Energy Efficient Clustering for Lifetime Maximization and Routing in WSN

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***Abstract*: Wireless Sensor network (WSN) is a quickly rising area for research and development. WSN can be seen in various fields like environmental monitoring, battle field surveillance, border security surveillance, motion tracking etc. A main issue of research in WSN is to arrange the sensors with different capabilities like power, sensing range, communication range in wireless network and route the sensed data from the sensors to a sink with dynamism. Clustering is a key technique used to lengthen the network lifetime by decreasing the energy utilization. In clustered WSN, Routing the sensory data to the sink without obstacle is impossible. So eliminating the obstacle in the routing area is essential. In this paper, grouping the sensors into clusters by energy efficient heterogeneous clustering, that often selects the cluster head from the cluster. Cluster head is selected with respect to the nodes residual energy and other parameters like transmission range and number of transmissions. In this work the connectivity is concentrated by Route identification technique with the help of shortest path algorithm to reach the sink among obstacles. Connectivity is considered as a measure of Quality of Service. We show that the proposed system reduces the energy utilization, average hop count and packet delay of heterogeneous WSN.**

***Keywords*: Clustering, Routing, WSN.**

1. Introduction

Wireless Sensor Networks consist of many tiny sensor nodes capable of sensing and wireless communication. Sensor nodes are distributed and autonomous used for various applications like environmental monitoring, human motion tracking, medical science and military etc. The region will be distributed with autonomous sensors. Each sensor will be capable of sensing and transmitting. Sensor node senses the environment and transfers the data to the sink node. Coverage depends on the sensing range and Connectivity of the node to reach sink depends on the communication range. Connectivity can be defined as an ability of the sensor node to sense the environment and transfer the information through the network to reach the data sink (Fig. 1).

Heterogeneous wireless sensor network consists of many sensor nodes with different energy, communication range and sensing range. Each sensor nodes are battery powered (energy). Energy is being a most important one because the battery present in the sensor node cannot be replaced often. The node has a non-rechargeable battery or impossible to replace batteries in most sensor fields. To lengthen the lifetime of the WSN, clustering is the key technique. Clustering will dynamically re-assign the member nodes in the cluster. So the network disconnection due to energy drain out nodes can be avoided. Energy consumption of the sensor node is reduced to increase the lifetime of the network. Only few works focus on lifetime maximization in heterogeneous WSN.
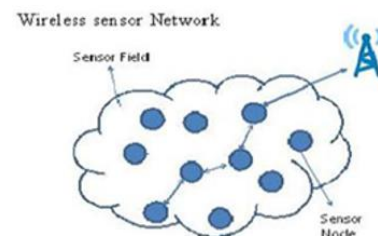

Fig. 1. Wireless Sensor network

2. Related work

A distributed approach to determine if a sensor in WSN is a cluster head to meet the preferred connectivity requirements [1]. Cluster based routing in WSN is used to reach network scalability and maximize lifetime [2]. The existing methods for prolonging the lifetime of WSNs focus on the issues of device placements [3], data processing [4], routing [5] and topological management [6]. In [7] Energy aware algorithm for the selection of sensor and to identify the relay node. Shortest path algorithm is used for choosing the path. In [8] ABC Based Sensor Deployment. Schedule the sensor nodes to achieve network lifetime. Target coverage is provided. Maximized coverage not provided for heterogeneous type of network. On observing the existing work, most of the techniques are applied only in the homogeneous type of WSN and not in the heterogeneous network.

3. Proposed work

In the proposed work, to reduce the energy consumption and to maximize the network lifetime an energy efficient Heterogeneous Clustering (EHC) technique and a Route identification technique in clustered WSN among obstacles are used. Sensor network are often deployed in remote areas. As the energy capability of the nodes is restricted and battery powered,

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some method should be introduced to preserve energy to avoid node failure. Clustering is one of the key concepts for energy consumption and to increase the lifetime of a sensor node in a network. After deploying the sensor nodes randomly in the region of interest, each sensor nodes in the field try to form as a cluster. Each node only interacts with a small set of sensor nodes within the transmission range. At the beginning all the nodes are not clustered. Each node in the clustering process use different types of messages like Broadcast message, State message and Join message.
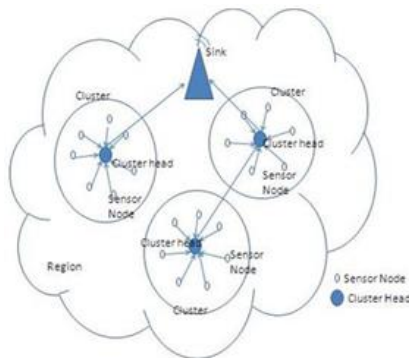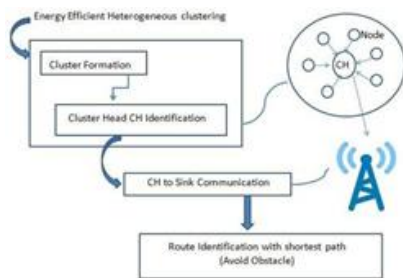

