# A Modified Approach for Cluster Head Election in Wireless Sensor Network

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**ABSTRACT**

*A wireless sensor network is a group of tiny sensor nodes which are randomly deployed over a particular area in order to sense the environment for over a long period of time. So energy preservation is always a challenging issue. In the present work, a new scheme is proposed that uses fuzzy logic for energy efficient cluster head election. Fuzzy logic control is capable of making real time decisions, even with incomplete information. Conventional control systems rely on an accurate representation of the environment, which generally does not exist in reality. Fuzzy logic systems, which can manipulate the linguistic rules in a natural way, are hence suitable in this respect. Moreover it can be used for context by blending different parameters - rules combined together to produce the suitable result. Simulation results show that proposed scheme improves network lifetime as compared to the old scheme. Author also classified a clustering algorithms based on the parameters of cluster formation and CH election criteria and also focuses on clustering routing protocols on the basis of cluster, cluster-head, clustering characteristics and entire proceeding of the algorithm.*

**Keyword:** - *WSNs, SNs, BS, CH, Non-CH.*

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## 1. WIRELESS SENSOR NETWORKS

A Wireless sensor network is composed of tens to thousands of sensor nodes which are densely deployed in a sensor field and have the capability to collect data and route data back to base station. Wireless Sensor Network is used in many application now a days [1], such as detecting and tracking troops, tanks on a battlefield, measuring traffic flow on roads, measuring humidity and other factors in fields, tracking personnel in buildings. Sensor nodes consist of sensing unit, processing unit, and power unit.

The “many - tiny” principle: wireless networks of thousands of inexpensive miniature devices capable of computation, communication and sensing. A WSN application there are two types of nodes: source node – the node which actually sense and collect data – and sink node – the node to which the collected data is sent. The sinks can be part of the network or outside the wireless sensor networks. Usually, there is more number of source nodes than sink nodes. In most of the general

### 1.1 Clustering in WSNs

A wireless sensor network can be an Unstructured or Structured network. An unstructured network do not have a fix topology .A structured network has a fix topology. WSN is an unstructured network because sensors keep on changing their location continuously.[2] WSN can efficiently create routes among the nodes of a network. A WSN can be static and dynamic depending upon nature of route created. In static network, the configuration of nodes is done manually. Network administrator makes these entries in a static table and routers uses entries from these routing tables for performing their routing function well. In dynamic networks all configuration is made dynamically by a dynamic routing protocol. Node can leave and join the network dynamically at run time. As sensors in wireless sensor network changes there location constantly, so arranging a communication system for them is a typical task. To resolve this problem clustering algorithms for WSN are proposed which provides a structured way of communication for unstructured WSN.These algorithm divides WSN nodes into clusters choosing a cluster head for each node which performs data aggregation and data processing task for whole cluster thus saving energy. Cluster head thus consume more energy than other nodes.

Clustering [3] is the activity of creating sets of similar objects. Various researches are performed on clustering. Nodes in a clustered wireless sensor network can also be classified as primary nodes and secondary nodes. Primary nodes can perform data aggregation and data processing function instead secondary nodes only performs data forwarding functions.

