# A METHOD FOR WIRELESS SENSOR NETWORK ENVIRONMENTS CLUSTER USING GAME THEORY APPROACH

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## Abstract

In wireless sensor network clustering plays an important role. The nodes get divided into clusters and then cluster head is elected. The elected CH(cluster head) is onus for the data assimilation. The cluster head plays a vital role in this topology so the selection of cluster heads has to be done with utmost care. Based on the concepts of game theory a model has been derived. Nash equilibrium is employed for that. If a cluster head and the sink node get disconnected then data replication model is adopted. Overall throughput of the network is still guarantee even if a cluster head fails.

**Keywords**: WSN, Clustering, Game Theory, Nash Equilibrium.

## Introduction

In a deployed wireless sensor network, there may be more than two thousand sensors. Those sensor nodes are used to monitor the environmental condition such as air quality, noise pollution, humidity, temperature, etc.The sensed data is then transferred to the base station.

In general, there was an assumption that the sensor nodes are cooperative and share data with each other. But it's not true. The wireless sensor network is not like a traditional network. The wsn is limited to transmitting and receiving power. Some nodes pay attention to saving their energy those nodes will not participate in active communication. Such nodes are called selfish nodes. Even a single selfish node can bring down the throughput of the entire network to 30%.

The clustering of the wsn nodes is done worldwide. Thefollowing first process splits the network into clusters and elect a cluster head[CH]. The cluster head is responsible for data aggregation. There are many advantages in using cluster heads they are low energy, routing and scalability of the network. In general, the energy level of the cluster head will be higher than the nodes. This is because of faster communication between the member. By this method, a node with selfishness will get eradicated and it cannot be as a “head”.

Game theory is a concept in mathematics which deals with players in a strategy game. Here selfishness of a node is applied with game theory approach. Based on this method the cluster head will get elected.

## Literature Review

In a tree based topology of wireless sensor network, the sensor node might fail due to lack of address configuration [1]. To overcome this limitation the author has proposed an algorithm know as address based routing. This scheme can be implemented over low-power IPv6 sensor network like vehicular network and so on. A super node is implemented which monitors the addressing issues and configure it automatically for multihop network. And also the super node will communicate with the next super node to find the optimal path. By this method the latency of the routing will get reduced. The analysis of the result shows the effective shortening of the routing latency.

In a wireless sensor network, energy-saving optimization has become one of the hottest research areas in routing protocol design. This is because most wireless sensor nodes are equipped with non-rechargeable battery[2]. The author proposed a method for minimizing energy consumption and maximizing the network lifetime in a one-dimensional routing method. By using the optimistic routing theory a multihop decision method is employed to optimize the energy efficiency of a wireless network. the proposed method has significantly increased the performance of the network and also has saved a lot of energy in wsn routing.

A multi-hop routing scheme is needed for routing the data, this is because the intended sing node cannot be reached in a single hop routing[3]. By optimizing the routing path will significantly increase their performance. Usually, the sensors contain a small power source within it. The energy consumption routing has gained high attraction in the field of wireless sensor networks. The author has proposed add flooding based hierarchical protocol for this complex routing function. This method has been tested in various protocol family. By investigating the study the proposed algorithm has performed very well in large scale scenarios.

A routing protocol is implemented in association with virtual coordinates. It is fabricated in a model composed of end nodes without routing[4]. The concept of the routing protocol is to transform a random structure of sink nodes. Visual form virtual circle and virtual nodes. The virtual circle registry of the greedy nodes which is the proposed strategy by using this method it can overhead the problems found in this routing scheme. The experimental results show that the proposed protocol has a higher delivery ratio and also less shortest path length and low energy consumption.

An opportunistic routing method is proposed here to increase the performance of duty-cycled wireless sensor networks eradicating the default broadcast nature[5]. The proposed method is totally contrasted with the existing routing techniques where the packets are transmitted in a predefined path. This routing protocol selects a set of candidates as a potential forwarder to transmit the data. This will reduce the waiting time of sender nodes. But at the same time due to many candidates duplicate packet will get generated. This may affect the packet delivery ratio. To overcome these issues a priority-based metric system was implemented. By evaluating the performance in various small and large scale networks the proposed algorithm performed well by increasing the network lifetime and reducing the energy consumption along with time.

## Proposed Game Theory Approach

### Network model

Let us assume that there are n sensor nodes in a network. There are uniformly distributed within a range on the field it was also continuously monitored surrounding their environment. If your sink node is located far away from the base station then the data is delivered by the cluster heads. Suppose if a sink node is mobile which changes its position often. Then a set of rules should be followed.

- The nodes must be homogeneous and stationary after deployment
- The multiple nodes are pre located within the range.
- The nodes can adjust their transmitting and receiving power.
- Links will be in symmetric nature.

