Energy Efficient Clustering using Uniform Deployment for HWSN

Saurabh Mishra
Dept. of Digital Communication
Sri Satya Sai Institute of Science & Technology,
Sehore, Bhopal (INDIA)

Mukesh Tiwari
Dean Academic
Sri Satya Sai Institute of Science & Technology,
Sehore, Bhopal (INDIA)

Jai Karan Singh
HOD, EC
Sri Satya Sai Institute of Science & Technology,
Sehore, Bhopal (INDIA)

ABSTRACT

A wireless sensor network is capable of sensing physical quantities like pressure, humidity, temperature, real time object and also in the healthcare, and send these reports to the sink (i.e. the central entity), which will process the data and give an output understandable to a human. Wireless sensor network includes hundreds or thousands of sensor nodes. The sensor nodes are having very less energy resources and processing capabilities. Wireless sensor networks are hierarchically clustered, where some of the nodes become cluster heads, and the remaining nodes send their data to cluster head then these cluster head send the data to sink for further processing. We assume here that some of the nodes are having more energy than the normal nodes. So, there is heterogeneity present in the network in terms of sensor initial energy. In this paper we use this additional energy to increase the life time of sensor network. We developed an algorithm to increase the lifetime of sensor network by using the additional energy contained by some of the nodes and also remove the instability caused when the first sensor node dies.

Keywords: Cluster, Maximum Number of Nodes, Sensor Network

1. INTRODUCTION

Wireless sensor networks are self-organizing of sensor nodes [5, 6, 7] which can communicate with each other by broadcasting signal. These systems follow infrastructure based topology but each node can act as a router to forward packets to its neighbors. Now we describe our protocol for clustering in the wireless sensor network. The sensor nodes are uniformly distributed at the beginning in an area of interest. We have two type of nodes Normal node and advance node (having more energy than normal node) and then clustering starts.

2. ROUTING PROTOCOLS FOR WSN

As we all know that are so many protocols that are available to route the data in WSN known as routing protocol. These routing protocols are considered as key feature for sensor nodes along with the requirements of architecture and application [1, 2, 3, 9].

2.1.Hierarchical Protocols

Like MANET, energy is an important attribute to design a wireless sensor networks. For this single-tier network require the potent node to overload the increment in sensors density. This type of overload can cause decrement in response time for communication and poor chasing of events. Additionally, the one gateway architecture is not Scalable for the huge set of sensors that cover a larger area of interest since the sensors are not much efficient for long-haul type of communication. [7,8,9] for making the system efficient to deal with extra load and to be capable to cover a wide area of interest and not debasing the service. The key objective of hierarchical routing is to effectively sustain the energy uptake of sensor nodes by involving them in multi-hop type of communication in a specific cluster and by doing fusion and data aggregation to reduce the transmitted messages count to the sink [18]. Formation of cluster is based on the energy stock of sensors and sensor's proximity for cluster head. LEACH [19] is hierarchical type of routing protocol for sensors networks and its concept has been an inspiration for many hierarchical routing protocols, but few approaches have been developed independently.

2.2.Location - based Protocols

Almost all the routing protocols for WSN need information about location of sensor nodes. For so many cases location information is required to calculate the space in between two particular nodes, so the consumption of energy can be calculated. Infect, there is no addressing strategy for sensor networks like IP address. Information about location can be used for routing the data in an energy efficient mode. [13, 14, 15]. For example, if the region has to sense is known, then by using the sensor location, the query can be send only to that region which will eliminate the number of transmission significantly.

The paper is organized in the following manner. In Section III we discuss the primary details related to the wireless sensor network model, model for energy consumption of a sensor node and the assumptions related to the lifespan of the network. In Section IV we describe our algorithm. In Section V we present the simulation results in a comparative form for LEACH algorithms. In Section VI we give our conclusions.

3. SENSOR NETWORK MODEL

The primary assumptions used to model the sensor network are as follows.

3.1.Assumptions

1. All sensor nodes have the equal processing and communication capabilities.
2. Base Station (BS) has the rights to direct the existing CH operation asynchronously.
3. Data transmission from normal nodes to its CH performs using TDMA scheduled.
4. Symmetric radio communication model.
5. Senor nodes have the capability of adjusting the transmission power.