## 2. RELATED WORK

For certain applications, sensing is not a continuous process and may only occur at a certain time of the day. For example, to study early morning or late evening activities in a controlled environment, the nodes will only be activated for a few hours, during which they will sense the environment continuously. In such circumstances, it is feasible for the base station to gather the data and analyse it during a non-active time. As the base station is not performing real time analysis of data, it is possible for the base station to become mobile within the sensor field. This allows sensor nodes to transmit shorter distances reducing energy consumption and also decreasing latency 1. The scenario can be described as follows: Given there are N static sensor nodes randomly distributed in a known area and k cluster-heads are identified from the N nodes in a network with a mobile base station. The data gathering happens in rounds. In each round, a new set of cluster-heads are elected using the LEACHM protocol. The nodes associated with each cluster transmit their data to the cluster-heads. The cluster-heads then need to find the position of the moving base station in each round to transmit their data. Three different strategies are used to produce base station mobility as described in section III. The cluster-based routing protocol used in this study is the Low Energy Adaptive Clustering Hierarchy- Merging (LEACHM). The LEACHM is considered because it was shown to improve the performance of LEACH by 30% by distributing cluster-heads evenly in a network. The LEACHM protocol works in rounds and each round consists of two phases: setup and steady. In setup phase, clusters are formed in a network by identifying the cluster-heads similar to LEACH. These are called cluster-head aspirants and an extra negotiation phase is added to identify cluster-head aspirants that are so close to each other that their clusters can be merged. After the negotiation phase, some of the cluster-head aspirants become non-cluster-head nodes, which lead to a more uniform distribution of cluster- heads in a network. In steady phase, nodes transmit data to the cluster-heads, which in turn will transmit to the base station. Base station movement is introduced to LEACHM to study its impact on data collection and the amount of data collected per unit Joules of energy. In the proposed methods, the base station moves to a new location when the cluster-heads are not transmitting.[4]

To validate the benefits of base station movement, simulation was used. In the experiment described in this section, the LEACHM protocol with a static base station located at the centre of the sensor field is compared with LEACHM with a mobile base station in terms of the amount of data packets received by the base station per Joule of energy.

In this paper we studied the impact of base station movement on a clustered routing protocol (LEACHM) for wireless sensor networks. Three methods of base station movement were considered: adaptive movement influenced by the cluster- heads, random movement with specified velocity and direction and the semi-adaptive movement. All these methods were adapted to LEACHM. Even though there was an overhead in finding the base station location within these protocols, they each achieved a higher level of performance than LEACHM, where the base station was fixed at the centre of the network. Although the adaptive movement protocol achieved the highest level of performance, the simulation clearly showed that even a base station with random movement will reduce energy consumption in order to produce a wireless sensor network with more residual energy than a network with a static base station [4].

Recent advances in the MEMS-based sensor technology and wireless communications have enabled the development of relatively inexpensive and low- power wireless sensors. The potential applications of wireless sensor networks are highly varied, such as environmental monitoring, target tracking, and battlefield surveillance .Due to the sensors' limited power, innovative techniques that improve energy efficiency to prolong the network lifetime are highly required. The main source of energy dissipation in a sensor node is the transmission and reception of packets over the wireless interface, thus wireless data transmission is the most critical. In order to achieve high energy efficiency and increase the network scalability, sensor nodes can be organized into clusters. Small-world networks obey two distinguishing characteristics: they have a high clustering coefficient and have a small characteristic path length. In this paper we proper and evaluate a novel energy-efficient clustering algorithm for WSN with a high clustering coefficient which have a concrete significance related to multi-hop wireless networks. A high clustering coefficient supports local information spreading as well as a decentralized infrastructure. For networks with high clustering coefficient it is supposed that local impacts have a high global effect. [5]

SMCA (Small-world Model Based Clustering Algorithm), which selectively remove some links in a virtual way by the analysis of the edges' clustering coefficient and incorporate the average hop counts limits and the number of nodes limits in each cluster. It makes the network with a high clustering coefficient, which supports local information spreading as well as a decentralized infrastructure. For networks with high clustering coefficient it is supposed that local impacts have a high global effect. Simulation results show that our clustering mechanism not only balances the energy consumption, prolong the network lifetime, it clearly improve the network lifetime over LEACH and HEED for p=0.8, both the time until the first node dies and the time until the last node dies.

Ramakant et. al. [6] presented an efficient technique for clustering of sensor node in the WSNs. In the existing LEACH protocol the clusters are formed using the distance calculation from the node to cluster head. But for a network to be good designed there should be a better cluster formation.

