Study Of Aggregation Techniques In WSN

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Abstract

Hierarchical Wireless Sensor networks make use of aggregation techniques to transfer data to the sink/destination node. Various aggregation techniques have been proposed in literature to improve the network lifetime and energy of intermediate sensor nodes. These nodes transfer data/information to the immediate next node in the hierarchy instead of sink. The paper presents an exhaustive study of various aggregation techniques used in WSN and concludes by giving their comparative analysis.

Keywords-Wireless Sensor Networks(WSN), Network Lifetime, Aggregation Techniques**.**

1. Introduction to Data Aggregation and Routing Protocols

With the advancement in technology, sensor networks are now composed of compact and low cost sensing devices equipped with wireless radio transceiver for physical or environmental monitoring. The advantage of using these compact devices is that neither they require infrastructure based networks to collect data nor they need any human interactions while deploying. These sensor nodes continuously sense the environment, store the sensed values in their local storage, process the sensed values and then pass the processed values to the sink by single hop or multi hop transmission of data.
To enhance the lifetime of WSN, data aggregation techniques are used to gather and aggregate the data in an energy efficient manner. In data aggregation techniques, all nodes sense the environment and then send their sensed values(SV) to the most powerful node in their neighborhood called as the data aggregator node which perform data aggregation by using various data aggregation algorithms. After performing data aggregation, data aggregator node sends the aggregated data to the sink. Various data aggregation techniques that are being implemented are as follows:

- Centralized Approach: In this approach, eachsensor node selects the strongest node(one which has more energy than others) among its neighbors and then sends the data packets through the shortest possible path to that strongest node. This strongest node is commonly known as the header node which is capable of performing data aggregation and combining the various data packets into the single One. Intermediate nodes can be there between primary sensor node and the header node.

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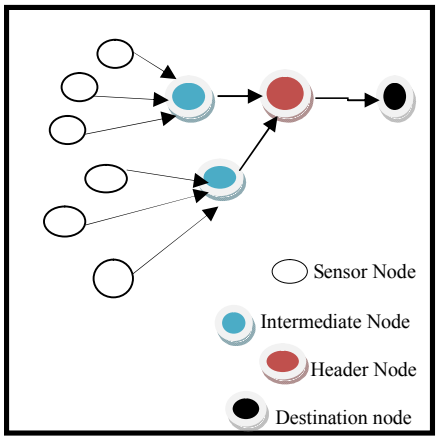

Figure1: Centralized Approach

- In- Network Approach: It is achieved in two ways:

  ✓ With Size Reduction:- Data received or combined from various nodes is compressed using various methods and algorithms to reduce the power consumption. Data compression involves encoding the information using fewer bits than the original representation of information.

  ✓ Without Size Reduction: - It only includes aggregating the data from neighbors and converting it into a single packet for further transmission.

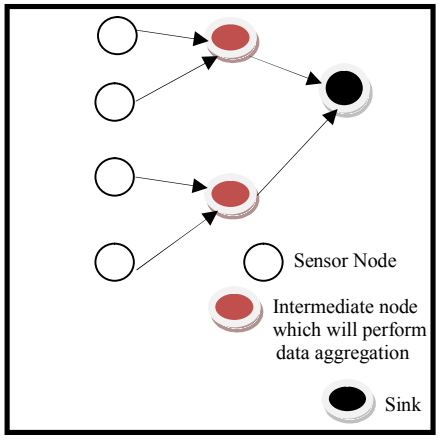

Figure2: In-Network Approach

- Tree Based Approach:In this approach for each data transmission a minimum spanning tree is created known as DAT(Data Aggregation Tree). Each node acts as a leaf node and sends its data to its parent node, which acts as a branch node, and the data in this way flows from the leaf node to the sink and the final parent node does the processing.

