Protract Lifetime by Exploiting Heterogeneity in Wireless Sensor Network

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ABSTRACT
Wireless sensor networks (WSN) are emerging in various fields like disaster management, battle field surveillance, agriculture etc. A large number of sensors in these applications are unattended and work autonomously. For a case we can also use set of single sensor in order to cover the whole area of our region but it is much costly and risky as well and it gives sometimes single point of failure. So providing heterogeneous sensors clearly shorts down many problems in wireless sensor network mainly as lifetime of network. Clustering is a key technique to improve the network lifetime, reduce the energy consumption and increase the scalability of the sensor network. In this paper, a novel technique is evolved to measure the impact of heterogeneity of the nodes over lifetime of the network and compare the performance by comparing with homogeneous sensor network.

Keywords
Cluster Head, Heterogeneous, Energy Efficiency.

1. INTRODUCTION
It has been noticed, the great growing interest towards the Wireless Sensor Networks (WSNs). As Wireless Sensor Network has unrechargeable and very limited and less energy resources which gives birth to the enhancing or increasing the lifetime of Wireless Sensor Networks as a great issue [14]. In some of the cases sensor nodes are used with comparatively different perspective in terms of high energy or functionality (which makes the WSNs heterogeneous) in order to prolong the lifetime of Wireless sensor Networks. Above all now days every application comprises of mixed nodes so we need to work to increase the lifetime of system using Heterogeneous Wireless Sensor nodes [2].
In the WSN, sensor nodes are mostly operated through batteries, which are of course limited in energy potential, and difficult or even sometimes much impossible to make them replace or recharged. For this particular reason, power should be controlled in a most efficient manner to make maximum use of the limited energy resources so as to minimize the energy consumed by sensor nodes for some application and thus prolong network lifetime. Especially for this particular purpose, energy efficiency of the sensor nodes must be taken in account in every aspect of operation and network design, not only for few individual sensor nodes, but also considering the communication of the entire network. Power control and Energy efficiency are the basic guarantee of any network performance, like for example, throughput and delay. Around most of energy efficient protocol that are designed for the heterogeneous sensor networks [7], are basically based on the clustering technique, which are effective in energy saving for Wireless sensor networks. This work seeks to investigate and analyze a novel technique for increasing the lifetime of Heterogeneous wireless sensor network by analyzing and optimizing clustering algorithm. Simulation for this respective algorithm is done using MATLAB and compared with the existing approaches to calculate the lifetime of the network

2. LITERATURE SURVEY
Now days, Sensor networks have a very crucial character in overall understanding of the probabilistic physical environment and also have the potential to give better and reliable result in a various kind of applications. One of the major and an essential consideration with the sensor networks is power consumption. The sensor network lifetime is based upon many factors which includes on-board battery capacity of the individual sensor nodes, the layout of overall sensor network, how total information is gathered, required number of sensor node for the overall system, the total number of allowed processing that can happen, and the finding of exact position for the gateway or base station/sink node. On-board battery provides the total power for sensors in the network, which can be considered to look like as the key aspect so as to achieve prolonged life. The impact of the preserving and saving power with respect to every sensor node can all together have more prominent effects on the total lifetime of entire system for respective sensor network, i.e. the conserving power considering each sensor node is directly proportional to the lifetime of the sensor network. Due to limited power with low computational resources and low memory, sensing devices are made deployed in large numbers. To build a better energy-efficient sensor network, there are many researches which are underway. Two methods are exploits to enlarge the lifetime of WSN (1) Global Level: Number of the redundant sensor node is increased in a sensor network. These nodes are sometimes called as backup nodes or the redundant nodes. They are used as alternative node in place of dying sensor node for performing sensing or signal communication in order to boost overall network lifetime. (2) Local level: changing the schedule of sleep time, sensing time, communication time or low power operation for each single sensor node.