## 3. PROPOSED WORK

### 3.1 Problem Definition

A wireless sensor network is an autonomous system of sensor nodes. It has a Base Station and sensor nodes. Sensor nodes collect data from their environment and send it to the Base Station. Heterogeneous sensor network contains high energy sensor nodes as well as low energy nodes. A single-tier network can cause the gateway to overload with the increase in sensors density. Such overload might cause latency in communication and inadequate tracking of events. In addition, the single-tier architecture is not scalable for a larger set of sensors covering a wider area of interest because the sensors are typically not capable of long-haul communication. Hierarchical clustering is particularly useful for applications that require scalability to hundreds or thousands of nodes. Scalability in this context implies the need for load balancing and efficient resource utilization. All nodes in a network can be organized in hierarchical structures called clusters.

### 3.2 Objectives

In this research we study few of clustering Routing techniques in WSN. The summarized of goal of work for the dissertation as follows.

- To study the existing techniques of clustering in Wireless Sensor Networks.
- To propose and implement energy efficient based method for clustering.
- To compare the existing technique with the proposed technique using the parameter Energy Consumption per Round.

### 3.2 Protocol Assumptions

We have assumed that the sensors are distributed in a uniformly randomized manner throughout a field and the network has the following properties:

1. There exists a unique BS located away from network
2. Each Sensor node has a unique identity
3. Sensors cannot move after being deployed

We propose a simple, static clustering model which will improve the concept of old Scheme. For a network to be energy efficient we make use of clustering.

### 3.4 Implementation

The basic parameters used for simulations are listed in table 3.1.

Table 3.1: Parameters employed in Simulation

| **Parameter** | **Value** |
|---|---|
| Field Size | 50m X 50m |
| Location of Base Station | 25m X 25m |
| No. of Nodes | 100 |
| Probability of cluster | 0.1 |
| Initial Energy of sensor node | 20 J |
| The Data packet Size | 4000 bits |
| DeltaT | 10 |
| $\eta$ | 0.4 |
| α | 0.6 |
| $E_{fs}$ | 10 J/bit/m$^2$ |
| $E_{mp}$ | 0.0013 J/bit/m$^4$ |

### CH Election

As mentioned earlier, in hierarchical architectures, the nodes are divided into clusters and a set of nodes is periodically elected as a CH. CHs are used for more complex tasks, such as: the management of each cluster, collecting data from non-CHs, data aggregation, and sending the collected data to the BS. In this context, it is important to use multiple metrics for CH election to provide an energy-efficient and load balance model. Furthermore, the cluster formation process can lead to poor energy use, if the CHs that are elected are only based on a single metric. In this context, CLENER proposes an equation, which is used by nodes to enable them to become a

CH. During the initialization of the network, BS broadcasts a startup message, which enables the node to compute the distance to BS. Following this, the nodes are able to adjust the transmission power according to distance, which reduces the energy consumption since higher transmission power consumes more energy. After adjusting the transmission power, each node generates a random number (μ), which ranges from 0 to 1. Then, the node decides to become a CH by comparing $\mu$ with the $T(n)$, which is computed by means of Equation 2. If $\mu$ is less than $T(n)$, the node becomes a CH for the current round.

$$T(n)= \eta \frac{p}{1-p\left(r \bmod \frac{1}{p}\right)} + \alpha\left(1 - e^{\frac{-RE^2}{2\sigma^2 RE}}\right) \quad (1)$$

Where $\eta$ and $\alpha$ are weights to give importance, the sum is exactly 1. The Residual Energy is denoted as $RE$, and $\sigma_{re}$ means the energy variance, which is used to produce better CH candidates.
Equation 1 uses a gauss function, due to the fact that has better result in terms of energy efficiency and representation in the context of an imprecise environment.
Now, the node that becomes CH broadcasts a ch message, which contains the value of its remaining energy. Then, CH waits for a join message from the non-CH nodes. However, if the CHs do not receive a join message, this CH should not become CH. Algorithm 1 describes the steps for CH election and cluster formation.

