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A Survey on Grid Based Data Aggregation in Wireless Sensor Networks

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Abstract

Wireless sensor networks (WSNs) comprises of sensor node. Such networks have enormous application in environmental observation, disaster management, security and defence, etc. Wireless sensor nodes are relatively smaller in size; contain restricted processing capability and extremely less battery life. This limitation of less battery life makes the sensor network vulnerable to failure. Data aggregation is an important method in WSNs. Data aggregation helps in minimizing the energy utilization by removing redundancy. Here we have studied about data aggregation as well as summarized different scheme employed in this process.

Keywords*: Wireless sensor network, sensor nodes, data aggregation, grid based scheme*

1. Introduction

The Wireless sensor network [1] is ad-hoc network. It comprises of light weight wireless nodes called Sensor nodes, utilized in physical or environmental circumstance, measures the physical parameters namely sound, pressure, temperature, and humidity. The sensors nodes are employed in huge amount with the cooperation among the nodes are able to create an ad-hoc network that is able to report to base station. Wireless sensor network comprises of a variety of applications namely surrounding observation, calamity management, health observation, though wireless sensor network is a resource limited taking into account energy, estimation, memory, and restricted transmission. Every sensor node present in the network communicates among each other or with the neighbor nodes.

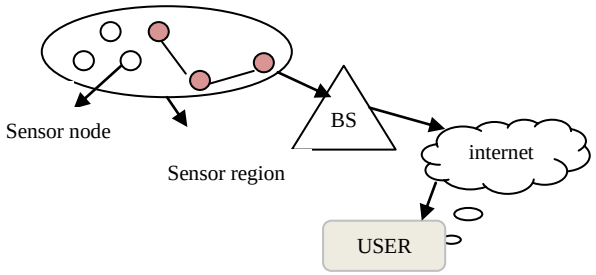

Figure 1. Architecture of Sensor Network

Data generated by sensor nodes by, depending on the process of sensation, observes and broadcast the observed packet to the base station. In this mechanism direct transmission is required as the base station might be situated at relatively far distance apart from these nodes. Since packet has to be broadcasted far distances it requires a huge volume of energy as a result an enhanced approach should deploy fewer nodes to forward the packet to the base station. Such nodes are known as aggregator nodes, mechanism is termed as data aggregation in wireless sensor networks.

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2. Clustering in Wireless Sensor Networks

These nodes are deployed densely in wireless sensor network implies that the physical surroundings would generate data that can be nearly associated to such nodes and forwarding the kind of data is more or less redundant. These facts motivates for collecting sensor nodes as a result collection/class of sensor node that can be merged or data can be compacted mutually and forward only compressed data. This can minimize localized traffic in individual class and also minimizes global data. This collection mechanism of such kind of nodes deployed densely in large scale is known as clustering. The process of merging and compressing of data belongs to a particular cluster called data fusion (aggregation) [2].

3. Data Aggregation

Data aggregation is a approach [1] which tries to eliminate the localized congestion problem. It tries to gather essential data from the sensors that surround the event. Then forward only the essential data to the end point in this manner eliminating congestion and its related issues.

Generally in this type of networks, the nodes are typically resource-limited and battery restricted for conserving the energy and resources, data should be aggregated to evade irresistible amounts of traffic in the network. The objective of such approach is to decrease the amount of unnecessary transmission of data and redundant data improve the energy life in such networks. This approach is a mechanism of one or various sensors gathers the detected outcomes from several nodes. The gathered data should be carried out by nodes to minimize the overhead of communication before forwarding to the base station. This type of network consist mainly of three kind of nodes namely; simple ordinary nodes, aggregator node and querier. Aggregator node receives the observed packet by the ordinary sensor nodes from the surroundings necessary these nodes gather data present in the network from various nodes merges the message employing some aggregation operations; send the outcomes to top aggregated node or the querier node that responsible for generating the query.