A sensing node in the system can sense the objective environment or communicate along with the other node such as neighboring node or clusters head [12] etc. as long as its on-board battery power survives. The whole of the 60% of the total energy is not utilized because of the property that sensor node has to stay awake to communicate with other neighboring nodes. Therefore, we have to maintain lifetime of the given sensor network by modulating the network parameter such as in number of nodes or power scheduling. For the sensor node level in case if we need to use battery power more efficiently then sensor node should be programmed to sense the events at different time interval or at the different sample as asked. However, the drawback is that if we adjust the power scheduling, then in some occasion sensor does not transmit any important novel information even though if there is some environment event

occurring because sensor node is not in the awake state for all the time. Optimally nodes should have Operation on a very low battery levels, should be very inexpensive and dispensable, operation may be unattended, should be adaptation to the environment, coordination among neighboring nodes. The main focusing goal of the wireless sensor networks is mainly based on the very simple equation:
CPU + Sensing + Radio = Many important potential applications.

Some of the important dependencies which are important to understand are like (1) System Evaluation Metrics for any wireless sensor network [3] are Lifetime, Coverage, Cost and ease of deployment, Response Time, Temporal Accuracy, Security, Effective Sample Rate.(2) Factors responsible for wireless sensor network are Fault tolerance, Scalability, Production costs, Hardware constraints, Sensor network topology and Environment. (3) Lifetime of Wireless Sensor Network depends on Number of Alive nodes at certain time describe the Network Lifetime, Network Lifetime Based on Sensor Coverage, Network Lifetime Based on Connectivity, Network Lifetime Based on Sensor Coverage and Connectivity, Network Lifetime Based on Application Quality of Service Requirements. (4)The factors that are responsible for the network lifetime are Mobility, Heterogeneity, Application Characteristic, and Quality of service and Completeness.

The major impact of the Heterogeneous network in wireless sensor network [2] is (a) Better network lifetime, for this to be in actuality the heterogeneity can be in terms of Computational heterogeneity: It means that the certain types of heterogeneous node have a better or the powerful microprocessor or more memory as compared of the normal node. With this more powerful computational resource heterogeneous nodes can then provide more complex and strong data processing with the longer term storage. Link heterogeneity: It means that the certain type of heterogeneous nodes has the high bandwidth along with better than the normal node. This Link heterogeneity provides more reliable and better data transmission. Energy heterogeneity: It means that this heterogeneous node is more powered or its battery is replaceable. If we apply any of the heterogeneity [16] then we can enhance the network lifetime. (b) Reliability in Data Transmission- The reliability can be maintained as the heterogeneity will not let the node to die very soon and the computation heterogeneity will help to make the report fast. (c) Decrease in data transmission Latency- The channel heterogeneity can help to decrease the time at which the report is send or any event detection report.

Performance Measurement is another important perspective for any system. The performance of WSN can be measured by (1) Network Lifetime- Lifetime will tell the time till which the data was correct in terms of reliability and the generated event report. (2) Cluster Head per round- The number of cluster head that are chosen. The number of times and according to the area number of clusters that are chosen helps to provide the performance of the network. (3) Number of Alive nodes- The time till which the number of nodes are alive and does not cross the threshold or they are up to coverage and connectivity through this the performance of the system can be calculated. (4) Throughput- The number of Packets that are being transferred or delivered or reported to the sink or the event report gives the performance of the networks. As we saw above that to increase the lifetime of WSN clustering approach and heterogeneity plays an important role. [4] The advantages of the Clustering Approach can be many like the size of the routing table can be reduced; bandwidth is saved as the data is only sent to the cluster head. The cluster head (CH) has to apply different strategies to increase the overall lifetime of the sensor network, there will be no collision of packets as only the cluster head will send the data, cluster head can adopt scheduling strategies. The direction of objective of our proposed work is to design an efficient, moreover scalable algorithm that can be used to prolong the total functional lifetime of the heterogeneous wireless sensor networks. It is required and desired that all the protocols that are designed for a sensor network should be energy aware and which in turn will improve the overall lifetime for the network. We have proposed an algorithm for the clustering in order to select a cluster head [4] in a heterogeneous wireless sensor network which is having a certain probability, which will depend on their energy that is compared with that of overall system. Heterogeneous network system will surely increase the lifetime. In order to achieve this we can analyze the optimal settings that are required for this network architecture, it include the optimal number of clusters that are required and the amount of total energy required by each of the CH. Finally, we can provide an overall estimate of the lifetime of the system or the network by analyzing the number of rounds and the dead nodes with which the critical data has to be sent to a particular location that will be sensed by nodes which are alive in a given round.

