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Lifetime Enhancement of WSN by Heterogeneous Power Distributions to Nodes: A Design Approach

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ABSTRACT

Wireless Sensor Networks (WSNs) have gained growing attention from both the research community and actual users. The lifetime is a critical parameter for Wireless Sensor Networks (WSNs). As Wireless Sensor Network is a system which allows communication among the nodes which have different parameters like battery, transreceiver, sensor etc. This paper focuses on battery part of the node and the efficient utilization of energy source, that is, battery in sensor node to reduce the energy consumption of nodes, so that the network lifetime can be extended. Most previous sensor network lifetime enhancement techniques focused on the uniform battery allocation among homogeneous nodes.

This paper focuses on improving wireless sensor network lifespan with heterogeneous spatial power consumption distributions with Lossless Sleep Doze Coordination (LSDC) protocol. This paper gives solution to the lifetime–aware battery allocation problem for sensor networks with heterogeneous power distributions. We have conducted simulation based evaluation to compare the performance of the proposed heterogeneous spatial power consumption distributions with LSDC protocol against homogeneous distributions.

Keywords

Wireless sensor network, lifetime, battery allocation, LSDC protocol.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) that consist of a large number of low-power, short-lived sensor nodes. If one of the node in the network is dead, the entire Network collapses. As the node contains a fixed battery, in many instances, it seems infeasible to replace or recharge batteries of sensor nodes. Some nodes deplete their batteries more rapidly than others due to workload variations. Most of the previous sensor network lifetime enhancement techniques focused on balancing power distribution, based on the assumption of uniform battery capacity allocation among homogeneous nodes.

Wireless Sensor Network is a distributed data acquisition systems consisting of numerous wireless sensor nodes. They have the potential to allow sensing in applications and environments where it was previously impossible. For example, WSNs may be used in weather monitoring, security, tactical surveillance, disaster management, and intelligent traffic control applications. Distributed infrastructure-free operation in remote locations makes replacing batteries expensive. WSN lifetime depends on the distribution of power among nodes in addition to average power consumption.

The research work in the past on lifetime extension had focused on distributing power consumption evenly among sensor nodes based on the assumption that homogenous nodes with equal battery capacities are used. Distributed battery configuration has the potential for both cost and energy efficiency in WSNs with heterogeneous spatial power consumption distributions. Conventional power balancing can be inconsistent with energy efficiency because some tasks and communication events are spatially heterogeneous In the multilayered architecture of WSN, node which is near to head node has heavy workload because they are responsible to collect data from node which is situated far away from head node and transfer this collected data to head node. Heterogeneous battery allocation has the potential to reduce cost by reducing battery capacity for lightly loaded nodes and to increase WSN lifespan by allocating more energy to heavily loaded nodes. In brief, heterogeneous battery allocation has the potential to improve network lifespan.

Some drawbacks of past work are like when protocol selects head node, there is no consideration about energy of nodes, and since head node is single it may occur bottleneck at head node. This paper has approached to improve the lifespan of Wireless Sensor Network by introducing a variant to standard sleep synchronization protocols. This protocol considers one node per grid to be in the idle listening state called as doze state for fixed interval of time. Thus, node does not have to remain active throughout its ON period and its overall lifespan increases for given amount of energy.

2. PRIOR WORK

In sensor networks, where the replacement of batteries is prohibitive, the problem of lifetime maximization has become increasingly important

The following contributions of this paper.

1. The paper proposed an approximate method to obtain the node partitioning. it also provided an energy–cost model for battery packs based on real data, which permits to calculate the corresponding energy under different battery pack configurations given a specific budget.

2. Based on the optimal node partitioning and energy cost model for battery packs, the paper proposed a heuristic to solve the cost-constrained WSN energy allocation problem.

3. The paper also proposed a multi-state proactive algorithm in the form of Sleep Doze Coordination (SDC) protocol to lower the duty cycle of each sensor node and maximize the network lifespan with lower power consumption.