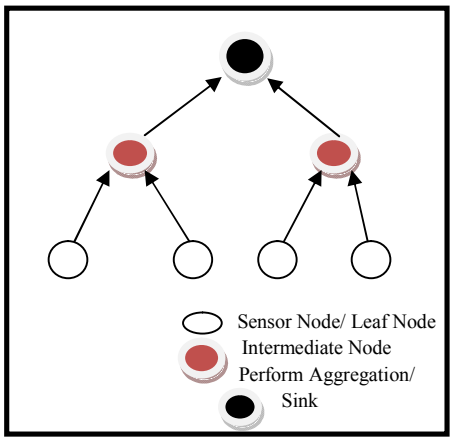

Figure3: Tree Based Approach

- Cluster Based Approach: It is the most efficient approach where network is divided into clusters containing various nodes in each cluster. In each cluster, one node is selected as the Cluster Head(CH) .This is done using algorithms and after one process cluster head changes so that optimization can be achieved. These CH perform the data aggregation reducing the packet size as well as redundancy and then transmit the data packets to the required location.

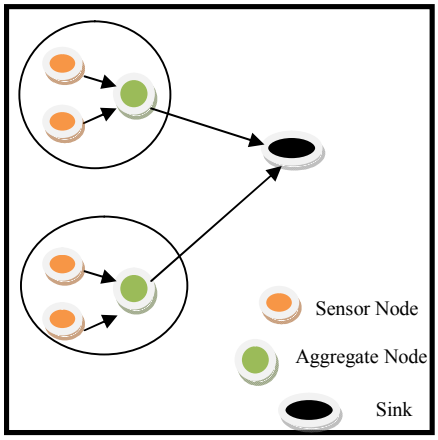

Figure4: Cluster Based Approach

2. Literature review

Gitanjali and Singh[1], have proposed the PDORP algorithm to minimize energy consumption by the nodes. PDORP algorithm uses Proactive and Reactive routing model. PDORP is supported replicating the concept of however water drops mix to make rivers and rivers successively mix to hitch the ocean by choosing the shortest path based mostly on altitudes of the land through that they flow. The advantage of PDORP is delay, load and throughput are improved. The limitation Of PDORP is, it consumes more energy.
Shetal and Rana[2], have proposed ESPDA(Energy-Efficient Secure Pattern-based Data Aggregation ProtocolAggregation Protocol). In this, termination node makes the use of "slicing and mixing" technique. In this technique they slice the private data into pieces

and send these pieces ofdata to the neighbors while one piece is kept by itself. All the leaf nodes wait for a certain time and then mix (sum) each of accepted slices (data into portions) and the slice (piece of data) left out itself to achieve a latest result then to the intermediate node. The intermediate node aggregates the accepted data or information & then sends it to its parent. Using ESPDA energy of the network is efficiently used, but there is less security in the WSN.

Nair et al. [3], have used LEACH(Low Energy Adaptive Clustering Hierarchy). The aim of LEACH is to provide scalability for cluster formation and good balancing of energy consumption. In this clustering protocol the WSN needs that the homogenous nodes are randomly deployed and then the whole network is divided into clusters and each cluster have a cluster head(CH). Sensor nodes senses the data and then send the information to their CH and CH aggregate the information and send the aggregated information to the sink. Limitation of this is, probability of selection of CH with very low energy and it effectively work for only large network.

Sreenivasulu and Reddy[4], have used DCSDA method. DCSDA is suitable for cluster based strategy. An aggregation process is defined as the process of compressing the sensed data from various autonomous nodes by applying minimum, maximum, average and other functions. The data aggregation will lead to the reduction in energy consumption. In various data aggregation sessions, the cluster head (CH) and Co-Cluster Head (CCH) passes instructions to the sensor nodes to forward their data sets. The CCH performs the aggregation process and passes to the CH. The CH directly communicates to the base station. The total duration of the sessions for aggregation is identified based on the buffer capacity of sensor nodes and reading capability. Double cluster head aggregation approach considers the two nodes as CH and CCH, by taking various factors into consideration like minimum distance, residual energy and nodes lifetime. Use of DCSDA provide security and overhead of the network. DCSDA method is suitable for highly densed networks.

