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# *Enhancement of Network Lifetime with the Help of Heterogeneous Wireless Sensor Networks: Survey*

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***Abstract:*** ***Energy efficiency is one of the scarcest resources in the wireless sensor networks. Most important fact about the energy saving is deployment of sensor nodes with in network area, so energy which used in network remains balanced through whole of network. Clustering algorithm is a kind of key technology used to reduced energy consumption. It can be used to enhance the lifetime and stability period (death of first node) of network by consuming minimum amount of energy. Energy efficient protocol used to characterize the heterogeneous wireless sensor network. From the previous paper observation it is observed energy imbalance in wireless sensor networks occurs due to relaying of data from different parts of network towards the sink node, So for improved energy balance instead of using only sensor nodes it is necessary to deploy relay node with sensor nodes to manage such imbalance. In this paper we havesurvey the previous techniques used for enhacement of energy consumption.***

***Keywords:*** ***wireless sensor networks, connectivity, coverage, node deployment, stability period, energy balance, network lifetime.***

## I. INTRODUCTION

In recent research advancement in wireless sensor and micro-controllers enable a new wide area monitoring paradigm commonly known as wireless sensor network. In wireless sensor network hardware enabled to have deployment of small sensor nodes having limited signal processing , low power and wireless communication capacities. Wireless sensor networks uses sensor nodes in various environmental conditions to sense the event that occurred around the sensing field [2]. Such as environment monitoring, smart offices, military surveillance and transportation traffic monitoring to perform in efficient way. In order to achieve high performance, low fault tolerant and low energy consumption nodes are deployed randomly in interested area or very close to it. In wireless sensors networks power consumption can be a crucial task [7] , low power consumption mainly required to enhance the network lifetime. In wireless sensor networks, the hierarchical routing tree is maintained to when each node selects its parent (CH node) and children (non-CH node). Wireless sensor networks can be used in many applications such as health monitoring, Environment, habitat monitoring and in the military application to inform troops about the dangerous areas in military surveillance range. Communication in wireless can be explained in the three ways. These are Time Driven, Query Driven, and Event Driven. Time driven approach is used to transfer and receive data on timely basis. Event Driven approach is used to inform the sink node or CH node about an event occurred in the sensing field. Query driven is used to make a request about the required information from CH or sink node. In wireless sensors networks clustering techniques are used to enhance the lifetime of the sensor network. In clustered network sensors node can take their own decision to perform sensing task [8], constructing new topology and routing data toward a particular area. In clustering nodes assembles themselves in form of clusters and in which one node acted as CH, all other nodes called non-Ch nodes have to sense data and transmit data to CH and then CH aggregate data and transmit the aggregated data to sink node. Clustering has numerous advantages which explained as follows:

 

1. Clustering reduces the size of routing table stored at the individual nodes by localizing the route set up within the cluster (Akkaya 2005).
2. Clustering helpful in removing redundant exchange of messages among sensor nodes.
3. CH can prolong battery life by using energy efficient techniques.
4. A CH can perform data aggregation in its cluster and decrease the number of redundant packets.
5. A CH can reduce the rate of energy consumption by scheduling activities in the cluster.

Furthermore the rest of paper organized as follows. Section II is related work in Heterogeneous sensor networks; Section III is Simulation Parameters and Section IV conclusion.

### *A. Heterogeneous Model For Wireless Sensor Networks*

This section presents a paradigm of heterogeneous wireless sensor networks and also provides an overview of impact of heterogeneous resources.

### *B. Type of Resource Heterogeneity*

There are mainly three types of resource heterogeneity in sensor nodes : computational Heterogeneity, link heterogeneity, and energy heterogeneity.

- **Computational heterogeneity:** Computational heterogeneity means the heterogeneous node has a more powerful micro-processing techniques and more memory to do the complex data processing and longer term storage.
- **Link heterogeneity:** Link heterogeneity means heterogeneous node must have more bandwidth and long distance transmission than normal nodes. Link heterogeneity can provide more reliable data and transmission.
- **Energy heterogeneity:** Energy heterogeneity means because nodes which are deployed in sensing field having a low battery power so energy heterogonous devices required enhancing network lifetime [8].

