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Clustering Based Data Aggregation and Data Dissemination Schemes in Wireless Sensor Network – A Review

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Abstract: Wireless Sensor Networks (WSN) consists of large amount of sensor nodes that are deployed in areas to monitor various physical phenomenon. Sensor nodes are small sized, having limited memory and battery-life. Due to limited sensing, computation and communication capabilities amount of data communication is to be reduced. Data aggregation is a process of collecting and aggregating the data and forwarding the fused data to the base station (BS). Data aggregation is used to reduce the energy consumption by removing redundancy. This paper reviews the work done by various researchers in area of data aggregation and data dissemination in WSN. Review work will be expressed on the basis of comparison parameters like-clustering method, performance metric, implementation tool and protocol or algorithm. Among the various approaches of data aggregation, cluster based approach proves to be most energy efficient and hence improving the lifetime of the network.
Keywords: Wireless Sensor Network (WSN), Data aggregation, Clustering, Cluster head (CH), Base station (BS).

I. INTRODUCTION

A Wireless Sensor Network consists of huge amount of sensor nodes that are deployed in a limited area. The basic idea of wireless sensor network is to distribute the small sensor devices, which can then sense, process and forward the information to its neighbouring devices, over a particular location for a particular purpose like surveillance, environmental monitoring etc. A wireless sensor network does not require any infrastructure for monitoring the environment.

Figure 1 shows a wireless sensor network. Sink node sends queries to the sensor nodes in the sensing region. Sensor nodes collaborate to accomplish the sensing task and send the sensed data to the sink node. Sink, which also acts as a gateway to outside networks, e.g., the Internet, collects data from the sensor nodes, performs some processing on the collected data, and then send processed data via the Internet to the users who requested to use the information. Figure 2 shows the components of a wireless sensor node. A wireless sensor node composed of various components like microcontroller, radio transceiver, small memory unit, limited power source and one or more sensors [1]. Every sensor should be capable of sensing, processing and communicating the processed data to the neighbouring nodes to form a network. In Wireless Sensor Network the sensors communicate with each other and with the sink node or base station (BS) through single-hop or multi-hop communication. As most of the energy is consumed during data transmission, so we use data aggregation for energy efficient data transmission.
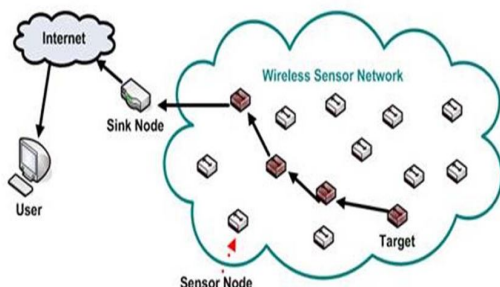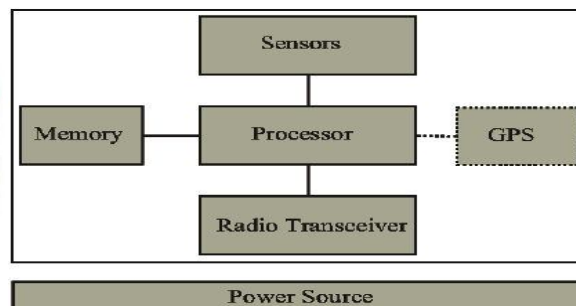

Fig 1: A Wireless Sensor Network

Fig 2: Components of WSN node

This paper reviews the various clustering based data aggregation and data dissemination schemes in a wireless sensor network. The rest of paper is organized as follows. Section II, discussed about Data aggregation approach. Section III, provides the study of related work done in data aggregation schemes. Section IV, a comparison of related work has been done. In section V, we concluded this paper.

II. DATA AGGREGATION IN WSN

Data aggregation technique has a major role in the wireless sensor networks. Data aggregation is the process of collecting and aggregating the data in an energy efficient way to enhance the lifetime of the network. The main goal of data aggregation technique is to remove unnecessary transmission from collected data so that energy consumption of network is minimized and lifetime of network is increased.

A. Factors involved in Data Aggregation
Some of the main factors that are involved in data aggregation process in wireless sensor network are as follows [2]:
1) Energy Efficiency
2) Network lifetime
3) Communication Overhead

Various approaches are used for data aggregation like, centralized approach, decentralized approach, in-network aggregation approach, tree based approach, cluster based approach, hybrid approach etc. Among all the approaches cluster based approach proves to be much more energy efficient to improve the network lifetime.

B. Cluster Based Approach
The main issues with WSN are 1) network lifetime or we can say battery lifetime of sensor nodes, and 2) communication overhead of nodes. So energy efficient approach is required which can use less energy to improve lifetime of network. Among various approaches for data aggregation, clustering proved to be a better option. In cluster based approach, network is divided into different clusters i.e. Small sized WSNs. In each cluster, a cluster head (CH) is chosen among the cluster members on the basis of higher energy which aggregates data locally within the cluster and sends the aggregated data to the sink node. For each round of data transmission, a new cluster head is selected. This is done to avoid the more energy consumption by single node i.e. cluster head. In a clustering process two type of transmission is performed i.e. Intra-cluster communication and Inter-cluster communication [3]. Intra-cluster communication is performed among cluster members and cluster head of a cluster. This type of transmission is generally single-hop. Inter-cluster communication takes place between cluster heads of different clusters or between cluster head and the sink node. This communication takes place in a multi-hop fashion.

