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Energy Efficient Multilevel Clustering Protocol For Wireless Sensor Networks With Improved Stability

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***Abstract*— In this paper, the authors propose a Energy Efficient multilevel clustering protocol for Wireless sensor networks with improved stability. In our proposed model election of cluster head depends on average residual energy and distance between different sensor nodes. The non cluster advance node and sensor node's job has to maintain stability of its link with a cluster head during group formation, which depends on calculated predefined connection time. Each sensor node and advance nodes has been allocated with a particular time slot in an ascending order in a time division multiple access schedule based on the pre defined connection time. In steady phase, may be a sensor node or an advance node transmits their useful data, which sensed from their monitoring field within their given time slot and broadcasts a message which contain a request message to join a new cluster group and at the same time avoid data loss when this sensor node or advance node has going to lose its connection with the existing cluster group. Our simulation results shows clearly that the EE-SEP protocol ensures the reduced data packet loss by using an Assistant cluster head with cluster based routing (CBR) protocol also saves the energy by stable election protocol combined with low energy adaptive clustering hierarchy. Our proposed model outperforms than existing SEP protocol and the LEACH protocol in terms of average energy consumption and less control overhead cost and improved network's lifetime with improved stability.**

Keywords—Stability, clusterbased routing, energy efficient,Assistant cluster head.

I. INTRODUCTION

Modern era is the era of Wireless sensor network (WSN) we can say it undoubtedly because it's application area is so huge, in every field of life. Form simple application like measuring temperature to complex applications such as battle field surveillance in military and disaster management field. As the sensor nodes having limited capacity, routing techniques have to be improved; it is the most challenging issue in WSN. Sensor network has to maintain the reliable data delivery, data fusion and data aggregation for effective communication between different sensors nodes present in the network. The sensor network has to more efficient for maintaining smooth communication and secure data delivery to the base station, at the same time energy consumption must be reduced and prolonging the network lifetime efficiently with optimal clustering technique and data delivery technique.

The sensor network performance can be degrade with inefficient use of available network energy and as a result of this the network has to face the short life cycle. So energy budget has to be taken care of with proper optimal use of energy. Here to solve this problem, we propose Energy Efficient Stable Election Multilevel clustering model (EE-SEP) to reduce the probability of network failure by decreasing the energy consumption by sensor nodes and advance nodes; at the same time we try to improve the stability of the sensor network by increasing the time span of the sensor node before the death of the first node and thereby increasing the life time of the sensor network. Here we take a heterogeneous WSN, as the node's energy level is different; advance node has higher energy than normal sensor nodes. But the percentage of advance nodes is less because we have to balance the energy budget.

II. RELETED WORKS

The main goal of different hierarchical clustering techniques and routing techniques is to provide a heterogeneous sensor network with less number of transmissions to base station and less complex multi hop communication with optimal energy budget, LEACH is the basic hierarchical routing technique for sensor networks which is proposed by W.Hiezelman et al in the year 2000. It sets the standard for most of the hierarchical clustering and routing protocols.

Threshold Sensitive Energy Efficient sensor network protocol (TEEN) innovative model proposed by A Manjsehwar and his team in the year 2001. Threshold value plays the very important role in this protocol. This model has two different kinds; one is hard threshold and other referred as soft threshold. Hard threshold is the minimum priority of the sensor node to trigger itself which gives the capability to sensor nodes for event transmission. The events must belongs to interest range events otherwise the event cannot be transmitted. In this method number of transmission reduced to a significant level. Here the soft threshold gives the minimum

priority to sensor nodes to transmit data with no duplicate data values. This protocol suits for time critical events or applications.

The enhanced model of TEEN is APTEEN (Adaptive Threshold Sensitive Energy Efficient Sensor network Protocol). This novel idea is the brain child of A Manjeshwar and his brilliant team members in the year 2002. It realizes the work of TEEN and extends the functionality of TEEN by giving same priority to periodic data collection events and time critical events. Still TEEN performs outstanding than APTEEN and LEACH due to less number of data transmission. But it compromise with extra overhead cost for multi level cluster formation.

Stable Election Protocol (SEP) for clustered heterogeneous Wireless sensor networks (WSN_s) (G Smaragdakis et al., 2004) is the improved LEACH. The basic difference between SEP and LEACH is that it uses two different energy levels where LEACH uses same energy level for all sensor nodes. It has two different nodes i.e. normal sensor nodes and advance sensor nodes. Here it uses weighted election probability method for cluster head selection. This method increases the network stability. Our proposed model take inspiration from this technique and aims to provide an energy efficient multi level improved SEP model.

III. PROPOSED WORK

Before discussing our proposed model (EE-SEP) here we present heterogeneity impacts on WSN and performance metric

A. Heterogenity 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.

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.
- Throughput: Throughput of the sensor network reflects the amount of data transmission of the network. The effective rate of inter data transmission from and intra data transmission of the sensor network.

