AN23-WSN

Literature reviews

Kick off phase: Understand the WSNs , its applications, deployment methods

Training/ Pre-requisites

- **Understanding of Wireless Sensor Networks**
- **Tools: MATLAB for simulation**

Motivation

In practical applications where sensors are wirelessly connected, performance in terms of efficient bandwidth and battery utilization in data gathering is preferable so that lifetime of the network is improved. In view of this it is required to conduct study on energy-efficient data aggregation methods suitable in WSNs which would provide improvement in its performance. Mobility is important in WSN that enhance performance of the network in terms of connectivity and QoS. Topology management is regarded as a viable technique to ensure stable, reliable, trustworthy and efficient network infrastructures in ad-hoc networks like WSN. Clustering techniques helps to manage mobility in highly dynamic networks. An efficient clustering technique can be designed to support many objectives such as

Energy Consumption

In WSN, transferring the aggregated data from nodes direct to BS will be higher energy consuming task. However, indirect communication has complexity in determining the optimized routes.

Load balancing

While data is being transferred, it results in unbalanced energy consumption, network congestion, data loss, and inefficiency in many real time data driven applications. clustering techniques solves this problem by load balancing through more clusters and more layers.

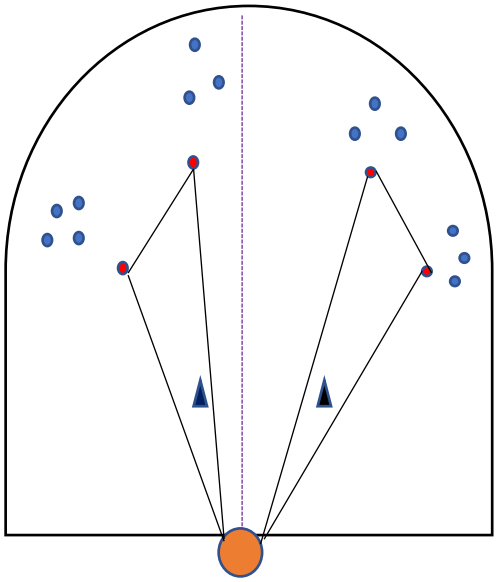
QOS

Quality of Service in WSN is optimizing the jitter , improving the throughput, and minimizing the delay

Literature survey

In multi-hop transmission the problem that persist is energy holes, uneven energy consumption, and unreliable data transmission. In [1], a scheme for collaborative data collection using multiple mobile nodes (MN) as sink nodes has been suggested. A dynamic clustering algorithm has been adopted to form cluster with randomly arranged sensor nodes. Further, a sensor node with higher energy is selected as a cluster head for data collection from the cluster.

In [2], Authors propose artificial immune algorithm and particle swarm optimization algorithm to reduce the energy holes thereby, improve network life. This optimization has not only reduced the energy consumption, but reduced the traversal path.



In[3], authors propose an energy-efficient data gathering scheme by Circular Clustering and Hybrid Crow Search Algorithm , which enhance the lifetime of network. Here, data gather node selection, initially starts with circular cell clusters in the whole of the area of the sensor network. Later, a multi objective based weighted sum method is used for proximity, communication cost, residual energy and coverage. Then for dynamic mobile sink node hybrid crow search algorithm is used for its mobility.

In [4], method is proposed to minimise inter-cluster communication cost to provide reliable data transmission employing a tree to find association between two nodes on a weighting method. Here clusters are formed based on residual energy level and algorithm selects sensor node as cluster head for routing data packets to sink nodes that has higher residual energy.

WSN model creation

a)W and H represent the width and height of the maximum transmission range. NL represents the number of the created layer. $NL = \frac{\sqrt{W \times H \times N}}{2 \times (H + W)} + 1$

b) Number of nodes in the sensor network is represented by N, number of available clusters in the initial layer is denoted as NCL.

$$NCL\_i = \frac{N}{\sqrt{2\pi}} \times \frac{Efs}{E\ Mpf} \times \frac{M}{d^2_{BS}}$$

Where Efs= additional energy to overcome free space loss

EMpf= for multipath fading, d^2_{BS} =mean square distance between all nodes and base stations.

base station sent a message consist of some attributes are (a) Node's location, (b) Cluster ID, (c) Layer ID (d) Activation flag, and (e) Node ID. Based on these attributes, the relay nodes or cluster head and sensor nodes are selected.