4. Requirement of Data Aggregation

In wireless surroundings the nodes are spread over a broad region. Usually users do not contain globular data on these nodes distribution. That is the reason when user's demands reading from sensor of parameters like moisture and heat in arbitrary area, networks may suffer from uncertain massive traffic. This issue demands data aggregation to meet with the user requests and organize the overlapped aggregation trees of various users effectively. Various real world applications like environmental observation, defence, research *etc.*, are utilizing the wireless sensor network so such applications need transmitting a massive amount of observed data that resides in one of the end in the network to other. As wireless sensor networks mainly deployed with minimum battery consumption, the life duration of a battery is considered as a key limitation in any real world application. This demands the necessity of such protocols that are effective and reliable for aggregating the observed data[3].

Energy is consequently exhausted when the same data value is forwarded to the station independently from various sources. It is advantageous to process data locally decreases the volume of bits to reduce send mainly over far distances. In an ideal way in this method every sensor must spend the same volume of energy in every data collecting round.

Data aggregation is an effective and reliable approach if it enhances the functionality of the network. Assumption is, all sensors are important so it is necessary to limit the

consumption of energy of every sensor. Immediately when a sensor node receives broadcasted query by the base station, the former step is to handle the query.

5. Types of Data Aggregation

They are classified broadly into two type as depicted below:
1. Address-centric (AC)
2. Data-centric (DC).

5.1. Address-centric (AC)

In address centric routing protocol [4], a query is forwarded to a particular address or a given sensor based on the address given in the query. It transmits data along the shortest path to sink. Data is transmitted from this particular location to the base station. The source with the given address in the query send its data straight to the base station.

5.2. Data-centric (DC)

On the other hand in data centric routing [4] rely on the condition specified in the query, all sensors fulfilling that condition, require to replay, thus the query is flooded to every node which are in its communication range.

6. Data Aggregation Approaches

Numerous approaches of data aggregation are present [5] some of them are depicted as:

Centralized Approach: In centralized approach simply single sensor node plays a major part of aggregator node and rest of the sensor nodes are linked to the aggregator node. The remaining nodes observe the packet, forwards to the aggregator node; termed as centralized node. A huge amount of loads is on that aggregator node, this node requires sufficient amount of energy and security as every packet is concentrated over the centralized node.

Decentralized Approach: In decentralized every node executes aggregator function to the sensed data. In this approach, no requirement of individual centralized aggregator node however every node posses equal preferences to aggregate the observed packet. In this method each node is linked to their neighbor node. This approach is advantageous for providing extendibility, reliability vigorous modifications.

Network Aggregation Approach: Here more than one node can be aggregator node i.e. sub-aggregator node. This approach aggregates various data into individual data. It is essential for enhancing the network lifetime and minimizes the forwarded data size in the network.

7. Pros and cons of Data Aggregation in WSN

Advantage: With the aid of data aggregation mechanism we can improve the strength and accurateness of data that is achieved by complete network a definite amount of inconsistency lies in the data that is gather, from sensor nodes as a result process of data fusion is needed to the redundant data. Other advantage is reducing the traffic burden and saves energy of the sensors[1].

Disadvantage: The aggregator nodes send fused data that is received by base station this head cluster or aggregator node is attacked by suspicious attacker. If a head cluster is affected, then the base station (sink) is unable to certify the accuracy of the aggregate

packet which is transmitted to it. Other shortcoming is the uncompromised nodes may transmit multiple replica of the aggregate result to the base station (sink) .It results in maximizing the power consumption at these nodes[1].

8. Grid based Scheme

Grid-based Data Aggregation [1] is extremely useful for mobile surroundings where the time period of an event at a certain instance is relatively minimum. Such scenarios consist of variety of sensor network applications like defense monitoring, meteorology prediction, etc. the sensor network environment is partitioned into pre-defined set of grids or regions. Each region or grid is responsible for monitoring and reporting events that may take place within the region to the sink nodes. Additionally, one sensor device depending on geographical location corresponding to either the sink or the centre of the grid is elected as data aggregator. Rest of the sensors in the gird is aware of this information. At the period of event recognition all other sensors are supposed to transmit the event information to the data aggregator. The data aggregator after gathering data from other sensors transmits only the crucial information to the sink node.