### *C. Classification of Clustering Attributes*

Clustering objectives like load balancing and fault tolerance, increased connectivity and minimum cluster count and also used to enhance network lifetime (Abbasi 2007).

***D. Cluster properties:*** In cluster properties it is to be analyzed the internal structure of the cluster and how the member related to each other.

- **Cluster Count:** In this property CH count can be calculated to minimize the energy consumption. Previous designed techniques are used to calculate the optimal number of clusters for heterogeneous wireless sensor networks.
- **Intra-cluster Topology:** sometimes clustering scheme used between CH and nodes are to be direct, but sometimes multi-hop sensor –to-Ch connectivity required.
- **Connectivity of CH to BS:** CHs send the aggregated data to BS directly or indirectly with the help of other CHs nodes. It means there exist a direct link or a multihop links [3].

## II. RELATED WORK

In previous research works in the field of homogeneous and heterogeneous wireless sensors networks can have some overflows in energy consumption; network stability period means death of first node in the network [3]. Many previous techniques are use in wireless sensor networks. In the field of homogeneous networks all nodes deployed in sensing field must have same amount of energy. On the basis of random number generation each node elected as CH. CH sends request to its

 

nearest node which are in the range of cluster-head. All non-Ch nodes join the cluster head and send information about an event which has occurred in sensing field. In homogeneous sensors all nodes died at the same time and the network lifetime and performance degrades. There are many examples of homogeneous wireless sensor networks , one of them is LEACH(low energy adaptive clustering hierarchy)[1].It is a self-organizing, Adaptive clustering protocol and uses a randomization to distribute energy among nodes in sensor networks.In LEACH each node organize them into local clusters . Each cluster has a local base station which is known as Cluster Head. When a node is decided to be a Cluster head it broadcasts its status to other nodes in network. Based on the communication or signal strength the node calculates the amount of energy consumption between node and the cluster-head. Non-CH nodes which join the cluster-head can require minimum consumption of energy. Once each node organized into clusters, each cluster-head establishes a TDMA schedule for nodes in its cluster.TDMA schedule in used to avoid the interference between data packets and can receive data from non-Ch nodes without repetition. Once the CH node receives data from its member node it aggregate data and transfer data to sink node using TDMA from where normal user can access data.

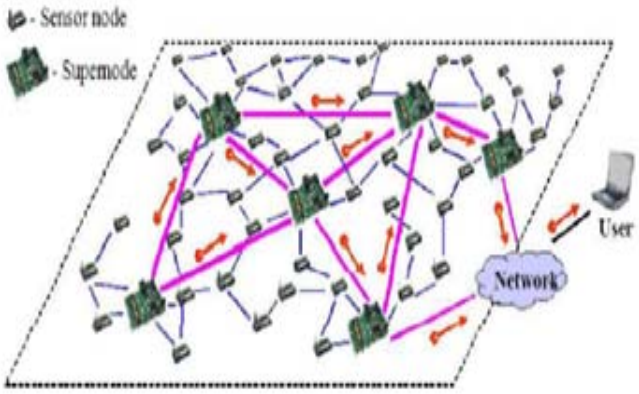


***Fig1. Architecture of Heterogeneous Wireless Sensor Network***

***A. Setup phase:*** In beginning of each phase, each node can uses the implicit formula to calculate the T(n) and choose a random number between 0 and1.

$$T(n) = \begin{cases} \left(P_n \,/\left(1 - P_n \left(r \bmod \left(\frac{1}{P_n}\right)\right)\right)\right) & \text{if } n \in F \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

In this if chosen number is less than the calculated threshold then chosen number selected as cluster-head. In this a node broadcast (CH node) an advertisement message to inform the node in the network that node is selected as CH. All non-Ch nodes join the CH node near to its transmission range and which needed minimum amount of energy. Once a node decides to which cluster it belongs, they inform the needed CH by sending a join-request message to it using CSMA or MAC protocol. This message contains the node ID and CH ID. Then CH node maintains a TDMA schedule to each node to send data and TDMA used to avoid collisions and avoid minimum consumption of energy.

