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A Study of Tree Based Data Aggregation Techniques for WSNs

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Abstract

Wireless sensor network consists of a huge quantity of less-price sensor nodes. These nodes has restricted power of battery, and the replacement of battery is not a simple task in wireless sensor networks because there are a huge quantity of nodes. Data Aggregation is a significant method to attain power efficiency in wireless sensor network. Data aggregation at the sink by all the nodes results in flooding of the data which causes greatest energy utilization. Though a lot of protocols are planned so far to get better the energy efficiency further but still a lot improvement can be made. In this paper, various data aggregation techniques have been discussed. The overall purpose of this survey is to explain data aggregation techniques and to find limitations of General Self-Organized Tree-Based Energy-Balance Routing Protocol (GSTEB).

Keywords*: WSNs, DATA AGGREGATION, GSTEB,TREE BASED.*

I. Introduction

Recently wireless communication technologies continue to develop in various areas to offer novel opportunities used for networking and services. One fastest growth area is WSNs (wireless sensor networks). It contains numerous stations called sensor nodes, which will be tiny, lightweight and transferable. Each sensor node is prepared by means of a transducer, microcomputer, transceiver and power source. The transducer, based on sensed physical effects and phenomenon generates the electrical signals. The microcomputer's work is to processes as well as stores the sensor output. The transceiver's work is to gets commands from a core computer and broadcasts information to that computer. Every single sensor node has a battery to get energy. Due to the progress in micro-electro mechanical systems, sensor devices could possibly be built merely lightweight wireless nodes.

WSNs are highly distributed networks of nodes, and have now been set up in vast quantities to monitor the environmental atmosphere or manufacture systems. There's a rising significance of the sensor nodes to cope with additional technical functions in data acquisition and processing, and a significant requirement for these battery-powered sensor nodes is energy saving solutions. Three chief tasks are achieve through three sensor subsystems the environment sensor; the info processor so as to performs restricted computations on the sensed information; and the communicator that carry out information swaping among neighbouring nodes. Each sensor has limited degree processing power, energy and sensing capacity. However, the sensor network produce a solid, reliable and perfect network. The sensors cooperate amongst each other and can work together, choose leaders, assemble their data and next broadcasts an even more results from the sensing.

Further the paper consists of following sections: Section II explains data aggregation techniques. Section III explains the GSTEB protocol. Section IV presents the literature review. Section V explains limitations of various techniques discussed in literature review and GSTEB protocol. And finally Section VI presents conclusion and future scope.

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II. Data Aggregation Techniques

The sensor nodes collect sensory information via monitoring geographical area. Sensory information in sensor network is combined by sink node by using wireless hop-by-hop broadcast. The right aggregation function is used at sink node used for arriving data from in-between sensors nodes and hence it conserves the energy. Aggregation helps to reduce the total amount of network transfer and to condense energy utilization on sensor nodes. In data aggregation technique as shown in Fig. 1 data collected to sensor node by using aggregation methods.

A. Tree Based Data Aggregation

This approach builds an aggregation tree . This tree is a minimum spanning tree, sink node act as root node along with leaves are assumed as source node. In this technique data is transfer from leaves node towards sink node and aggregation is performed through parent node.

Ex. TAG (Tiny Aggregation) performs the data aggregation procedure by means of queries process. It provides facility for aggregation within distributed, low-power, wireless environments. The working of TAG is divided into two steps:

a) Distributed phase: In this the aggregated queries are pushed down into the network.

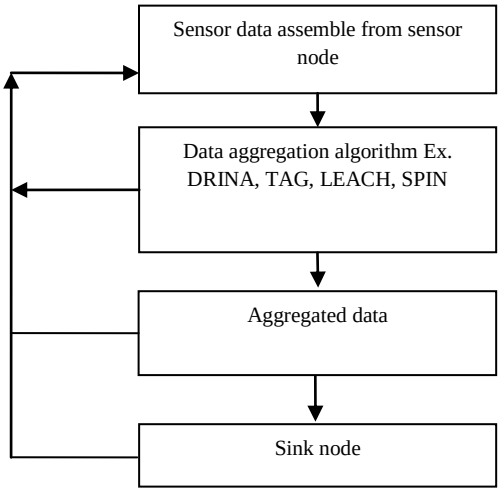

Figure 1. General Structure of the Data Aggregation Algorithm

b.)Collection phase: In this aggregated values are continually routed up from childrens to parents.