3. APPROACH & IMPLEMENTATION

We have taken heterogeneity of the sensor nodes on the basis of the energy. The nodes in starting will be having different initial energies x, y and z so as that it will be comprising of the hierarchy of sensors that is a first layer of normal nodes then overlay of advanced over which the overlay of super nodes in a definite proportion with respect to the increase energy. The deployment of all three sensors will be done in a field (X*X) and the sink will be deployed at the center of the field having no energy constant. The System model architecture is defined with the cluster based WSN having 100 number of sensor nodes that are dispersed in a field. The Base station is located basically inside the field very remotely. This field is composed of the several clusters. And each cluster has one CH which generally acts as the local control for data transmissions. All of the components in this are based basically on the following assumptions and of the radio model. (1)The WSNs will be mainly consisting of the heterogeneous sensor nodes Normal, Advance and Super Nodes. (2) The BS is located inside the WSNs system. (3)The Sensor nodes are heterogeneous with initial energy. (4) All sensor nodes with BS are stationary after Deployment (5) All sensors are location unaware (6) Communication will be single hop (7) All sensors are of equal significance.
In the model it will take the hierarchical type of clustering protocol so as to efficiently maintain energy consumption for nodes by the single-hop communication within the cluster and doing data aggregation in the order so as to decrease number of the transmitted messages for sink.

For the phases, first of all in the set-up phase the cluster heads are to be selected and the clusters are organized and in the steady state phase, actual data transmission will take place to the sink. After the steady state phase next round will begin. The Clustering will be on election probability or the remaining energy or the comparing with that compared of the threshold value. The system will have the different threshold and the probability for all three different nodes. Within one epoch the number of normal nodes when considered will be less than of the other two as other level of nodes will be having the sub epochs within the same round therefore increasing the total number of rounds and the interval for the first node to be dead. We have considered a heterogeneous network with three types of nodes. Finally we will analyze the network lifetime by using the energy parameters of heterogeneity, namely the few advanced and super

nodes of (a) and (y) times more energy than the normal nodes so as to prolong the overall lifetime of the sensor network. Super and advanced nodes have to become cluster heads more often as compared to the number of times the normal nodes. This heterogeneous will provide the change in total initial energy of the system network whereas it does not affect the total spatial density of the network. We assumed the following variables: SE=Energy of the super node, AE=Energy of the advanced node, NE=Energy of the normal node. The energy level E2= NE.(1+y) and E1=NE .(1+a) for respective Super and advanced nodes. The energy spent in sending 'd' bits of data to 'L' distance, E(l,d)=L.Eelec + L.efs.d*d (where we have to send d bits to l distance). The representation of the nodes; O – Normal Nodes, ^- Super advance nodes, + - Advance Nodes and × - Sink at the center (as shown below in Fig.1.). Advance node energy = (NE+ aNE); Super nodes: (NE + y NE) where 'a' and 'y' are the number of times the advance and super nodes are more than the normal nodes. Heterogeneous model will be increasing the total system energy. Probability of node for CH= (Total number of Cluster / Number of nodes). Threshold has to be different. Maintain energy in all levels equally, to become cluster head the advance will have (1+a) times more chance than the normal and super will have (1+y) times more. For each round of cluster head taking (weights = Energy of each node / Initial energy of each node). Weight probability of Normal=(probability to become CH / (1+a.m.y.n)) , Wight probability of Advance=(probability to become CH/(1+a.m.y.n))*(1+a) and Wight probability of super=(probability to become CH / (1+a.m.y.n)*(1+y)). Calculating the threshold of Tnrm (normal), Tsup (super) and Tadv (advance) . Threshold will be for each of the nodes as = (its probability / (1-probability (j mod (1/probability))) where r is the current round and among the array 'G' in which the nodes that has not become CH from last (1 / prob) round. This way we will have one round like that the number of cluster head will be maximum from super then advance then the normal node.

4. RESULTS

The above mentioned technique, to enhance the lifetime of the heterogeneous wireless sensor network is implemented on Matlab for the above mentioned scenario. The result states that the time at which first node and last node dies is much less than the homogeneous WSN report (lifetime). The lifetime is increased drastically with reference to the first node died and the last node died (fig. 4, 5, 6) (failure of the network). This way the proposed algorithm provides the reliability and increased lifetime of the network.

