Improved Reliability: In homogeneous sensor networks communication links possessing low reliability due to lower end to end delivery rate with each hop. But in heterogeneous sensor networks, the number of hops minimized during data transmission between normal sensor nodes and the base station. So here higher end to end delivery rate will be achieved.
- Here we take assistant cluster head same as number of clusters present in the network for secure data transmission.

B. Performance Metric

- Number of cluster heads per simulation round: As the cluster heads aggregate the data, which would collect from its group members. So it would be a instantaneous performance metric.
- Stability period: Network stability period refers to the time period between the start of network operation of the sensor network to the death of the first alive node.
- Number of Alive nodes per simulation round: This is an instantaneous measurement, more alive nodes per round means more stable network.
- Energy efficiency with respect to distance factor: Advance nodes having more energy than normal sensor nodes should be placed in distance places like border region so the network performance is so much enhanced and there by network become more stable i.e. stability is more improved.
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4. SIMULATION RESULTS

4.1 Figures and Tables

Table 1: Simulation Parameters for I-SEP

Simulation Parameters	Values
Sink	At(50,50)
Simulation area	100*100m
Threshold distance do	75m
Cluster radius	30m
Energy consumed by Electronics circuit to transmit or receive E_{elec}	50nj/bit
Percentage of Advance sensor modes	0.1
Probability of becoming cluster head	0.1
Amplifier energy for short distance transmission E_{fs}	10 pj/bit/m2
Amplifier energy for longer distance transmission E_{mp}	0.0013pj/bit/m4
Data Aggregation Energy	5nj/bit/signal
Message size	2000bits
InInitial Energy for normal sensor nodes E_i	0.5j
Initial Energy for Advance sensor nodes E_a	0.8j

Table 2: Simulation Parameters for ID-SEP

Simulation Parameters	Values
Sink	At(50,50)
Simulation area	100*100m
Threshold distance do	75m
Cluster radius	30m
Energy consumed by Electronics circuit to transmit or receive E_{elec}	50nj/bit
Percentage of Advance sensor modes	0.1
Probability of becoming cluster head	0.1
Amplifier energy for short distance transmission E_{fs}	10 pj/bit/m2
Amplifier energy for longer distance transmission E_{mp}	0.0013pj/bit/m4
Data Aggregation Energy	5nj/bit/signal
Message size	2000bits
Initial Energy for normal sensor nodes E_i	0.5j
Number of Assistant cluster Heads	Same as number of Cluster heads
Initial Energy for Advance sensor nodes E_a	0.8j

Table 3: Simulation Parameters for SEP

Simulation Parameters	Values
Sink	At(50,50)
Simulation area	100*100m
Threshold distance do	75m
Cluster radius	30m
Energy consumed by Electronics circuit to transmit or receive E_{elec}	50nj/bit
Percentage of Advance sensor modes	0.1
Probability of becoming cluster head	0.1
Amplifier energy for short distance transmission E_{fs}	10 pj/bit/m_2
Amplifier energy for longer distance transmission E_{mp}	0.0013pj/bit/m_4
Data Aggregation Energy	5nj/bit/signal
Message size	2000bits
itial Energy E_i	0.5j

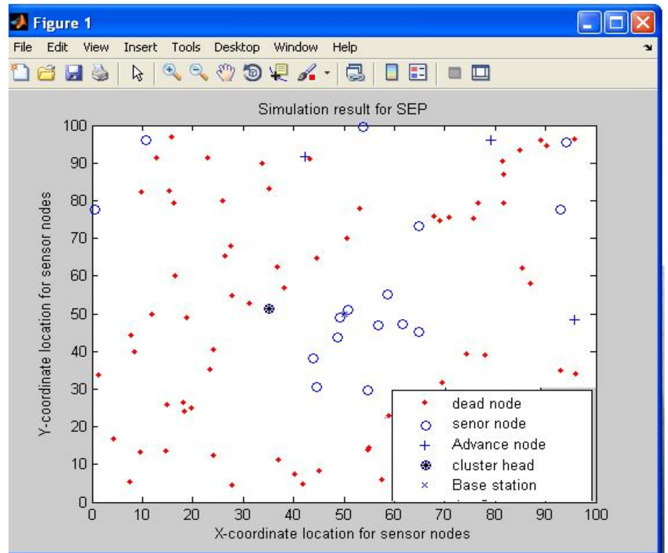

Figure 1: Simulation Result for SEP (1500 rounds)