6. The required transmitting power is calculated based on the received signal strength.
7. Sensor nodes are uniformly distributed in a circular region.
8. Sensor nodes can aggregate or wrap multiple data into a single-size data unit.

However we have flaccid the following two assumptions used in most of the previous research papers.

1. Homogeneous energy of sensor nodes.
2. Location awareness of sensor nodes.

3.2.Energy Consumption Model

We use the energy consumption model used by the LEACH algorithm. This model assumes free space trans- mission. Furthermore in this model a sensor node consumes E_{elec} (nJ/bit) energy at the transmitter or receiver circuitry and $\epsilon_{amp}(pJ/bit/m2)$ energy at the transmitter amplifier. A sensor node expends energy $E_{Tr}\ (l,d)$ or $E_{Re}\ (l)$[4, 5, 6] in transmitting or receiving a l bit message to or from distance d respectively. These can be computed using equations (1) and (2).

$$E_{Tr}\ (l,d) = E_{elec} * l + \epsilon_{amp} * l * d^2 \qquad (1)$$

$$E_{Re}\ (l) = E_{elec} * l \qquad (2)$$

Furthermore a CH node consumes EDA (nJ/bit/message) energy in aggregating multiple sensor data.

3.3.Life Span of the Sensor Network

The definition of the life span of a sensor network depends on the application where the sensors are deployed. There are three commonly used definitions in the literature [6, 9].

First Node Dies: This definition is appropriate in situations where death of a single sensor node warp the quality of the network. E.g. Intrusion Detection systems.

Percentage of Nodes Alive: Time until a certain percentage of sensor nodes is still alive. This definition is more appropriate for most of the applications with a requirement for a certain percentage of nodes alive for the network to output credible information.

Last Node Dies: Though this parameter can be considered as a way to measure the lifetime of a sensor network its practical applicability is very limited.

4. DESCRIPTION OF PROTOCOL

STEP 1: All the Sensor node deploy in sensing area. All normal node deployed in random fashion and advance node deployed uniformly in sensing region. Where sensing region is subdivided in circular region some percentage of advance node uniformly deployed in each circular region.

STEP 2: Each sensor nodes generate a random number and compare to its threshold. Threshold of normal node and advance node are different. When random number is less than threshold then sensor node become a cluster head, these node called candidate node.

STEP 3: Each candidate node broadcasts the message to join cluster, the set of nodes that are within the communication range can receive that message. If a node A hears from more than one candidate node than it calculates distance to candidate nodes. Send a request message for energy status. All the candidate nodes send back its energy status. Node A check energy status is above give threshold than node A join cluster, otherwise join another cluster.

STEP 4: After completion of step 3, the sensor network is divided into a number of clusters. Where each sensor node belongs to exactly one cluster and a sensor node is either a cluster head or directly connected to one. Each sensor node keeps record of the id of its cluster head, the time the sensor node has been a cluster member of its current cluster head, as well as the number of nodes in the cluster. A cluster head also keeps record of the member of that cluster.

STEP 5: It is possible for a cluster to grow too large. Consider a condition when a cluster is just below the maximum allowed size, and several sensor nodes joins at the same time. Finally, the cluster head will be informed of all the new sensor nodes. Since the size of the cluster outdo the maximum allowed size, one or several sensor nodes need to be disconnected from cluster head.

STEP 6: A node can leave a cluster, either because the cluster head is overloaded, or because it is moving farther from the cluster. Even if it miss the contact with the sensor node, that is the first hop to the cluster head, it might yet to be able to connect to another sensor node in the cluster. However, if the node is more than d hops farther from the cluster head, it must leave current cluster. When a sensor node leaves a cluster, it striving to find another cluster to connect. That cluster size must be smaller than the maximum allowed size, and the sensor node cannot be more than d hops away from the cluster head. If various such clusters are found, the node joins the biggest one. If no such cluster is found, the sensor node forms a cluster with itself as cluster head.

5. SIMULATION AND RESULTS

We simulate wireless sensor network using Matlab simulation tool. All the parameter taken for simulation describe in subsection.