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3. SIMULATION RESULTS

To validate the performance of proposed heterogeneous distribution with LSDC protocol, we simulate the protocol and utilize the network with 31 nodes randomly deployed between (x=0, y=0) and (x=1700,y=1500) with packet size 512 kbps. The initial power of all nodes is considered to be 10J.These parameters are summarized in Table1 and Table2. Some simulation result with the analysis of trace file will be given.

Table.1: Power consumption in mW for different mode used in the simulation experiments

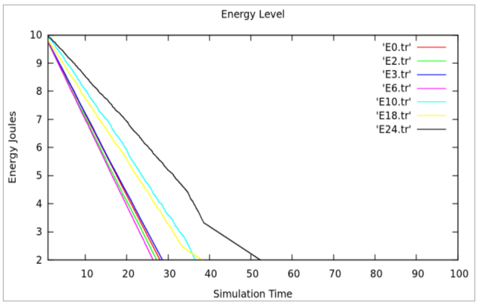
Tx power	0.6
Rx power	0.3
Sleep power	0.001
Transition power	0.2
Transition time	0.5 sec

Table.2: Summery of the parameters used in the simulation experiments.

Number of nodes	31
initial node power	10 J
Simulation time	100sec
CBR rate	200kbps
Radio propogation model	Two ray ground
Antenna model	Omniantenna
Energy model	Battery
Interface queue type	Queue/droptail/priqueue
Link layer type	LL

3.1.Homogeneous distribution of energy:

Snapshot 1 shows simulation result of homogeneous distribution of energy across each layer. In this same energy i.e. 10J is assigned to each node. Node E0 is head node which was dead earlier due to gathering, processing and communicating data in the network. Node E2 is nearer to E0 than node E24. As node E24 collected information in allotted range and transferred it towards the head node. Node E2 collected the information from the E24 and passed it towards the head node. As simulation result shows E2 dead earlier than node E24.



Snapshot 1: homogeneous distribution of energy(joules) vs simulation time(sec)

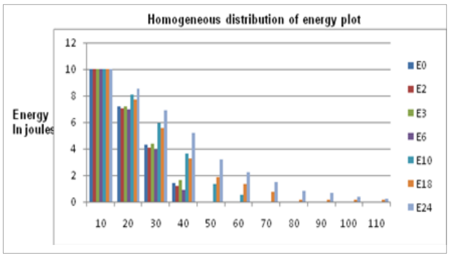
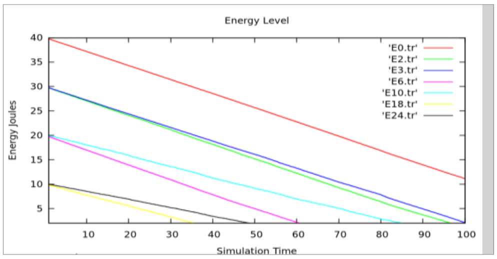


Figure 1: **Energy in joules vs simulation time (sec) in seconds of homogeneous distribution of nodes**

Figure 1 shows trace file comparative result of homogeneous distribution of energy across each layer. Node E0 is head node which was dead earlier due to gathering, processing and communicating data in the network. In this, same energy i.e. 10J assigned to each node. As result shows energy of node E0 is dead at 40 sec. whereas node E24 which is last layer node alive up to 100sec,but as cluster head will be dead, whole cluster will collapse.

3.2. Heterogeneous distribution of energy



Snapshot 2: **heterogeneous distribution of energy of nodes**

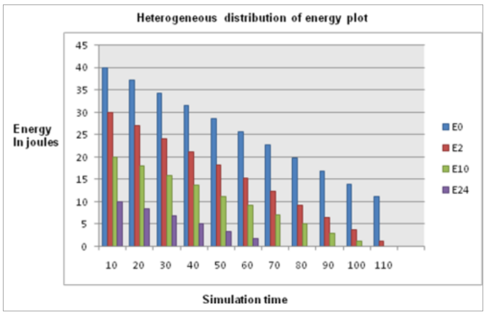


Figure 2: Energy in joules vs simulation time(sec)of heterogeneous distribution of energy of nodes

Snapshot 2 shows simulation result of different level battery allocation approach which increases network lifetime by moving energy capacity from low power consumption nodes to high power consumption nodes. As figure2 shows node E0, E2, E10, E24 assigned 40J, 30J, 20J and 10J resp. Unlike homogeneous distribution, the cluster head node E0 kept alive during simulation time. Therefore, the lifespan of network is increased.