B. Centralized Data Aggregation

Data is collecting at middle node in centralized data aggregation technique. For this process it requires the help of shortest pathway by using a multi-hop wireless protocol. The information packets are transmitted to a middle node by the sensor nodes, that can be the powerful sensor node. The head combined the information that is often queried. Every intermediary node has to transmit the information packets starting from the child nodes in the direction of leader. Hence a large number of messages need to be send out for a problem in the most effective case equal to the summation of exterior path lengths for every single node. Ex. DD, SPIN.

a) DD (Direct Diffusion)

It is data-centric protocol that sense data by means of attribute-value pairs such as for duration, geographical area, and interval.

b) SPIN (Sensor Protocol for Information via Negotiation)

It make use of meta-data. Meta-data are swapped amongst sensor nodes using a information announcement method prior to broadcast.

C. Cluster Based Data Aggregation

This process composed of hierarchical structure of nodes where sensor nodes are splitted into clusters with some particular nodes to act as a cluster head that are selected to combine data and onward it to the sink. Ex. LEACH, HEED

a*) LEACH (Low Energy Adaptive Clustering Hierarchy)*

It is initial protocol which is based on cluster. It runs into different rounds. Every round has two steps; first step is cluster setup which made the cluster in self adaptive mode, furthermore second step is steady phase that used for data transfer. Through the setup phase, all nodes will come to a decision whether becoming a Cluster Head or not. When CHs are selected, all of the other nodes will pick a unique CH and adhere to the cluster based on the power of various received broadcast messages. Through the steady-state phase, cluster heads merge the data obtained from their cluster member and broadcast the combined data to BS by single-hop communication.

b) HEED (Hybrid Energy Efficient Distributed)

In HEED primary parameter is residual energy and secondary parameters are network topology characteristics. It is used to crack tie among candidate CHs, as a metric for cluster selection to accomplish load equilibrium. In this all nodes are consider as homogenous. Every one sensor nodes has identical initial energy. HEED is a marked enhancement of LEACH on the types of cluster head selecting .In every round, HEED selects cluster heads based the left over energy of each one node and a secondary parameter for example nodes closeness to their neighbours or nodes degrees. HEED make sure merely 1 cluster head in just a definite range, as a result identical CHs distribution is accomplished over the network. HEED effectively enhance network life span and is suited to condition such as where each node has different initial energy as Compare to LEACH.

D. In Network Aggregation(INA)

In the scenario of wireless sensor networks, INA uses various ways for transfer the packets of data starting from intermediate nodes towards the sink node and this data is gathered from different source nodes. The aim of routing protocol related with data aggregation is just a main component for INA. The thought of this type of data aggregation is to aggregate the data needed for the calculation of the derivatives as near to the source as possible. In this sensor node, that has high power are elected as aggregator. INA considers the fixed predefined grid or area for aggregation of data. This method is appropriate for fixed nodes and not for movable nodes. It is not easy to recover the original information because of in network processing such as compression, filtering and grouping which loose the correctness .

III. GSTEB Protocol

General Self-Organized Tree-Based Energy-Balance Routing Protocol (GSTEB) constructs a routing tree via a procedure in which for every single round, BS (base station) allocates a root node and transmits root node's selection to every sensor nodes. Then, every one node chooses its parent by taking into consideration simply itself as well as its neighbours information, as a result making GSTEB a powerful protocol. Simulation end results reveal that GSTEB include a improved performance as compared to other protocols in balancing energy utilization, hence prolong the duration of wireless sensor network.

It considers a condition where in the network collects information at regular intervals from a topography in which each one node continually senses the surroundings and transmits the data back to base station. Network life span has two definitions in general:

a) The moment starting from the begin of the network process to the death of initial node within the network.

b) The moment starting from the begin of the network process to the death of very last node within the network.