Fig. 2. Clustered network

Fig. 3. System architecture

Each node broadcasts a message to all its neighbors. According to the number of received messages and with respect to the residual energy and delay the node will decide by itself to be a cluster head. The node with high residual energy will have less delay. Once the delay expires the node will give a state message to its neighbors as a cluster head. All other nodes will give a join message and form as a cluster (Fig. 2). Each cluster head can form a connected network. Cluster head will communicate with sink node and transfers data. Energy efficient heterogeneous clustering is the proposed technique which works with the heterogeneous type of sensor nodes. Here heterogeneity means the nodes with different energy level, transmission range, sensing range etc. are grouped as a cluster. EHC form a clustered WSN. It performs the cluster formation and the cluster head identification in a distributed manner. Route identification technique with shortest path algorithm which avoids obstacles is used to identify the shortest route to reach the sink node for communication (Fig. 3). After routing path has been established by cluster heads it will form a connected network. The cluster head identification should be

changed time to time dynamically to increase the network lifetime. This dynamic cluster formation will reduce the energy consumption and increase the network lifetime.

In this paper, the lifetime of the network is the time from the start of the network operation till the death of the first sensor node in the network. The lifetime of the WSN is divided into trips to balance the energy usage among sensor nodes. At the start of the trip, each sensor involves in the cluster formation and cluster head election using EHC. Each sensor sense the data and forwards it to the cluster heads, which routes the data to the sink node using route identification technique.

4. Methodology

A. Energy efficient Heterogeneous Clustering

The sensor nodes are distributed randomly on the sensing field. Energy efficient Heterogeneous Clustering (EHC) will form the cluster and cluster head identification in a distributed approach.

- *Cluster Formation:* After deploying the sensor node n in the region of interest. The node in the region will makes decision independently. Clustering is a key technique to form cluster and is completely distributed. The nodes in the field are formed as a small region called cluster. And each cluster will elect a node as a cluster head. Steps to form a cluster and cluster head identification is discussed in the cluster head identification phase.
- *Cluster Head CH identification:* In this work, n nodes are randomly deployed in the network. Each node has initial energy $E(i)$, transmission power $P(Tx)$ and other required parameters by the time they are deployed. The main purpose of the cluster head CH selection is to determine the normal nodes and the cluster head in the network. Every cluster head should be connected with the sink node directly or through some another CH. Now the competition is set among each node that is qualified to be a CH. Node can be identified as a CH only when it has a high residual energy $E(r)$ and with less delay D. Initially each node is given with $E(i)$ and $P(Tx)$ as input. Process each node separately in each trip.

B. Route Identification Technique

Cluster head is identified and it is allowed to communicate with the Sink S to form a connected network.

- *Network Connectivity:* Connectivity is considered as a measure of quality of service. In order to avoid disconnection during data transfer, the node has to maintain its connection with the nearest nodes. The connectivity depends on the communication range and should identify the shortest path to reach the sink.
- *Route Identification:* For identifying the shortest route to reach the sink, initially input the clustered WSN. Consider n is a node, for each n with the help of the graph method send data to the CH. If n is a cluster head send data to the sink S. If the CH does not have the nearest node as the

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sink node, then send the data to the nearest CH to reach S. If n is an obstacle, avoid the obstacle and apply the shortest pathalgorithm (Dijkstra) to reach the sink node with shortest path. Consider the clustered network as a Graph G and take a node as Source src. Assume the node as the vertex v. For each vertex in G, assign the distance as infinity, distance to src as zero and the current cost to be infinity. Starting nodes distance is permanent and for all other nodes it's temporary. U is the node with smallest distance. Q is the set of all nodes in the graph G. If a calculated distance of a node is smaller as the current one, update the distance and set the current node as previous node. Set the node with minimum temporary distance as active. Set its distance as permanent. Repeat the process to identify the shortest route to the sink node from each CH

5. Results and discussions

An Energy efficient heterogeneous clustering technique is proposed in WSN that selects the cluster head to create a connected network. In this technique sensors make local decisions on whether to join the network as a cluster head or as a member node of a cluster. The decision of each node is based on the residual energy and an estimate of how many of its neighboring CH will benefit from it being a cluster head. It is a distributed technique where cluster head can be changed with time to increase the lifetime of the sensor nodes present in the network. The proposed work is implemented using NS2 simulator. Network simulator produces one or more text-based output files that contain detailed simulation data, if specified to do so in the input script. The data can be used for simulation analysis or as an input to a graphical simulation display tool called NAM.

6. Conclusion

Wireless sensor networks can be homogeneous as well as heterogeneous. In this paper, heterogeneous type of network is used. In the proposed work, an energy efficient heterogeneous clustering technique in WSN is implemented. Clustering is a highly excellent technique to reduce energy consumption and to increase the energy efficiency of the network. This will enlarge the network lifetime. Route identification technique decreases the delay and speeds the packet delivery in the network. Comparing the proposed technique with the existing technique shows the high performance of the proposed work. This work is implemented to mainly focus on the energy efficient clustered WSN to prolong the network lifetime.

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