4. COMPARATIVE ANALYSIS

Objective of this work is to note the difference in lifetime between two approaches. We compare the simulation time of the node in LSDC and heterogeneous distribution. Figure3 shows the comparison between LSDC and heterogeneous distribution of energy. As result shows that simulation time is more in LSDC than heterogeneous distribution. As figure shows that node E0 dead earlier than E0 LSDC. LSDC increases network lifetime by approximately 5-10% over heterogeneous distribution of energy to node according to their level.

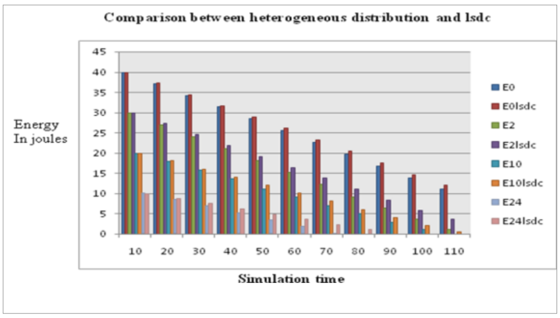
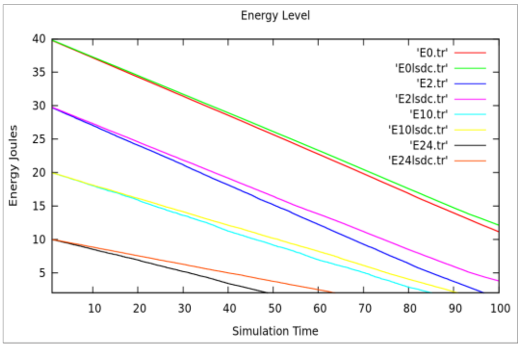


Figure 3 Energy in joules vs simulation time (sec) comparison between heterogeneous distribution and LSDC



Snapshot 3: Comparison of energy in joules vs simulation time(sec) between LSDC protocol and heterogeneous distribution

Figure 4 and 5 shows comparative analysis of different nodes of heterogeneous battery allocation and LSDC protocol. As node E2 is nearer to head node than the node E24. The figure shows node E2 and E24 dead earlier than the node E2 and E24 with LSDC protocol.

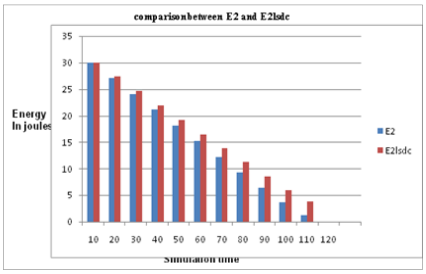


Figure 4: Comparison of energy in joules vs simulation time(sec) between node E2 and E2lsdc protocol

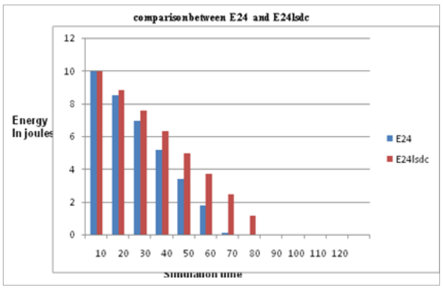


Figure 5: Comparison of energy in joules vs simulation time(sec) between node E24 and E24lsdc protocol

4. CONCLUSION

In this paper, we have outlined and evaluated the problem of lifetime maximization to energy constraints. Unbalanced power distribution due to intrinsic many to one traffic in WSNs results in uneven battery depletion and WSN lifetimes. Previous energy balancing techniques considered homogeneous node WSNs with uniform battery capacities. Simulation result shows the lifetime of the node during homogeneous power distribution. To avoid the earlier network failure, this paper formulates the heterogeneous WSN battery allocation that increases network lifespan. From simulation result we concluded that this technique can provide improvement in lifetime with LSDC protocol. By introduction of ‘doze’ state, successful reduction in the overall power consumption of the network is achieved.

5. REFERENCES

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