In our proposed model we also take two different energy levels. We consider lower energy level for normal sensor nodes and the higher energy level taken for advance sensor nodes in the sensor network. The above mentioned benefits are valid for our proposed model due to heterogeneity in terms of energy.

We simulate our model with Mat lab 2010 simulation tool with standardize simulation parameters which we taken from our reference papers. All most all parameters with some extra parameters like number of Assistant cluster heads in sensor networks, Threshold value for selection of Assistant cluster head (ACH). Simulation area is same but base station position is different and initial node energy values are different.

EE-SEP is a most energy efficient model. Operational procedures are same as in SEP protocol. Here the improved stability due to ACH. It also provides secure data delivery in the network. It also maintains the backup data future use, when the main cluster head does not work or dead due to energy depletion or link failures, it takes the responsibility of the main CH. Thus it results excellent network performance. Network throughput increased to a significant extent. At the same time network life time is also increased with balanced energy budget.

IV. SIMULATION RESULTS

Table I : Simulation Parameters

Simulation Parameters	Values
Sink	At(50,50)
Simulation area	100*100m /200 *200m
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	0.01
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
Initial Energy E_i	0.8j

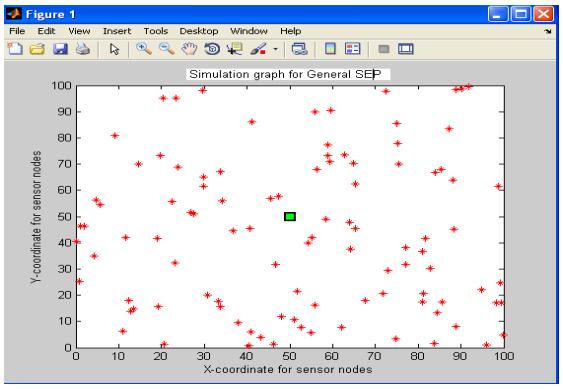

Figure 1 Simulation of General SEP (2000 rounds)

The above figure (Figure 1) clearly shows that all the sensor nodes and advance sensor nodes are dead when the simulation round reach 2000. From this we can conclude that General SEP protocol performance degrades quickly as the simulation rounds reach 1400. This case is also valid for increased number of sensor nodes in the network. It affects the network life time. This is the main drawback of this protocol as number of node increases to a significant extent.

The Simulation graph of modified SEP (Figure 2) describes that it performs better than SEP, because one advance node is alive in the network as simulation round reaches 2000. So more improvement require as we need more and more sensor nodes and advance nodes should alive to give better performance. As the performance level increased it reflects in network life time, network life time can better and it gives more stability to the network. It is the main goal in the field of WSN which can be achieved by good routing and advance clustering technique with balanced energy budget.

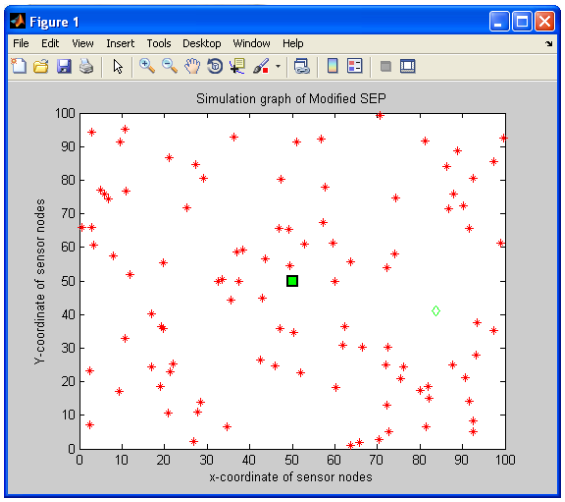

Figure 2 Simulation of Modified SEP (2000 rounds)

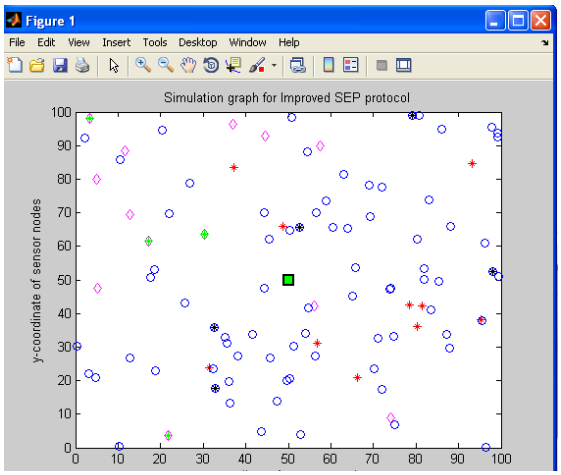

Figure 3 Simulation of EE- SEP (2000 rounds)

In our proposed model we try to give a good solution to the above discussed problems. The simulation graph presented in Figure 3 clearly indicates that only few nodes are become dead nodes with 2000 simulation rounds. Approximately 8-10 nodes are dead and about 90 percentages of nodes are alive. This is a good sign of more stable sensor network. Network performance level enhanced better. In this way network life time prolongs to a greater extent, this is the actual goal which is achieved by our proposed method. We also maintain the balanced energy efficiency. Thus network cost also minimized to significant level. It gives better throughput.