Two extreme cases in data fusion are:

Case(1): The data among any sensor nodes can be completely fused. Each one node broadcasts the identical quantity of data despite how much data it obtains from its children.

Case (2) The data cannot be combined. The length of message broadcasted by every relay node be the total of its individual sensed data as well as obtained data from its children.

The chief plan of this protocol is to achieve a longer network life span for diverse applications. In every round, base station allocates a root node and transmits root's identification and its coordinates to every sensor nodes. After that the network computes the path either through transmitting the path information from BS to sensor nodes or by having the same tree organization being dynamically and independently built by every node. For both cases, GSTEB can modify the root and restructure the routing tree with little delay and little energy utilization.

IV.Literature Review

N. Li et al. [1] planned a novel technique - Adaptive Data Aggregation Mechanism (ADAM) - based on a single characteristic in WSNs on Low Energy Adaptive Clustering Hierarchy (LEACH) protocol: the similarity of data sent from neighbouring nodes. Adopting ADAM, the cluster head examined the statistical characters of packets received from nearby nodes to achieved the optimal aggregation parameters, breaked the data into blocks and then used a smaller data sample to symbolize repeated blocks in communication in order to minimize inter-node level redundancy. At the sink, applied the inverse-operation, the original information can be completely recovered. The exact message designs, the algorithm and also the factors for example frame size as well as block size were formulated and tested. And from the reproduction, proved the efficiency of ADAM in realized data combination through significant compression proportion and as a result expanded the lift-time of the networks.

F. Nawaz et al. [2] proposed a data aggregation & routing protocol for Wireless Sensor Network (WSN) that was mainly appropriate to mostly deployed wireless sensor networks. This method combined hierarchical design of the LEACH protocol with a gradient based routing method. By means of merging these two protocols and acquiring the significant aspect of node power (energy) into concern while choosing the cluster head, a strong approach for data aggregation as well as routing was developed. Simulation outcomes showed that the planned protocol enhanced the WSNs performance in two methods. Earliest, the data aggregation quality reduced 75% load of data lying on the sensor network and next, cost aware multi-hop communication and energy aware clustering enhanced the life span of network in contrasts to LEACH routing protocol.

D.Mantri et al. [3] proposed and evaluated the group based data aggregation technique, in which grouping of nodes based on existing data and relationship in the intra-cluster and combination of CH at the network level helped to reduced the energy consumption. In addition, proposed method used additive and dividable data aggregation function on cluster head the same as in-network process to reduced energy consumption. Cluster head transmitted aggregated data in the direction of remote sink as well as cluster

head nodes transmitted data towards CH. Simulation result showed that, proposed algorithm provided an enhancement of 14.94% in energy utilization as compared to main cluster based protocol LEACH which used only single CH, it in addition also improved the network stability.

J.Peng et al. [4] In wireless sensor network (WSN) energy efficiency was one of the most important issues. Because the power mostly dissipates in case of data broadcast, the data communication had turn into the most significant subject of wireless sensor network in recent times. Otherwise, the data precision was one more key aspect of data communication. In order to optimize these aspects, a good routing protocol was projected. The planned algorithm was created from LEACH, and power effectiveness and latency was considered as the researching factors in this. The overlap of detect regions was examined and a nodes-adaptive programme was planned to reduced the quantity of data with LEACH protocol.

B. S. Mathapati et al. [5] proposed a novel protocol called An Energy Efficient Reliable Routing Protocol for WSN which be cluster based. Data combination was fundamentally employed to collect and combine data in an energy efficient way so that network life span was improved. The protocols of data aggregation aimed to eliminate redundant data communication. Power utilization was a very significant feature to be considered in case of data collection which was a limited source and were irreplaceable. Besides power utilization, reliability was also of main concerned in case of data aggregation. Initially they created clusters as well as a CN (coordinator node) was chosen close to the cluster so as to examine the nodes within cluster. The coordinator node select a cluster head in every cluster depending on the power level as well as the distance towards the coordinator node. The packets of data transmitted via the nodes are combined at the cluster head and sent out to the coordinator node . The coordinator node calculated the loss percentage and compared it by a threshold value of the loss percentage. Based on this value, the forwarded node calculation was increased or decreased and the cluster volume was adaptively modified, make sure reliability as well as balanced power utilization.