Node selection is done based on probabilistic approach. The best node in the cluster is selected as a cluster head node based on the proximity, communication cost, energy consumption and coverage range.

Clustering

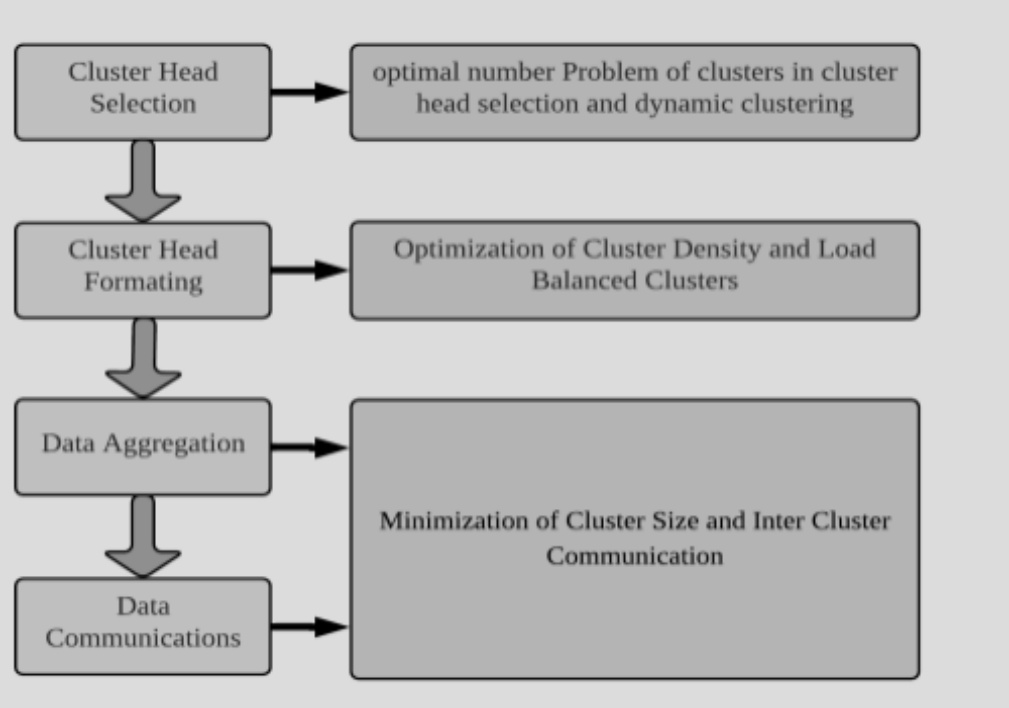
Clustering ensures energy conservation by adopting low-cost communication techniques. It divides the network into different groups of nodes, called clusters. Each cluster has a Cluster head(CH)that oversees the activities of the other nodes in the cluster. The CHs can also reach the BS by creating a group and communicating with the BS in a multi-hop pattern. The CH first gathers the data collected by all the nodes before forwarding them to the BS. Cluster formation aims to reduce the workload of the CHs and the member nodes are assigned to the nearest CH, based on the Received Signal Strength Indication (RSSI) .

In selecting CH mainly factors considered include the CH's mobility, communication, and role. The metrics used during CH selection include the distance from the CH to the nodes, the distance between the CH and the BS, the distances between the nodes and the BS, residual node energy, RSSI, node degree, cluster density, node weight, and position metrics.CH must serve as relay for traffic reaching Sink node.

Clustering objectives include

Load balancing
Fault tolerance
Scalability
Network topology
Lifetime
Data aggregation

Cluster Optimisation[5]



[5]

CH selection is a significant to improve energy efficiency and lifespan of the network.

self-organized schemes and assisted schemes are adopted.

self-organized schemes can be grouped into probability and non-probability-based schemes, while assisted schemes can be grouped into BS-based and CH-assisted schemes

