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SURVEY ON ENERGY EFFICIENT AND LOAD BALANCED DATA COLLECTION ALGORITHMS IN WIRELESS SENSOR NETWORKS

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ABSTRACT

The extensive development of wireless sensor networks lead to deployment of numerous real world applications. The sensors which is in mobility is used to sense physical or environmental conditions and store the data to be collected by the base station of the sink. The efficacy of wireless sensor network relies on the data collection stratagem. In the study of many data collection algorithms for WSN, the algorithm fails to provide the consistency of the network in respect of coverage distance, delay, traffic, load balance, energy efficiency and end-to-end connection. To support high scalability and better data aggregation, sensor nodes are often grouped into disjoint, non-overlapping subsets called clusters. Clusters create hierarchical WSN, which incorporate efficient utilization of unlimited of sensor nodes and this extends network lifetime. This paper compares various data collection topologies in terms of providing better Quality of service.

KEYWORDS: clustering algorithms, energy efficient clustering, network life time, wireless sensor network.

INTRODUCTION

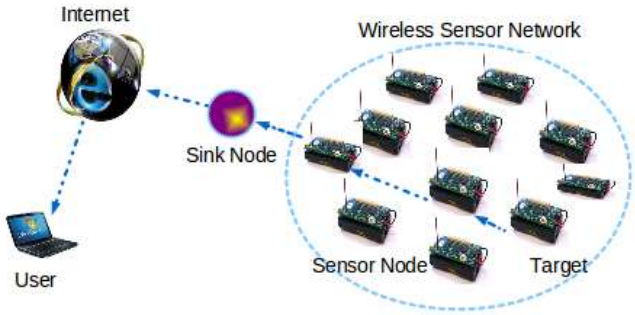
WSN in recent time had a prominent development because of the use of Nano technology and MEMS [micro electro mechanical system] having small numbers of sensors and actuators in a distributed environment to construct the network. The areas of applications of wireless sensor networks includes economics, monitoring, military surveillance, infra structure protection, mining, inventory tracking etc. The effectiveness of any wireless sensor networks depends on the quality of sensing, mobility, network lifetime, scalability, coverage, energy consumption, etc. [1] Generally WSN is deployed in remote location or places, which could be hazardous in reach of humans. The goal of these deployed WSN is to deliver data collected from the sensors to the sink nodes. The data collection is an important factor for the estimation of WSNs. To perform data collection several network topology has been analyzed in terms of better Quality of service. Choosing of a better topology could help in reducing constraints like long-range communications within a network, node failure, computational resource crisis etc.

DATA COLLECTION

The sensing of data from the deployed sensor nodes and delivering to the sink node for further analysis is called data collection. The data collection depends on the topology management with varying unicast/broadcast communication between sensors. The energy consumption is one of the important roles in the performance of WSN. The energy consumption is directly proportional to transmission distance between sensor nodes. The various topologies for data collection depend on the location of the sensor group in respect to other members. The topology must be able to manage the addition of new sensor node or its failure. The various topologies discussed here are [10]ss
i) Flat ii) Chain topology iii) Custer based topology iv) Tree based topology v) Cluster tree based topology.

Flat Topology

The flat topology for the data collection uses flooding, direct communication and gossiping methodologies. The data packets collected by the sensor node is passed to the sink by forwarding it to the nearby sensor nodes. The forwarding sensor must be at a one-hop distance. The disadvantage of this topology is it does not follow a define structure. It cannot withstand failure of a sensor node. Problems like implosion/overlapping may occur.



Chain Topology
The group of sensors deployed in a chain like structure, one of the sensor node in the chain is elected as a leader. The remaining sensor nodes can communicate with other sensor nodes along the path. With a high mobility among the sensor node the path may get deteriorated. The delay from the distant sensor node is the main demerit of this topology.

Cluster based Topology
The sensor nodes deployed are formed into a cluster and a cluster head is elected and the cluster head collects data from the cluster members and sends it to the sink. This process is carried out in two phases, one is setup phase and the other one is steady phase. In the set up phase the cluster head selection is either achieved by centralized or distributed cluster head selection algorithm. The steady state is done on the basis of setup phase where the data is transferred in the path assigned. This topology does not work well with mobility based sensor environment. The data transmission rate might affect and is not reliable in the intra cluster communication when a frequent change in the cluster member takes place.