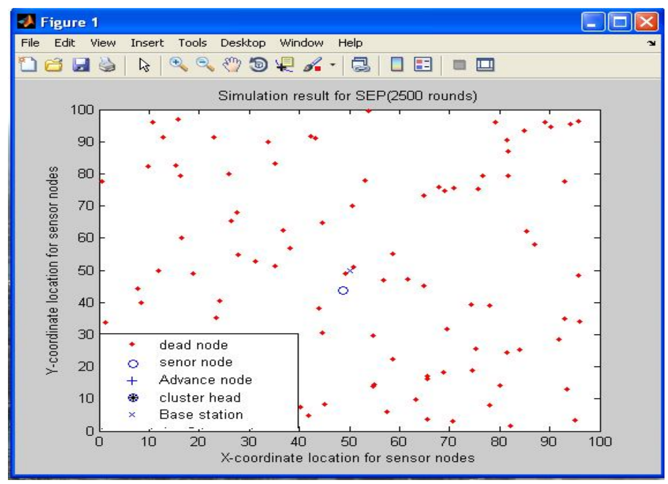

Figure 2: Simulation Result for SEP (2500 rounds)

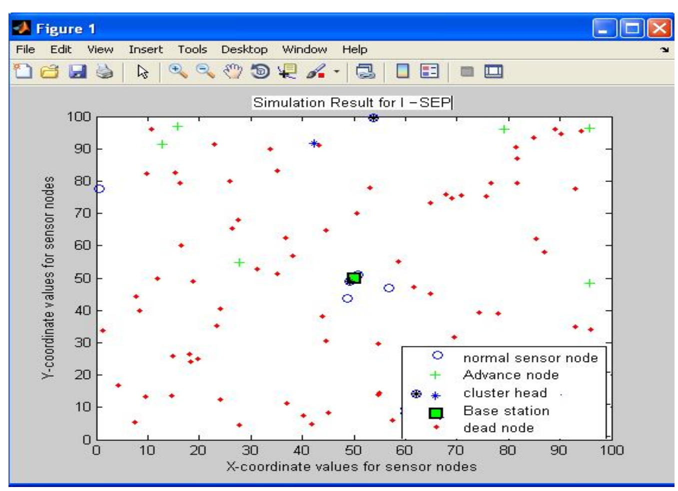

Figure 3: Simulation Result for I-SEP (1500 rounds)

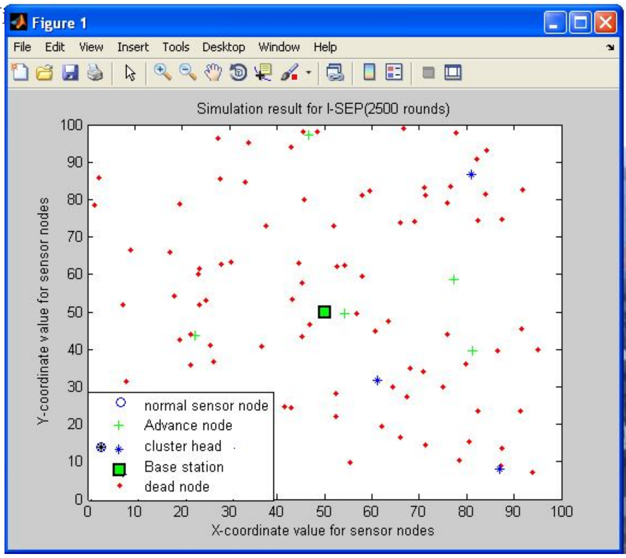

Figure 4: Simulation Result for I-SEP (2500 rounds)