9. Related Work

1. In [6] Jonathan Beaver presented a data aggregation approach for position aware routing in wireless sensor networks. For minimizing the forwarding data packet size in the network they exploit group by queries. The limitation of this lies in building phase of routing tree which is arbitrary. For information repossession base station floods a message and next node to be elected is the one who floods message first to the base station.

2. In [7] R. Govindan presented the diffusion-based protocol for sensor network. Data created by these nodes are termed by employing attribute-value pairs such that a node demands data simply by forwarding the interested data. Data that matches with the interested one is send towards the node.. Intermediary nodes can store and aggregate data. Directed Diffusion pursues the method of initial low-rate data transmitting to create a reinforced route from sender to receiver then packet is send transmitted from that path.

3. K. Dasputa [8] focused on the problem of maximum lifetime data aggregation, given the position of the sensor and available energy together with position of the base station. Finds an efficient way in which data should be gathered and aggregated from all sensors and forwarded to the base station in such way the lifetime is maximized. Here presented an approximation scheme for solving this problem. This scheme is based on the intelligent selection of aggregated data tree from the candidate set of trees. In addition two simple approaches for generating candidate set of data aggregation tree are also depicted.

4. In [9] L. Yu, presented a scheme, which “Group” Among other stations only the sink effectively and arbitrarily creates a structure of grid cluster to spread queries and packets. A small portion of the node takes part in choosing the head cluster. The head cluster can appropriately combines data to lessen the volume of data packets. “GROUP” also spread the energy burden among the nodes in the network.

5. In [10] Zhao, presented a direct diffusion which mainly concentrate on minimizing the data size recovered from multiple sources by removing redundancy and minimizing the number of transmitted packets over the network. But the issue with this scheme is the recognition of another finest path when the current path is lost.

6. In [11] Hüseyin presented a unique deterministic data aggregation method for wireless sensor network. This scheme employs a deterministic sampling approach in contrast to

arbitrary sampling. The size of resulting sample is relatively less and need minimum communication power which results in enhancing the life of network. Data compression is also utilized as an aggregation approach in such network.

7. Xiao-fei, *et al.*, [12] devised a constant piecewise approximation algorithm for compressing data. Because of minimal packet size, the life of the network is enhanced to a certain limit. The shortcoming of this algorithm is that the data is lost and it is fruitful to particular dimensional period cycle. Data aggregation in tree based network performed at the intermediate nodes and appropriate for applications which need in data aggregation.

8. In [13] Yoo presented a Gradient based routing which is an expansion of direct diffusion in which the life of the network is enhanced by evenly disseminate traffic over the network. In this mechanism, sensor nodes need to computes the number of hops from base station also known the height of nodes. The packets are transmitted over that link those possess largest gradient values. The gradient is achieved by subtracting a node's range from that of its adjacent nodes.

9. In [14] T. V. PADMAVATHY *et al.*, employed coverage-preserving centralized node-scheduling approach to minimize energy utilization and as a result enhances system lifetime, by turning off some redundant nodes. The algorithms employed and let a 2-D region employing arbitrarily a sensor set S = {s1, s2, ..., sn} with a static sensing range r, it operates in three phases. The first part deals with searching the region of every sensor. The second part manages the disjoint set creation planning calculation advancement. The third part manages the job of the incorporated calculation in a given topology with distinctive rates of zone secured.

10. In [15] S. Mahajan adopts two-layered hierarchical chains. In lower layer, ECBSN relay on PEGASIS and adopts various chains. Every chain consists of a leader, the node with the maximum remaining energy. This scheme further links the leader of every lower level chain to create an individual higher layer chain. In the higher level chain, the nodes which possess minimum distance to the base station are elected as higher layer leader, responsible for forwarding the aggregated packet ultimately to the base station. In stage of data communication, the passing of token process of every lower level chain is similar to PEGASIS. At arrival of the collected packet, the leader of every lower layer chain sends to the higher level leader, ultimately sends to the base station.