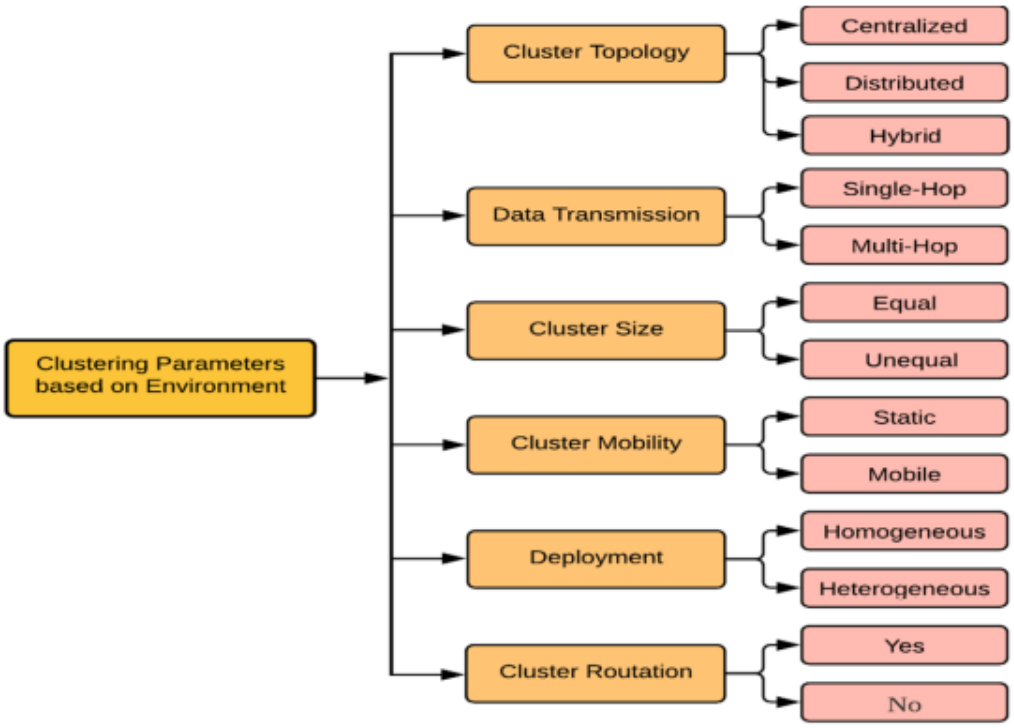
Cluster Formation Phase starts by broadcast messages sent out by the newly elected CHs to announce the acquired status and ends with the join message sent by each node to its optimum CH.

Methods include-event-driven and optimal clustering schemes.

Optimal clustering the -in terms of cluster size based on the application type and data transmission, reduce energy usage by relay traffic, residual energy, and data correlation. Event-driven schemes aims to improve network lifespan by removing dispensable clustering from the network

Data Aggregation from multiple sensors are gathered to remove redundancy during the transmission stage and provide fused information to the BS. Most data aggregation schemes aim at data gathering and aggregation in an energy-aware manner.

Data Communication phase involves transmitting the data aggregated by the CHs to the BS for further processing based on the application type. SNs transfer data to BS directly in single hop transmission.



[5]

MATLAB simulation of WSN formation

AN_WSN live script is uploaded where basic WSM is created and plotted.

References

[1]. Aiping Pang , Fan Chao , Hongbo Zhou , Jing Zhang, “The Method of Data Collection Based on Multiple Mobile Nodes for Wireless Sensor Network” , IEEE ACCESS , volume 8,January 24, 2020.

[2]. Z. Hong, X. Dongliang, and L. Zhanming, ‘‘Path planning algorithm of mobile sink based on immune particle swarm optimization,’’ J. Central South Univ. Nationalities (Natural Sci. Ed.), vol. 37, no. 4, pp. 126–129 and 136, 2018.

[3]. Praveen Kumar Kodoth, Govindaraj Edachana, “An energy efficient data gathering scheme for wireless sensor networks using hybrid crow search algorithm”,IET Communications,2021,906,921.

[4]. UN Nisha, AM Basha ,”Triangular fuzzy-based spectral clustering for energy-efficient routing in wireless sensor network”, The Journal of super computing, Springer, April 2018

[5] Ahmed Mahdi Jubair 1 , Rosilah Hassan, et.al, “Optimization of clustering in Wireless Sensor Networks: Techniques and Protocols”in Applied science 2021,MDPI , 11(23), 11448; https://doi.org/10.3390/app112311448.