**Cluster Formation**

In old Scheme, non-CHs select the best CH by considering a multiple metrics, i.e. residual energy and a distance from non-CH to CH. Then, non-CHs compute a probability value to each CH candidate using Takagi-Sugeno Fuzzy System (TS). The non-CH chooses the CH with a higher probability value and sends a join message to CH. Now in present work ,three linguistic input variables of the system are used which are the remaining energy which can be expressed in percentages, the distance between non-CH and CH (expressed in meters) and the distance between Non-CH and Base Station (expressed in meters). The specifications related for the input and output functions of the system and their respective Linguistic Values (LV) are as follows:

- Residual energy: u=[0,100]: LV = low, average, high;
- Distance: u=[0,100]: LV = small, average, big;
- Dist_base: u=[0,100]: LV = small, average, big;
- Probability: u=(0,1]: LV = very high, Medium high, high, Moderately medium, fairly medium, medium, Moderately low, low, very low.

## The Pseudo code of Proposed Model is as Follows:

Step1: Start
Step 2: Create a Network
Step 3: Create Clusters from network using:

a. A CH is selected from the Sensor nodes.
b. Based on last step, Non-CHs select the best CH by considering a multiple metrics i.e. residual energy, distance from non-CH to CH and distance from non-CH to base station using the concept of Fuzzy logic and Cluster is created.

Step 4: Stop

Figure 3.1 shows the comparison of energy consumed by traditional and new scheme. It shows that the new scheme is more energy efficient than the traditional approach.

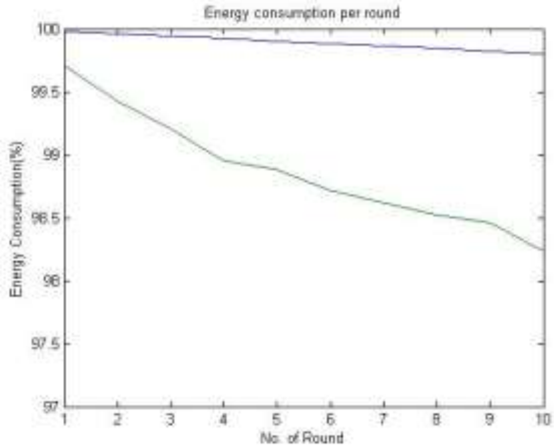


Figure 3.1: Comparison of Energy Consumption

## 4 RESULTS

Table 4.1 shows the results in numeric values which shows that the proposed scheme is far better than the old scheme.

Table 4.1: Simulation Results

| Scheme | Round no. | Energy % | Energy consumption (%) | Difference in Energy consumption (%) |
|---|---|---|---|---|
| Old | 1 | 99.69 | 2.01 | 1182.35 |
| | 10 | 97.68 | | |
| Proposed | 1 | 99.98 | 0.17 | |
| | 10 | 99.81 | | |

## 5 CONCLUSIONS AND FUTURE SCOPE

### 5.1 Conclusion

In this dissertation, we have presented an efficient technique for clustering of sensor node in the WSNs. In the existing approach, the clusters are formed using the distance calculation from the node to cluster head. But for a network to be good designed there should be a better cluster formation. For a better cluster formation the concept of fuzzy logic is used in which non-CHs select the best CH by considering a multiple metrics, i.e. residual energy and a distance from non-CH to CH with distance between Non-CHs and Sink. Then, non-CHs compute a probability value to each CH candidate. The non-CH chooses the CH with a higher probability value and sends a join message to CH. The use of fuzzy logic is suitable, whenever it is not possible to use a mathematical model for the system. Additionally, fuzzy can reduce the complexity of the model, computational effort and memory. Energy consumption is affected by message communication between nodes, so our technique is efficient than traditional old approach.

### 5.2 Future Scope

A further direction of this study can be that the chosen cluster head should be given an extra amount of energy at the time when it will get selected as cluster head. It is for long life of cluster head and Network. The parameters which can be used in the algorithm are density, distance from the base station, intra-cluster distance and cluster heads distance from each other. Our goal was to propose a new scheme to select the best cluster heads that combine the various criteria affecting the energy efficiency of cluster heads and cluster heads rotation among the nodes. Energy preservation is always a factor to be elaborate for future work. There are some of more factors which could be considered for future work. Which are Throughput, Network lifetime, delay between data transmission from node to CH etc.

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