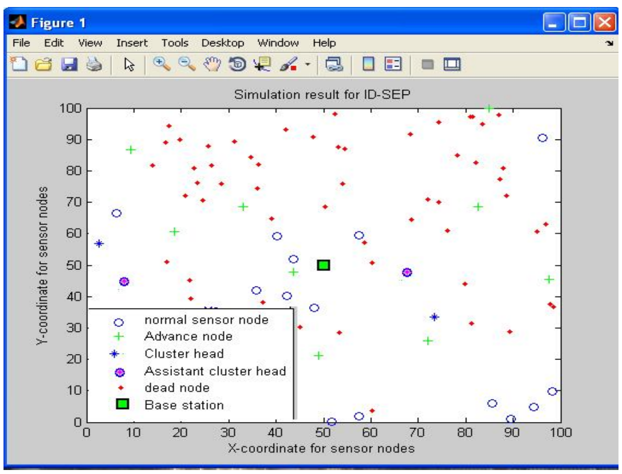

Figure 5: Simulation Result for ID-SEP (1500 rounds)

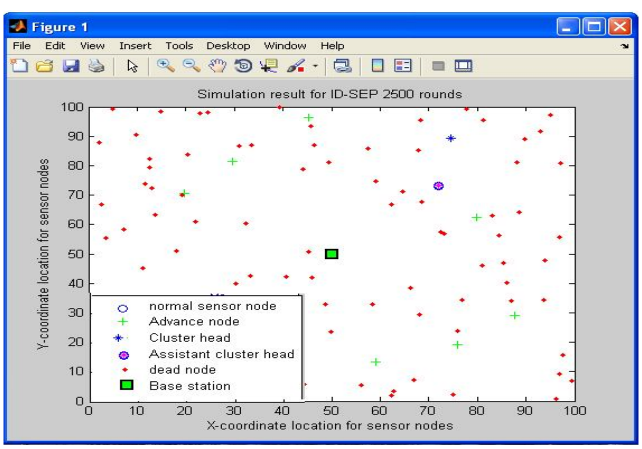

Figure 6: Simulation Result for ID-SEP (2500 rounds)

From the Simulation graphs (Figure-2, Figure-4, Figure-6) it is clear that I-SEP and ID-SEP shows outstanding performance than general SEP protocol. In SEP almost all nodes are died, all advance nodes are died having higher energy level than normal sensor nodes at 1700 round. But I-SEP and ID-SEP having all most all advance nodes are alive with cluster head and assistant cluster heads respectively still 2500 round and they work actively for more rounds. Thus network efficiency and lifetime improved to a marginal level. So it again enhances the network stability.

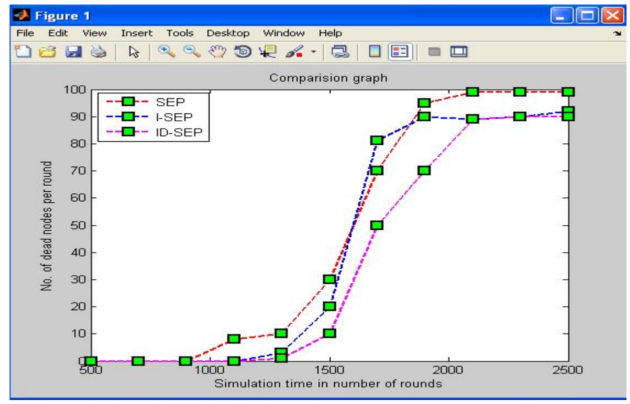

Figure 7: Comparison graph

The comparison graph (Figure-7) clearly indicates that the I-SEP and ID-SEP models are more stable and undoubtedly enhancing the network life time as well.

5. CONCLUSION

Our research work in the field of WSN is like not even handful of water in a sea of Wireless sensor network. Still more good jabs to be done such as more optimized and more fault tolerant model can be designed. Also we can add flavors like enhancing security, enhancing more energy efficient. Also more flexible and stable model in real field can be proposed with more research works. Still we try to provide a better model from the existing models in this regard.

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