D. Kumar [6] proposed and evaluated two new protocols which are clustering based for various wireless sensor networks, which were called S-EECP (single-hop energy-efficient clustering protocol) and M-EECP (multi-hop energy-efficient clustering protocol). In case of S-EECP, the cluster heads were selected by a weighted possibility depending on the proportion among remaining energy of every node as well as normal power of the network. The sensor nodes which has more preliminary power and remaining power contain additional probability to be selected as cluster heads as compared to sensor nodes with low power while in case of M-EECP, the selected cluster heads send the packets of data in the direction of the BS through multi-hop transmission method. Finally, reproduction results indicated that this protocols prolonged network life, and achieved load equilibrium amongst the cluster heads superior as compared to the other clustering protocols.

Z.Han et al.[7] proposed a General Self-Organized Tree-Based Energy Balance routing protocol (GSTEB). In this a routing tree is built by means of a method in which, for each one round ,base station assigned a root node and broadcast this selection to all other nodes. Then, every node choose its parent by taking into consideration simply itself as well as its neighbours information, as a result prepared GSTEB a great protocol. Simulation end results showed that this protocol enhanced performance as compared to other protocols in balancing power utilization, thus prolonged the duration of wireless sensor network.

S. Rani et al. [8] proposed Energy Efficient Inter Cluster Co-ordination Protocol(EEICCP) which is based on a layered technique designed for the clusters and communication amongst the clusters all through cluster heads and cluster coordinators is prepared. They investigated the impact of uniform densely deployed network with new

approach of layering of clusters by inter cluster coordination in condition of energy, time, reliability and complexity within wireless sensor networks that were hierarchically clustered. Assumptions were made about the nodes that they were arbitrarily distributed and were static, they had identical level of energy, base station's coordinates and the dimension of the WSN area were well-known. Selection sort by split and conquer approach was used to perform the preceded work of EEICCP.

A. Jain et al. [9] aimed to define a novel centrality metric "cluster optimal degree centrality". Their proposed centrality metric addressed the optimal numbers of member nodes along with energy efficiency of a cluster. Finally based on the definite centrality metric, a Fuzzy Inference method based cluster head(CH) selection technique had been proposed. The new results had established that the method can successfully prolonged the network lifetime and enhanced cluster head selection and resulted in high throughput as compared to LEACH, Cluster Head Election Mechanism using Fuzzy logic (CHEF) and Low Energy Adaptive Clustering Hierarchy-Expected Residual Energy (LEACH-ERE). They had proposed a new procedure of clustering based upon cluster optimal degree centrality and expected residual energy.

M. Saxena et al. [10] proposed an energy aware algorithm based on clustering for longer time of MANET (Mobile Adhoc Network). In this method network was divided into small and self controllable groups used for enhanced network lifetime. The projected algorithm would be an energy efficient clustering algorithm which used both scalability as well as energy metric for cluster layout. Maxheap was used for choice of cluster head. The Clusters were designed using max-heap on the basis of energy level; the node which had the highest energy in the cluster will acted as a cluster head.

M. Samanta et al. [11] proposed a method to hold fault tolerant by function division. firstly, the entire network was considered as a set of clusters. One cluster head was selected from all cluster and later some of its functions were spreaded among its two neighbours. This was achieved in a manner that the power utilization of the sensor network gets minimised. In the course of reproduction they had recognized that proposed schema reduced the cluster head load and prolonged the network life span.

K. Nitesh et al. [12] proposed an algorithm for introduction of minimum number of relay nodes with complete coverage and connectivity of the wireless sensor network with the limit of diminishing the whole communication price. The algorithm was based on spiral sequence generated for randomly deployed sensor nodes. The simulation results established the effectiveness of the algorithm. The proposed algorithm was based on spiral series generated out of the set of coordinates of the sensor nodes. The investigated results had been compared with the existing algorithm CRNSC (Connected Relay Node Single Cover) and the optimal solution. They had showed that the results of algorithm were very close to that of the optimal solution and improved than CRNSC under various scenarios of sensor scope and density.