III. RELATED WORK

Mao Ye et al [8] introduced a clustering method called Energy Efficient Clustering Scheme (EECS) for WSN. This method is suitable for the environments where periodic data aggregation is required. During cluster-head distribution, this method selects the cluster-head with the maximum residual energy provided by local radio communication. This method is one of the ways to provide balance between cluster head loads. Woo Sung Jung et al [4] proposed a hybrid approach for clustering based data aggregation in WSN. This scheme can adaptively select a suitable clustering technique depending on the status of the network, and hence increases data aggregation efficiency as well as energy consumption. Jun Yue et al. [7] proposed an Energy Efficient and Balanced Cluster-Based Data Aggregation algorithm (EEBCDA) for WSN. EEBCDA divides network into rectangular grids, of unequal size, having a cluster head which rotates among nodes. EEBCDA increases energy efficiency, balance energy dissipation and enhances lifetime of network. Rabindra Bista et al [6] proposed a new approach for energy balanced and efficient data aggregation (Designated Path (DP) scheme) for WSNs. This scheme helps in removing two problems: hot-spot problem and data traffic problem in a network, by using pre-determined a set of paths. These paths are run in round-robin fashion so that all the nodes can participate in the workload of data gathering and the data transferring to the sink. However, in this scheme dissipated energy is increased. Zhong-Gao Sun et al. [13] proposed an energy-aware data gathering protocol (EADGP) that maximizes lifetime of a wireless sensor network. a cost metric and metric mapping function is presented to reduce energy consumption and load balance.

Liu Xiang et al. [10] have proposed a compressed data aggregation scheme that helped in achieving recovery fidelity and energy efficiency. This scheme used compressed sensing (CS) technique to achieve its purpose with arbitrary topology.

Vivek katiyar, Narottam Chand et al. [12] proposed a new energy efficient clustering protocol (FZ-LEACH) that eliminates the problem, of very large and very small clusters present in the network at the same time, by forming Far-Zone.

Saeid Mottaghi and Mohammad Reza Zahabi [11] proposed an algorithm that optimize the energy efficiency of LEACH algorithm by combining the concept of mobile sink and rendezvous nodes with LEACH algorithm. Kushal B Y and Chitra M [5] proposed a method that helps in enhancing lifetime of network. This method focuses on energy dissipation optimization by modifying CH selection approach in LEACH and avoids energy-hole problem of network. N. Brindha and S. Vanitha [2] proposed an algorithm

named Angular Query Region Division Routing Algorithm. This algorithm underlined two problems of data aggregation –network lifetime and energy consumption. It uses tree based data aggregation approach, which is useful in minimizing the energy consumption of the network by finding the shortest path between the leaf node and root node. Hence, network lifetime is increased. Khalid Mahmood Awan et al [9] proposed a new distributed algorithm which uses clustering technique to form unequal sized clusters of sensor nodes to transmit data to the base station. This distributed algorithm calculates the residual energy of nodes, distance from base station and number of nodes in order to increase the life time of sensor networks.

IV. COMPARISON OF EXISTING WORK

Various researchers had worked in the field of cluster based data aggregation on various parameters to enhance performance of protocol. The review work has been expressed by comparing the work done by researchers on the basis of some parameters like-performance metric, clustering method, simulation tool and protocol or algorithm. The comparison of existing work done is as follows:

Table I: COMPARISON OF EXISTING WORK

S.No.	Author/ Year	Protocol/ Algorithm	Simulation tool	Clustering Method	Performance metrics
1	Mao Ye et al. / Apr. 2005	EECS	MATLAB	Distributed	• Network lifetime • Load balancing
2	Woo Sung Jung et al. /2009	A hybrid approach proposed	Qual Net 4.0	Hybrid	• Data aggregation efficiency • Energy consumption • Data transmission ratio
3	Rabindra Bista et al./ Oct 2009	Designated Path (DP)	TOSSIM	Hybrid	• Energy efficiency • Network lifetime
4	Zhong-Gao Sun et al./2010	EADGP	MATLAB	Distributed	• Energy efficiency • Network lifetime
5	Jun Yue et al./ 2011	EEBCDA	MATLAB	Distributed	• Energy efficiency • Energy dissipation • Network lifetime
6	Vivek katiyar et al./2011	FZ-LEACH	NS-2	Centralized	• Energy dissipation • Network lifetime.
7	Liu Xiang et al./ Dec 2013	Method proposed	MATLAB	Distributed	• Energy Saving • Data transmission
8	Saeid Mottaghia et al/ Feb 2015	Algorithm proposed	MATLAB	Centralized	• Energy dissipation • Network lifetime.
9	Kushal B Y and Chitra M/ May 2016	Method proposed	MATLAB	Centralized	• Energy dissipation • Network lifetime.
10	N. Brindha and S. Vanitha/ 2017	Angular query Region Division Routing Algorithm	NS-2	Hybrid	• Energy dissipation • Network lifetime.
11	Khalid Mahmood Awan et al. / Apr 2018	Algorithm proposed	MATLAB	Distributed	• Energy dissipation • Network lifetime.

V. CONCLUSIONS

Data aggregation is an energy efficient process of collection and aggregation of data that helps in eliminating the redundant data and therefore, prolongs the network lifetime. This paper, reviewed various clustering based data aggregation schemes or methods that are proposed by different researchers to reduce the energy dissipation of sensor nodes and hence, improving the lifetime of wireless sensor network.

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