***B. Steady phase:*** In steady phase is used after the set up phase. Once the cluster established, the nodes transmit their data message towards CH. When the CH receives data from all nodes, then aggregate data and send data to Base station.

***C. Heterogeneous wireless sensor network:*** Heterogeneous wireless sensor networks mainly consist of mainly two more nodes having different amount of energy. In this type of sensor network node with high amount of energy acted as cluster head known advanced nodes and nodes with lesser amount of energy called normal nodes. In heterogeneous wireless sensor networks weight based data transmission is used, node having high amount of energy can used as the centralized point and aggregate data received data and transfer to Base station.

 

***D. Comparison between heterogeneous techniques:*** In this context we have discuss only four techniques used in heterogeneous wireless sensor networks.

**a) Energy balanced clustering algorithm S[3]:** In this technique stable election protocol (SEP) scheme is used to enhance the network life time by increasing stability of the network. Stability period means death of first node in the network from its initial deployment. In the scheme two nodes are used to perform the task of network normal nodes and advanced node contains different amount of initial energy. It is mainly centralized on the amount of residual energy and total energy of the nodes.

**b) Prolonging network lifetime via nodal energy balancing [6]:** In this technique of heterogeneous wireless sensor networks nodes energy is preserved, and algorithms are used to balance energy depletion among nodes by taken into consideration the previous used techniques. In this mainly a scheme is used in which distributed data gathering scheme used. In this type of network node create an energy balanced tree to enhance network lifetime in wireless sensor networks. Different characteristics are considered for classification of load balancing, low energy consumption. Existing work can investigated from the heterogeneous aspects includes power, communication range and amount of traffic from each node, transmission range.

**c) Evaluation of optimal Cluster size in heterogeneous network [4]:** In this technique the cluster based network is well known technique to prolong network lifetime. In order to improve the network performance optimal number of clusters in the network needs to be known. In [4] Norah Tuah et.al has investigated the problem of selecting an optimal [K] value. To minimize total energy consumption (TEC) for data communication consumed per round for data transmission from non-CH node to sink node in pre-deployment wireless sensor networks. K values can be varying between 1to 50. When a new cluster formed CH selected based on the minimum distance between sensor nodes and base station and a selected threshold distance. If distance between nodes is less than the threshold distance then free space transmission is used and if its value greater then multipath transmission used between nodes used.

***E. NETWORK MODEL***

a) **First Order Radio Model:** First order radio model is used for calculation of total data transmission rate data receiving rate [Clustering algorithm by Vivek Katiyar 2010] used to measure energy consumption in each round [1].

$$\begin{cases} E_{Tx}(k,d) = kE_{elec} + K\varepsilon_{freespace} d^2 & \text{if } d < d_0 \\ kE_{elect} + k\varepsilon_{multipath} d^4 & \text{if } d > d_0 \end{cases} \quad \textbf{(2)}$$

The formula defined in equation (2) is used for transmission of data within the transmission range and also for the larger range $E_{RX} = L*E_{elect}$ **(3)**

Equation (3) is used for the reception of data send by non-Ch members.

Thus energy dissipated in each round by CH can be calculated by following formula: [Multihop energy efficient protocol by LI HAN 2010]

$$E_{ch=} (m/c-1)*L*E_{elec} + (m/c)*L*E_{DA} + L*E_{elec} + L*\varepsilon_{fs}* d^2_{BS} \quad \textbf{(4)}$$

Where m is the number of nodes and c is the number of clusters. $E_{DA}$ is the energy dissipated in the data aggregation and transfer data to base station and $d_{BS}$ is the distance between CH node and Base station**.**

Energy used in non cluster head node is equal to:

$$E_{non-ch} = L*E_{elec} + L*\varepsilon_{fs} * d^2_{ch} \quad \textbf{(5)}$$

 