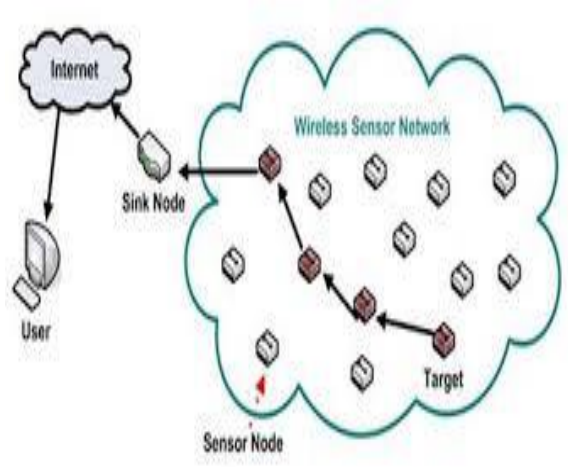


**Fig 1. WSN Model**

### Energy model

Use node with similar energy. All the nodes will have the same energy model and also the same transmitting and receiving power along with free space. each sensor node will consume an

amount of energy to transmit or to receive data. the energy consumed is directly proportional to the transmitting and receiving the power of the sensor node.

**Game Theory Approach for CH**

The cluster head takes much responsibility and uses high amount of energy for this. If the cluster head is selfish then the entire network throughput will go down to 50 percent. To overcome this issue Nash equilibrium what is a concept in game theory is applied to detect the exact cluster head for the cluster.

If Nash equilibrium has to be found for a game then the initial estimated value will be , say $x_10$, and $Z(x_1)$ unity-valued.

$x_1q$**+2 = (2 − γq)x₁q + γqZ x₁q , q = 0, 1, 2,3,4 ...,**

where 0 <γq<=2. The iterate at step q + 2 is taken as a weighted average of the updated point $Z(x_1q)$ and the present point $x_1q$. This merging of the algorithm under certain terms,explains formula. Algorithm will perform a static optimization of opponents in convergence to equilibrium.

In the event that all adjustments are known to us, we can straightforwardly discover the Nash equilibrium utilizing the relaxation algorithm.Nonetheless,in the event that we just approach one gamer result capacity and all gamers' previous activities, at that point at each stage in the constant cycle we pick the ideal reaction for that gamer,accepting that different gamers will participate as they had inthe past period.Thusly, convergence to the Nash standardized equilibriumwill happen asq →∞. By considering adequately numerous emphases, it is our mean to decide the Nash equilibrium x1∗ with a predetermined accuracy

The following steps state the conditions of convergence for the relaxation algorithm. This condition may be restrictive but it can solve all types of games

In this algorithm focus the existing a unique normalized Nash equilibrium point if :

[1]. $X_1$ is a convex compact subset of Rm,

[2]. the Nikaido–Isoda function **Φ : X₁×X₁ → R** is a weakly convex-concave function and **Φ(x₁, x₁) = 0 for x₁∈ X₁**,

[3]. the optimum response function $Z(x_1)$ is single-valued and continuous on $X_1$,

[4]. the residual term $rz(x_1, y_1)$ is uniformly continuous on $X_1$ with respect to z for all $x_1, y_1 \in X_1$,

[5]. the residual terms satisfy **ry₁(x₁, y₁) − μx₁(y₁, x₁) >δ kx₁– y₁k , x₁, y₁∈ X₁,** where **δ**(0) = 0 and **δ** is a increasing parameter**(i.e., δ(t2) >δ(t1) if t2 > t1),**

[6]. the relaxation parameters αs justisfy

**a)** γq> **0,**

**b)** **P**∞ q**=0** **γ** q **= ∞,**

**c)** **γ** q **→ 0 as** q **→ ∞.**

Notice that the convex set $X_1$ is able to represent coupled constraints and that the key condition may be satisfied in case of non-differentiable payoff function

**Experimental Results**

| Residual Energy | LEACH | PSO | GAME |
|---|---|---|---|
| 50 | 675 | 812 | 1865 |
| 45 | 612 | 795 | 1800 |
| 40 | 594 | 693 | 1732 |
| 35 | 580 | 675 | 1653 |
| 30 | 413 | 603 | 1541 |
| 20 | 112 | 572 | 1427 |

**Conclusion**

Clustering is an efficient approach in wsn. But the efficiency of the network depends on the cluster head. The proposed method uses a game theory approach to detect the cluster head. By using

this approach the selfish node will get eliminated in being a cluster head. Moreover, the candidates of the cluster respond to the head in a timely manner. This method eradicates the problem created by data replication. The simulation results prove that the proposed game-theoretic approach performs well in various wsn environments.

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