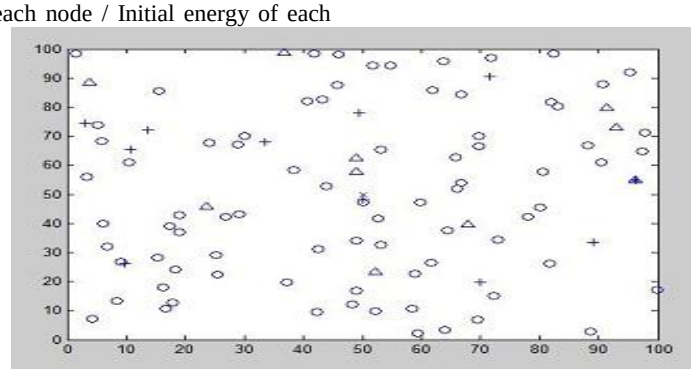

Fig.1. Deployed sensor nodes

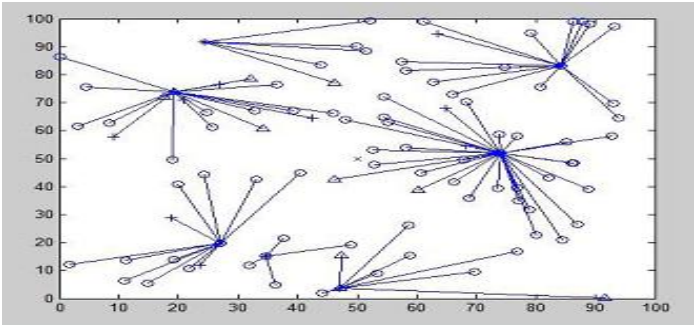

Fig.2. Cluster head formation

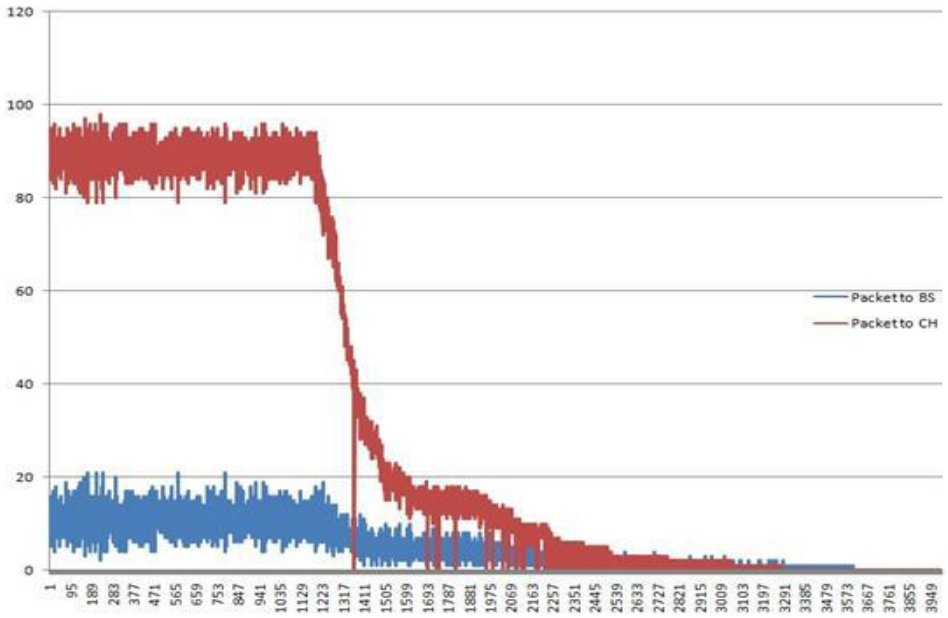

Fig.3.Transfer of Packets to Base Station and Cluster head

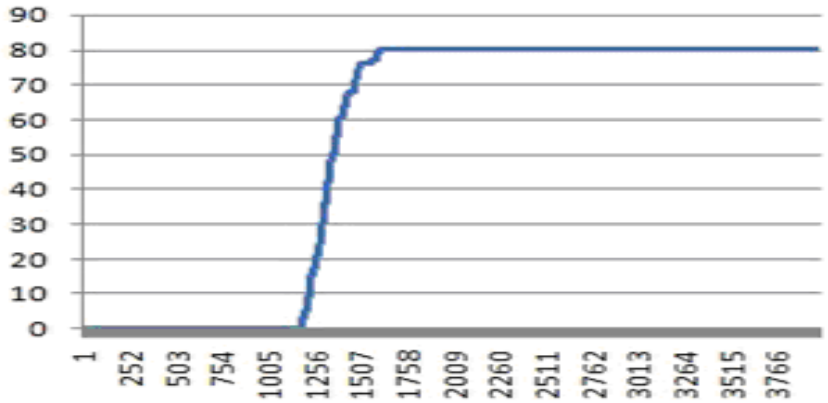

Fig.4. Normal Node Died

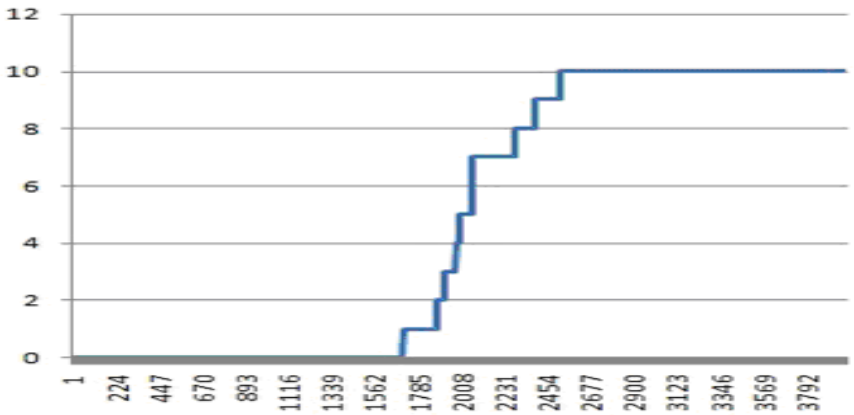

Fig.5. Advance Node Died

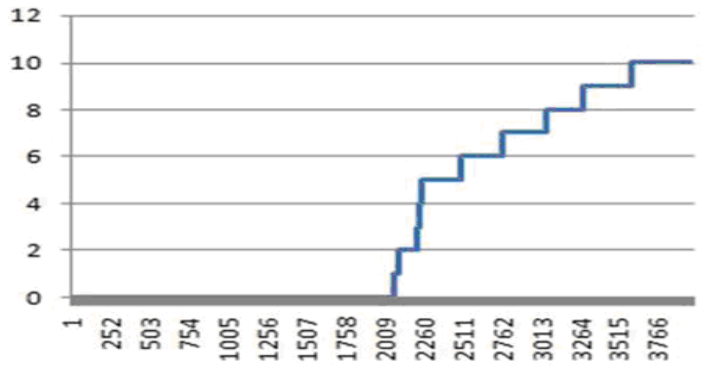

Fig.6. Super Advance Node Died