We can give conclusion from the graph presented in Figure 4 that EE-SEP performs better with increased simulation area (100*1000 to 200*200) and increased number of nodes (100 to200) . Still it gives better result; approximately 70% nodes are alive in the network. Thus EE-SEP works well with increased number of sensor nodes and simulation area.

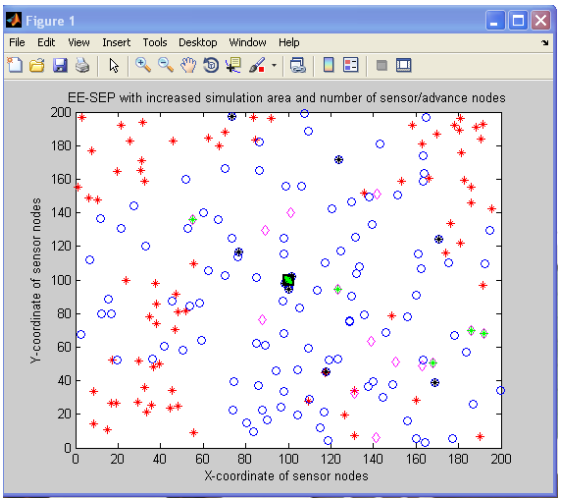

Figure 4 Simulation of EE- SEP (200*2000 simulation area and 200 nodes)

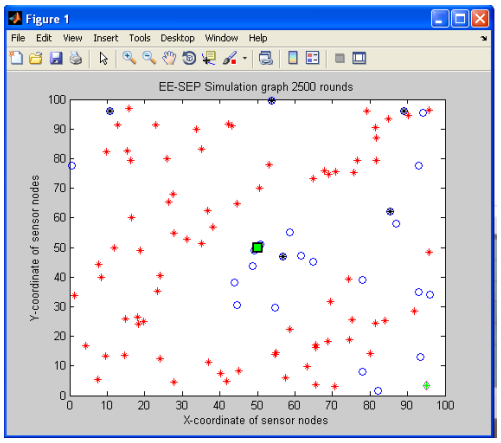

Figure 5 Simulation of EE- SEP (2500 rounds)

We can conclude from simulation graph of EE-SEP with 2500 simulation rounds that EE-SEP can works more than 2000 rounds. Approximately 21% sensor nodes are alive with 2500 simulation rounds, which clearly shows that EE-SEP performs good with 2500 rounds also at same energy budget, it shows that EE-SEP is a stable network than General SEP and Modified SEP.

The comparison graph (Figure 6) clearly shows that EE-SEP outperforms than General SEP and Modified SEP. We can undoubtedly say that our proposed model give the benefit of LEACH as it maintain low energy consumption and benefit of SEP with improved stability. At the same time dead nodes reduced and more and more sensor nodes and advanced nodes are alive with increased simulation rounds and increased number of sensor nodes and advance nodes with the required ratio (Figure 4).

We finally conclude with all our good technical works in field of sensor network could set a new mild stone for research community. Our proposed model is a well defined model for heterogeneous wireless sensor network with better stability and functionality with outstanding network performance level.

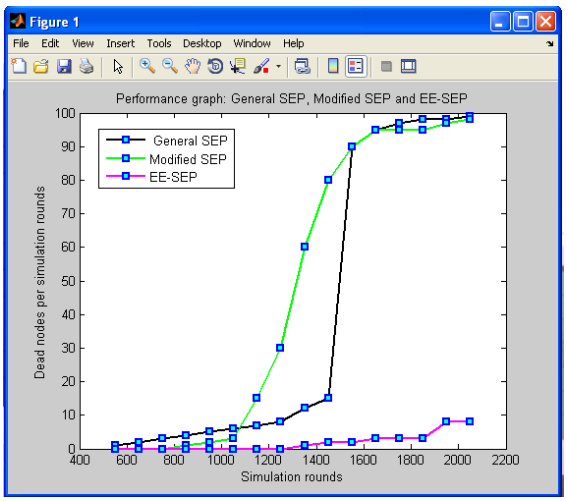

Figure 6 Comparison graph of EE- SEP with General SEP and Modified SEP

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