5.1.Simulation Parameters

The various parameters considered for simulation:

Network size: It is crucial to observe the performance of a clustering algorithm with respect to the number of nodes spread in the network.

Heterogeneity: The energy level in advance node.

5.2.Performance Metrics

Our aim is to maximize the stability period of network, and also to minimize the number of communications while forming a cluster.

Stability period: It is the time interval from the start of network operation until the first sensor node dead. We also refer to this period as stable region

Instability Period: Time interval from death of first sensor node to last sensor node die.

Network lifetime: It is the time interval from the start of operation of the sensor network until the death of the last alive node

5.3.Simulation result

For various parameters we have computed the results for the above algorithm. The parameters are size of network, maximum transmission range etc, shown in table 1.

Table 1: Simulation parameters

Parameter		Value
Network size		$(100m\ x100m)$
Node number		100
BS Position		$(50m, 50m)$
Initial energy	Normal Nodes	$2\ J$
	Advanced Nodes	$4J$
$d0$		$87m$
$\varepsilon f\ s$		$10pJ/bit/m2$
εmp		$0.0013pJ/bit/m4$
$Message\ Size\ (l)$		$4000\ bits$
$Tmax$		$500ms$
Rc		$20m$

5.3.1. Network lifetime

We observe the performance of our approach is better than LEACH. Number of node alive per rounds in the network as shown in fig 1, 2, 3. In case of our approach lifetime is more as compared to LEACH.

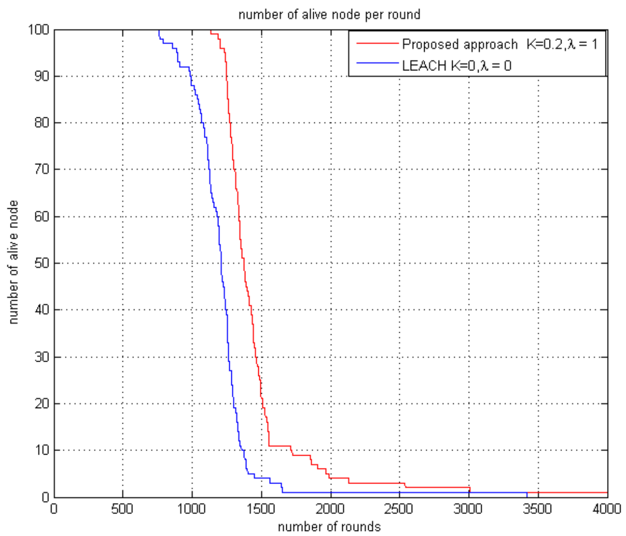

Fig.1: Number of alive nodes per round

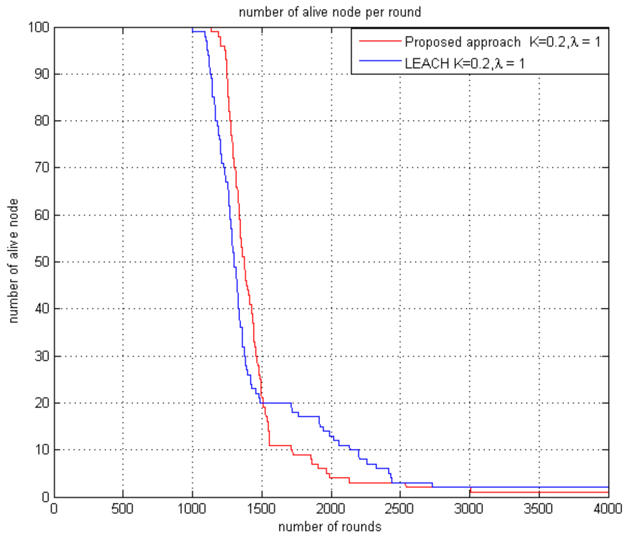

Fig.2: Number of alive nodes per round with heterogeneity $k = 0.2$ and $\lambda = 1$