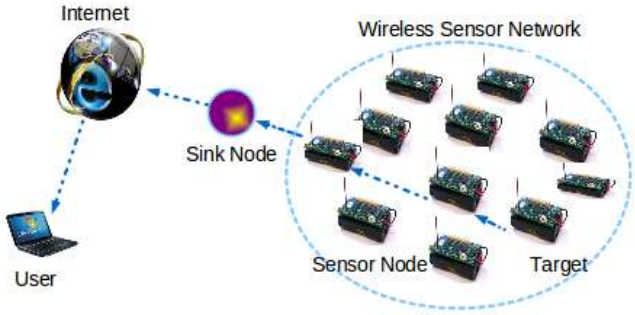


Fig. 1. Sensor architecture

Tree Based Topology
The logical tree is constructed among the deployed sensor nodes. The optimal path is obtained by spanning algorithms, either BFS or DFS. The data collected from sensors at the base is passed to the sink by traversing the tree structure. The logical tree structure avoids flooding of data packets. This topology helps in less power consumption. The disadvantage of this topology lies in terms of cost effectiveness and node failure intolerance.

Cluster tree topology
This topology elects a special node as a cluster head called Designated Device(DD) which has a greater transmission power and receiver sensitivity. The beacon signals are used to find Network identity.(NetID).The transmission signals are used to identify the location using the connection request and connection response receptions. The disadvantage is the creation of node id which is a tedious process.

ALGORITHMS BASED ON TOPOLOGIES

The various algorithms based on the different topologies mentioned are discussed with their working principle and merits-demerits.

CREEC:CHAIN ROUTING WITH EVEN ENERGY CONSUMPTION

Chain routing is focuses on even energy consumption [1]. The working principle using two strategies:
i) Maximizing the even energy distribution every sensor node being deployed. ii) The feedback mechanism to save energy for the depleted sensor nodes. This algorithm helps in maintaining average lifetime comprises of throwing-schedule and chain establishment. In the throwing schedule, sink estimates the integer of throwing to be consigned to any sensor node. In the chain establishment, a new chain is constructed when sensor nodes get depleted to save energy. The sensor nodes are arranged in descending order based energy levels and updates on every super node. The chain topology is constructed using Kruskal's MST algorithm, which gives the shortest link to add the sensors. CREEC gives better lifetime and distributed energy utilization. But the demerit of this topology is the excessive delay from distant nodes.

Hierarchical Geographic Multicast Routing For Wireless Sensor Networks(HGMR)

This algorithm [2] is a location-based protocol. HGMR offers a simple management of network with high scalability and energy efficient routing strategy. HGMR uses a partitioning method, where the network is partitioned into small cells, which again finds sub-optimal routing path. This helps in building overall optimal way of reaching the sensor node. The demerit in this protocol is unstable energy utilization around the Access points.

MBC (Mobility Based Clustering protocol)

In this protocol all the sensor nodes [3], which assigns itself to a particular cluster, have equal chance of becoming a cluster head. The cluster head election is based on threshold values such as residual energy and mobility of the sensor node. The intra cluster is the communication within the cluster, where all the sensor nodes in that cluster transmit data collected to the cluster head. The inter cluster communication is between one cluster and other cluster, where the cluster head collects data from cluster head and transmits to the sink. MBC proves to be better than other protocols such as LEACH, HEED in mobility based environments. The demerit in this protocol lies in facing the critical node can lead to link breakage. Packet dropping may also occur.

EEDCP-TB (Energy Efficient Data Collection protocol)

This protocol applies tree based data collection mechanism [4]. This protocol focuses on saving energy utilization by reducing excess usage of residual energy by all sensor nodes. This is achieved by avoiding flooding mechanism and data aggregation by cascading timing scheme. This protocol outperforms other flooding protocol such as TBDCS, EEDCP-TB in terms of energy consumption of prolonged network lifetime.

ECT (Efficient Converge cast Tree)

This protocol is a tree based topological structure [5]. This protocol focuses on network lifetime improvisation through weight balancing. The local information is gathered and using distributed algorithm, a weight balanced shortest path tree is constructed. Eventually the throughput is increased. The network Lifetime is also prevailed for a longer duration. The demerit could be time consumption.

Cluster Tree Data gathering Algorithm.

CTDGA (cluster tree data gathering algorithm) gathers [6] data from sensor nodes with minimum energy consumption. The beacon signals are used to send to the sensor nodes for finding the location. The similar residual energy sensor nodes form a cluster. The data is collected from sensor nodes and stored in cluster head. The data gathered in cluster head is passed to neighbor cluster heads. The data is in this way forwarded to sink in a tree link fashion. This improves energy consumption. But the network parameters play a vital role in the performance such as scalability, coverage, data transmission rate, cluster dimension, number of clusters and number sensor nodes in a cluster, mobility. Only when these factors are well defined , we can expect for better performance. The disadvantage is it uses centralized algorithm.