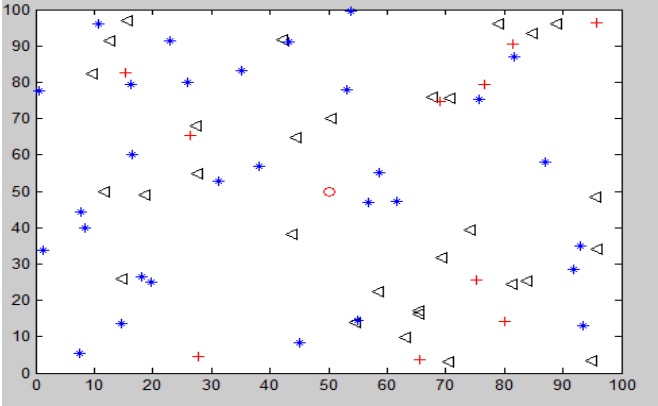


*Fig 2: Normal, advanced and super nodes are shown by, star, triangle and the plus respectively.*

Routing protocol for Balancing Energy Consumption in HWSN: Li X, et al.(2007) developed and analyzed a protocol based on residual energy and energy consumption rate (REECR). REECR protocol was not perfect in balancing energy and stability of network so they proposed a zone based improvement in REECR protocol, named as ZREECR (Zone Based Residual Energy and Energy consumption rate).This protocol improves the stability period.

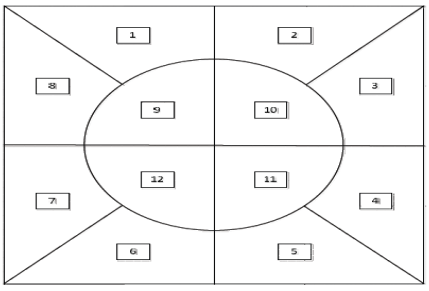


*Fig 4: A schematic diagram of different size zones*

**Table 1 : Comparison of Presented Clustering Algorithms for HWSN**

| Clustering Approach | Energy Efficient | Location Awareness | Cluster Stability | Balanced Clustering | Heterogeneity Level |
|---|---|---|---|---|---|
| Data Rate Allocation(2012) | High | No | Moderate | Yes | Two level |
| Analysis of Energy consumption(2010) | High | No | Good | Yes | Two level |
| Energy Balanced clustering algorithm for routing | High | No | Good | Yes | Two level |
| Evaluation of Optimal cluster size in HWSN | Fixed | Yes | Good | Yes | Three level |
| Prolonging network life Time with the help of nodal energy (2011) | High | No | Moderate | Yes | Three level |
| Design of distributed energy efficient clustering algorithm(2006) | High | NO | Moderate | YES | Two level |
| Enhanced Developed Distributed Energy Efficient Clustering(2013) | High | MO | Moderate | Yes | Three level |

 

## III. Simulation Parameters

In the given table the node are considered to be three levels having different amount of energy.

Table 2. Simulation Parameters

| Parameters | Values |
|---|---|
| Network field | 100m,100m |
| Number of nodes | 100 |
| $E_0$(initial energy of normal nodes) | 0.5J |
| Message size | 4000bits |
| $E_{elec}$ | 50nj/bit |
| $E_{fs}$ | 10nj/bit/m2 |
| $E_{amp}$ | 0.0013pj/bit/m4 |
| $E_{DA}$ | 5nj/bit/signal |
| $d_0$(threshold distance) | 70m |

## IV. Conclusion

In this paper, we provided a survey of all techniques used in the heterogeneous wireless sensor networks. All the existing techniques used the nodes energy and number of clusters technique to increase the network life time. In this paper we studied the stability period of network (time of death of first node in network). By SEP (stable energy techniques) only nodes with high energy selected as CH and other nodes are elected as cluster members. Nodes distribute their energy between clusters to enhance network lifetime. In addition to previous studies we have also observed that with the help of hierarchical routing used in wireless sensor networks helpful in increasing lifetime of the network and minimizes energy consumption.

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