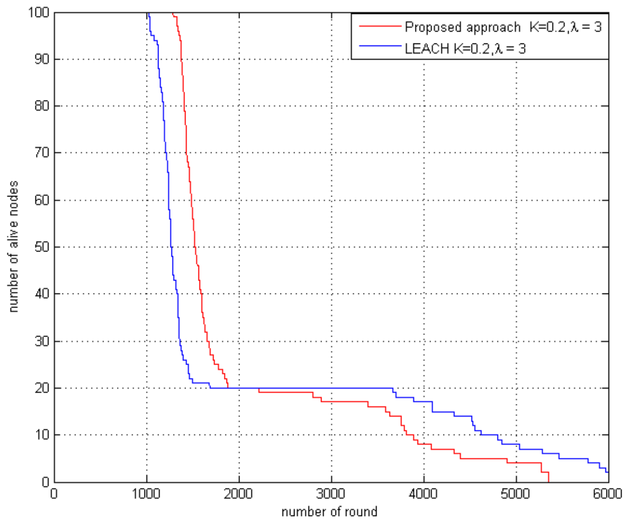

Fig.3: Number of alive nodes per round with heterogeneity $k = 0.2$ and $\lambda = 3$

5.3.2. Stability

In this parameter advanced nodes are deployed with two times more energy than normal nodes. The first node dies after 1000 rounds when we use the percentage of advanced nodes as 0.1 as shown in figure 4 and 5. On increasing number of advance node stable region is also increasing, as shown in fig 4.

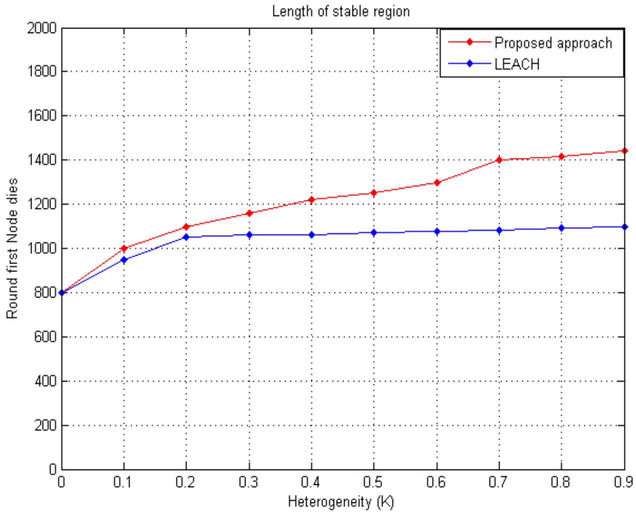

Fig.4: Length of stable region in term of heterogeneity

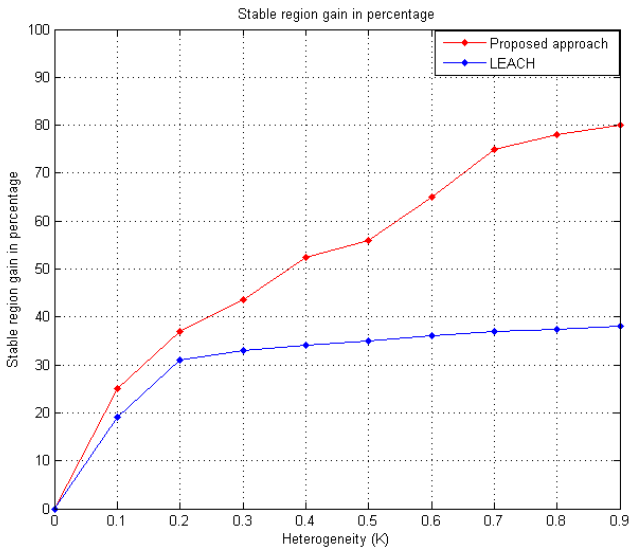

Fig.5: Gain in stable region (in Percentage)

It can be observed from the above graphs that if the advance nodes uniformly deployed with normal node in area then the stable region of sensor network is increased.

6. CONCLUSION

This paper presents a novel distributed energy efficient clustering approach based on distance and energy for selection of cluster head in heterogeneous wireless sensor network. In this paper we have decreased overall communication cost for selecting cluster head. Therefore it increases overall network lifetime. Our simulation shows that it gives better result than LEACH and other homogenous protocol.

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