11. In [16] Sumit Chaudhary implemented an technique which is reliable and effective for data aggregation and gathering of data in wireless sensor network by means of principles like globular weight computation of nodes, gathering of data for every head cluster and data aggregation scheme by utilizing data cube aggregation. Provide the precise usage of battery and low power utilization such that the user can forward various messages in restricted resources. Firstly, selects class of nodes and segment into clusters. These clusters will assure the deliberate parameter requests and circumstances. Afterwards a cluster head (CH) is elected between nodes which surround every cluster. It is the responsibility of CH for supervising all other nodes within particular cluster and gathering the packet by the nodes among the group and relaying the packet to the neighboring head cluster for additional data exchange and upgrading. The recently received nodes will be allotted as head cluster if the globular cost of received node is minimal, or else other cluster nodes will be given chance to take part and globular cost is again recomputed. Subsequently the data aggregation scheme is supposed as the collection of data, variety of queries from the user end are verified and converted into lower level schemes by a query processor. All data gathered and aggregated is kept at a storage location in database

server. At end the data is aggregated by data cube scheme and the entire collected packet are forwarded to the base station.

12. In [17] Dipak Wajgi *et al.*, proposed a clustering technique that is able to balance the load within the cluster by exploiting some nodes, these nodes are referred as backup nodes. These nodes are high energy and high processing power nodes substitute the head cluster after the cluster reaches to its threshold limit. In the proposed scheme the nodes with high energy and processing power are elected initially and among these nodes some set of cluster head are decided depending on their location, every cluster head for creating the clusters define their transmission range in form of power levels. The nodes which consist of similar energy and power level are supposed to go to sleep mode and there information is stored in the cluster head. The nodes which come under the communication range of the head cluster, head cluster floods a hello message so that these nodes can become member of the cluster. All the cluster members will transmit the observed packet to the head cluster. The cluster head transmits the aggregated packet to the Base Station directly or by exploiting some intermediate cluster head. As the energy level of the head cluster ranges to the threshold value, the cluster head will trigger the node that is in its sleep mode this node is then picked as a head cluster. The information about the new cluster head will be broadcasted to the entire cluster member and other cluster head also. The previous cluster head will become the general sensor node. This approach will enhance the network lifetime and achieves high throughput.

13. In [18] Yung-Kuei Chiang proposed CBDAS which stands for cycle based data aggregation scheme for grid based wireless sensor networks. The entire sensor region is segmented into two dimensional cell grid. Each cell contains a head whose is in charge for combining its data with the observed one by other in the similar grid and then transmitting out. In order to capably and quickly forward the data to the base station connect every head cell to create a cyclic chain. Every head cell on the periodic chain takes charge and becomes cycle leader liable for forwarding data to the base station. For every round, when the leader of the cycle demands from the base station, it transmits each direction a token moving among the cyclic chain. When the head cell gets the other token from its opposite direction, it drops the token and disconnects the cyclic chain, creating it as a one end and the other who send the token as the other end. Consequently both the end nodes correspondingly forward their collected data to leader of the cycle in its other direction.

14. In [19] Neng-Chung Wang proposed a grid based data aggregation scheme (GBDAS) for wireless network. In this scheme segment the complete sensor region into a two dimensional cell grid. In every grid, the node which posses the most unconsumed energy is regarded as the head cell, liable for aggregating its own data with the sensed data by alternate node of the cell and after sending it out. In order to reduce the data transmissions to the base station additionally connects every head of the cell to create a chain. The head of the cell in the chain, amongst the remaining energy is selected in turn as the chain leader. Aggregated data proceeds from straight on along the chain, and ultimately the leader of the chain forwards to the base station. In GBDAS, it is the responsibility of the cell heads to forward data toward the base station. Thus packet is forwarded to the base station significantly drop off in addition, to both the head and the leader selected in turn as per the energy level so that the energy reduction of nodes is evenly scattered.

10. Conclusion

Data aggregation is a approach which tries to eliminate the localized congestion problem. It tries to gather essential data from the sensors that surround the event. In this

paper we have conducted a brief study on data aggregation in wireless sensor networks including its pros and cons. Focusing on different types of data aggregation, its different approaches. Presented the requirements and importance's of data aggregation in wireless sensor network. Grid-based Data Aggregation is extremely useful for mobile surroundings where the time period of an event at a certain instance is relatively minimum In future we will enhance the network lifetime using grid based scheme.

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