Suraj et al. [5], have proposed Efficient Distributed Trust Model (EDTM) and Data Aggregation using Synopsis Diffusion. Use of these methods eliminate redundant data transmission from multiple sensor nodes and the energy consumption during aggregation process. Efficient Distributed trust model is used to calculate the direct trust and recommendation trust based on the number of packets received from sensor nodes in wireless sensor network. While calculating direct trust, the other trusts like communication trust, energy trust and data trust are considered. Recommendation trust is checked for its trust reliability to improve the accuracy of recommendation trust for sensor node. Synopsis diffusion is one type of In -network aggregation which is a general framework for combining multipath routing into a single route and to avoid double counting problem. This approach defines Order and Duplicate Insensitive (ODI) properties, which is responsible for the final aggregated result is independent of duplicate data. The limitation of these methods is the average sensor lifetime of overall bandwidth utilization is less.

Chopra and Kaur[6], the proposed model is entirely based upon the data aggregation and data forwarding technique.DA-MAC is formed which provide direct support from data aggregation. DA-MAC protocol provides channel contention information that channel is busy or not. The proposed is based upon the smart amalgamation of heuristic and greedy algorithm based aggregation. The greedy allows the algorithm to cover any number of data streams for the aggregation, whereas heuristic is responsible for the group formation before going for the aggregation. The major limitation of this is that, it may cause the loss of information on the local anchor nodes, which are managing the small groups within in the WSN cluster. The anchor node analyzes the ingress data comings from the local or slave nodes. The nodes sending the similar types and sizes of data are grouped in the several network sub-groups on the regional aggregator node, called anchor node. The local aggregator node aggregate the data into different streams according to the packet size, data volume and ingress data rate. The aggregated data header includes the detailed information of the source nodes in the aggregation header. The active slave nodes are

changed from one aggregate stream to another, if they changes the data volume, data rate or packet size.

Dhiman et al. [7], have used tree based data aggregation, information centric network. Tree-based. For determining the routing structure towards the sinks, they used the Link Reversal Algorithm. The main objective of this algorithm was to construct and maintain links to multiple sinks to seamlessly aggregate data. Another important function of this protocol is the information exchange between sinks. Due to the wide coverage, difficulty is generally faced in developing tree based routing protocols. But, due to the merge of independent sink-oriented trees, this protocol has wider coverage compared with the single-sink case. An Information-Centric Network communicates with information identifiers such as names, in contrast to IP. An IP-based network detects which information has to be served through an IP address and then transmits equivalent information. The communication protocol in an IP-based network is used to propagate packets to a host, which possesses information. In contrast, an Information-Centric Network concentrates on the purpose of communication rather than the procedure. The information is collected and represented as summary through Data Aggregation.

Sandhu, Kumar[8], have developed an energy efficient HEED(Hybrid Energy Efficient Distributed Protocol). In LEACH protocol, every node can become the cluster head regardless of its energy level. HEED overcome this problem where cluster head is selected with the comparisons of residual energy level and the node with highest energy level is selected as the cluster head. The objective is to reduce the energy consumption by the sensor nodes to increase network lifetime which is achieved with Energy Efficient HEED.

Perillo, Heinzelman[9], have used TAG protocol (Tiny AGgregation) for performing data aggregation. In TAG, user sends the queries for data aggregation from the base station. Operators implement the query through network and sensors sends the data back to the user through the same path traversed by the query base station. Advantages of TAGs are reducing communication bandwidth.

Table1 compare and contrast various protocols described on the parameters of hop count, scalability and energy efficiency.

S. NO.	NAME OF PROTOCOL	HOP COUNT	SCALABILITY	ENERGY EFFICIENCY
1.	PDORP	Multi hop	Low	Low
2.	ESPDA	Multi hop	Moderate	Low
3.	LEACH	Single hop	Good	Low
4.	DCSDA	Multi hop	Low	Good
5.	EDTM	Multi hop	Limited	Low
6.	DA-MAC	Multi hop	Medium	Good
7.	HEED	Multi hop	Good	Moderate
8.	TAG	Multi hop	Good	Low

Table1. Comparison of various approaches

3. Conclusion

With the use of data aggregation techniques network lifetime is increased by using resources in an eventful manner. Data aggregation approaches give better results in terms of latency, accuracy, battery utilization. With the use of data aggregation the percentage of dead nodes in sensor network is reduced by a large amount, it takes less transmission delay to transmit data to the sink and the information provided by the sensor nodes is more accurate after aggregation. So using data aggregation the performance of wireless sensor network is increased by a large amount.

4. References

4.1. Journal Article

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