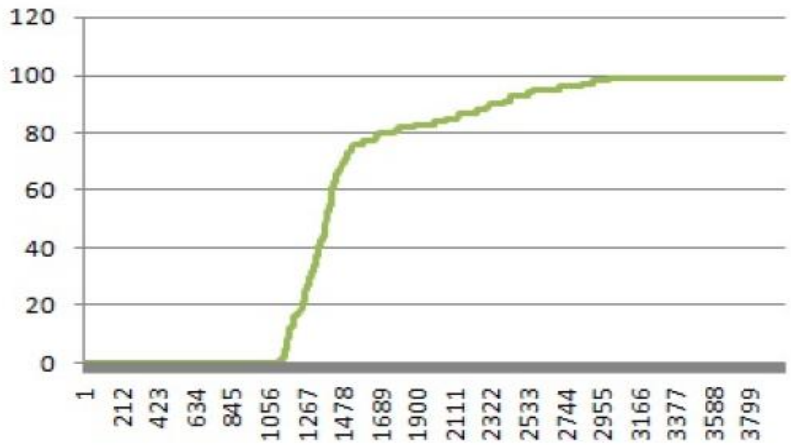

Fig.7. Overall Node Died Flow

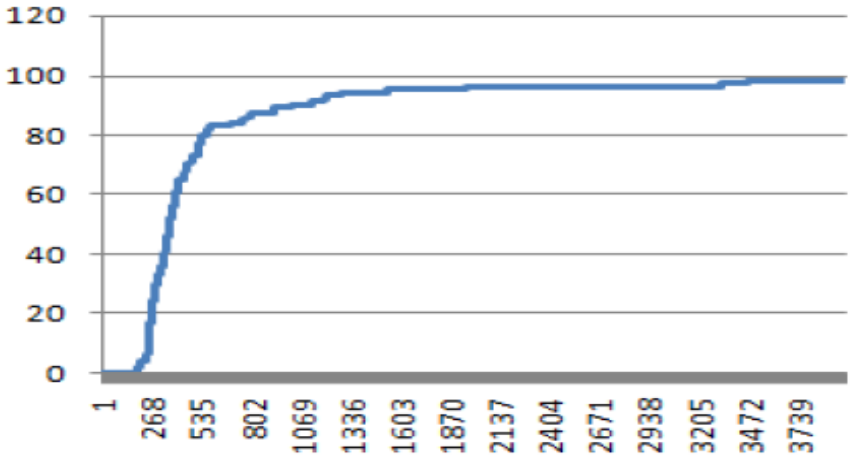

Fig.8. Rate of Node Dead in Leach

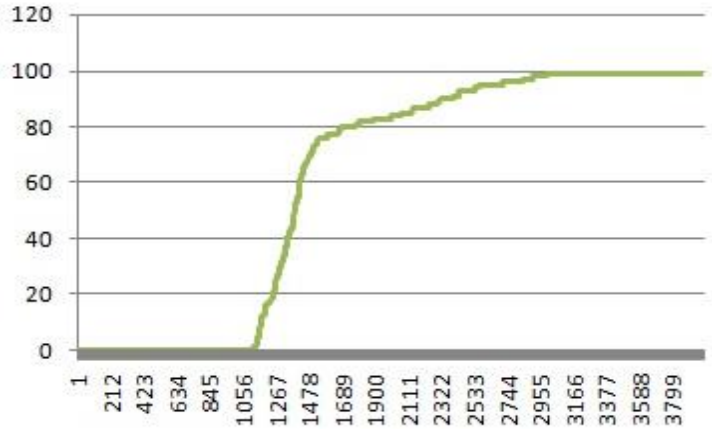

Fig.9. Rate of Node Dead in Proposed Algorithm

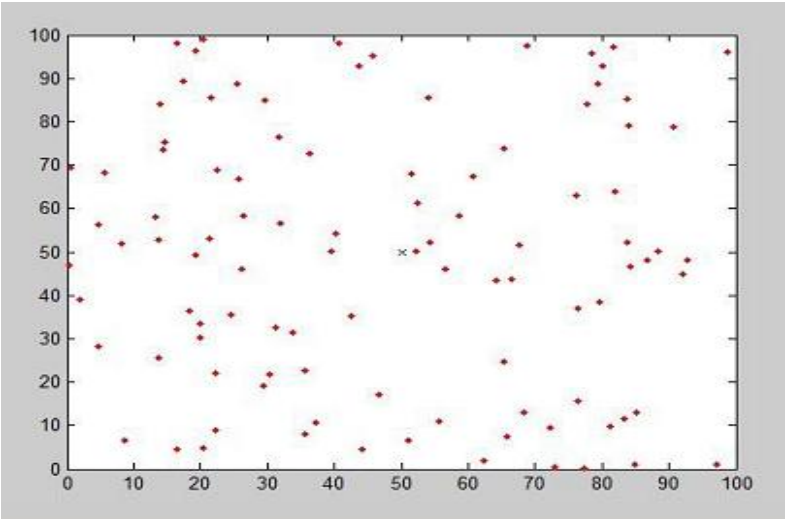

Fig.10. Node Marked As Red for Dead Node

5. FUTURE WORK

The Heterogeneous wireless sensor networks are much more complex than the homogeneous one. This network has battery heterogeneity, with no global knowledge. The sensors are deployed. The clustering technique is chosen for providing the improvement in system energy. The Future work can be to inculcate the avoidance of packet collision which will arise after implementing multi hopping. Another work that can be added is to add the concept of sleep and wait for further increasing the lifetime of heterogeneous sensor network.

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