Load balanced Clustering and Dual data uploading

- A three-layer framework includes sensor layer, cluster head layer, mobile collector.
- Enables 2 clusters to upload data simultaneously.
- Good scalability, long network lifetime.
- Finding polling point s and compatible pairs for each cluster is difficult.

Data collection in arbitrary wireless sensor network.

A centralized cluster based routing protocol with complex computational capability of the sink [7]. The protocol maintains a uniform distribution of cluster head over the network and nearly identical number of cluster members to balance the cluster head overload. The upper bounds and lower bounds for data collection capacity in arbitrary networks under protocol interference and disk graph models. On each round, the sink collects the energy level of these nodes in the network to select a set of nodes that are elected as cluster head. It arbitrarily picks up a cluster head to send the data to the sink. The disadvantage with this algorithm is it uses centralized algorithm.

Ref	Algorithm	Strategy	Merits	Demerits
A.	CREEC	Chain Topology-throwing schedule	Average lifetime, distributed energy utilization	Excessive delay from distant nodes
B.	HGMR	Cluster topology-with network partitioning	Scalability , energy efficient routing	Unstable energy utilization around Access points
C.	MBC	Cluster topology-all sensor nodes can get chance as CH.	Better performance on mobility based environments	Cannot tackle critical node, can lead to packet dropping
D.	EEDCP-TB	Tree topology-flooding avoidance and cascading timing scheme	Prevents excess usage of sensor nodes residual energy	Time consuming, costly operation
E.	ECT	Tree topology-weight balancing	Better throughput and network lifetime	Cannot tolerate node failure
F.	CTDGA	Cluster tree topology-special CH to collect data from neighbour CHs	Improves energy efficiency and network lifetime	node id creation is tedious process
G.	LBC-DDU	Cluster topology-3 layer framework-enables 2 clusters to upload data simultaneously	Good scalability, long network lifetime	Finding poll points and compatible pairs of each cluster is difficult.
H.	DCAWSN	Tree topology-BFS under protocol interference and disk graph models	Provides solution for data collection capacity	Nearby nodes unable to communicate due to barriers and path fading
I.	EECTT	Clustering topology-interaction between communication subsystem and sensing subsystem	Better performance and energy efficient	Any errors in nodes coordinates may propagate.
J.	CDSO	Clustering topology-self organization with distance and density distribution	Prevents loss of residual energy	Not suitable for mobility based environment

Table 1: comparison table for algorithms

Energy efficient in collaborative target tracking.

- Interaction between the communication subsystem and the sensing subsystem on a single sensor node.
- Sensing related methods and communication related methods using prediction algorithm methods.
- Any errors in nodes coordinates may propagate which may lead to wrong results.

The energy efficiency [8] depends on the exploitation of the nodes in every round of the data collection process.

Clustering algorithm with distributed self Organization

- Assuming residual energy of nodes following random distributed self-organizational structure.
- It is on the basis of the distance and density and density distribution, location based multi-cast protocol.
- Cluster tree creation [9] with node id is tedious process with distributed self organized structure

VELCT design

Velocity energy efficient link aware cluster tree is a proposed system in which the Quality of service is improvised.

- Minimizes energy exploitation, reduces end-end delay.
- Traffic is reduced in cluster.
- Constructs simple tree structure reducing energy consumption of the cluster head.
- Avoids frequent cluster formation
- Maintains cluster for a considerable amount of time.
  It consists of two phases: set up phase and steady phase.

Set Up phase

- Cluster formation and data collection tree construction is initiated to identify optimal path between cluster member and sink.
- The intra cluster and Data collection tree communication.
- Data collection node does not participate in sensing, simply collects data packets from the cluster head and delivers to the sink

Steady state : Transfer of data from cluster member to sink.
This protocol can be further improvised with load-balance; the number of nodes in the intra cluster arrangement can be divided equally among the clusters. Scalability can be improvised if there can be known possible mobility of sensor nodes.

CONCLUSION

In this paper we have examined the current state of proposed clustering protocols. In wireless sensor networks, the energy limitations of nodes play a crucial role in designing any protocol for implementation. In addition, Quality of Service metrics such as delay, data loss tolerance, and network lifetime expose reliability issues when designing recovery mechanisms for clustering schemes. These important characteristics are often opposed, as one often has a negative impact on the other**.** The proposed VELCT algorithm provides better Quality of service and solves the limitation of the other protocols. The VELCT get be improvised in its performance by enhancing load-balance in the cluster head.

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