Y.Xu et al. [13] projected a paradigm for power-efficient object tracking sensor network called the localized prediction paradigm. Localized prediction consisted of a localized network design as well as a prediction method named as dual prediction, that achieved energy savings through permitting a lot of the nodes kept on sleep mode and through reducing the total quantity of transmissions that are long -range. Performance estimation, centered on mathematical investigation, revealed that this paradigm can dramatically reduced the energy utilization in object tracking networks

O. Younis et al. [14] offered a protocol, HEED (Hybrid Energy-Efficient Distributed clustering), which at regular intervals chooses CHs depending on a remaining energy as well as based on another factor, that is node quantity or node proximity to its neighbours. They proved that by means of correct boundaries on node concentration as well as intra-cluster broadcast scopes, this protocol can asymptotically guaranteed joining of cluster networks. The end results demonstrated that their planned method was effective

in increasing the life span of the network as well as supporting scalable information aggregation.

O. Younis et al. [15] highlighted the challenges in case of clustering a WSN, as well as discussed the design foundation of various clustering approaches. They have also classified the proposed methods depending on the goals as well as design standards. They also discussed numerous key matters that affected the realistic use of clustering methods in wireless sensor network applications.

I.Wirjawan et al.[16] Virtual machines (VM) were promise in sensor networks as system software. Performance overhead was a chief obstacle for their extensive acceptance. Compiling the Virtual Machine bytecode to the local code addressed this, nevertheless increased footprint as well as code circulation expenses. As a result, there clearly was an essential trade-off among computing cost and communication cost as a result of code distribution. They illustrated a distant JIT (Just-In-Time) compilation facility that had been valuable in assembling interpretation by means of local execution to attained an proficient hybrid execution configuration.

B.Gedik et al.[17] developed Adaptive Sampling Approach (ASAP), which was method of adaptive sampling of energy-efficient periodic information gathering within sensor networks. The chief aim of ASAP was to make utilization of a dynamically changed node's subsets like samplers. Due to this the sampler node's sensor readings were straightly composed, but the non sampler node' values were guessed via the usage of probabilistic models that had been locally as well as cyclically built.

M. Tahir et al. [18] addressed the subject of network life span maximization for a particular category of WSNs that is wireless multi-media sensor networks. More data rates, within these sensor networks on the nodes, as contrasts to the conventional networks as well as the clear occurrence of more temporal relationship within the sampled data made them an appropriate applicant for the in-network processing, mostly at the wireless sensor node itself.

K. Guan et al. [19] In case of wireless sensor networks , multi-path direction-finding will get numerous paths starting from resource node towards sink node. A original multi-path direction-finding protocol within wireless sensor networks was planned, that can discovered many paths with more energy effectiveness. Performance investigation plus end results showed that planned protocol had superior performance compared to the existed protocols.

O. Younis et al. [20] proposed novel energy-efficient technique designed for clustering nodes in ad- hoc networks. Centered upon this method, they presented Hyhrid Energy-Efficient Distrihuted clustering (HEED) protocol, that at regular intervals select CHs according to a mixture of their left over power as well as secondary factor, for example node degree or node proximity to its neighbours. HEED did not made any guesses about the circulation or thickness of nodes.

V.Limitations of Reviewed Techniques and GSTEB Protocol

The review has found that the majority of algorithms has the following limitations:

Artificial bee colony:-As the tree based routing require shortest path between the source and the sink, but shortest path problem is NP-Hard in nature. Therefore the Artificial bee colony is required to enhance the GSTEB protocol further to find shortest route.

Clustering: The use of clustering has also been ignored in GSTEB routing protocol, so clustering is required to reduce the redundant data.

Dense networks: GSTEB has only applied on the small networks, the effect of dense network has been ignored in the GSTEB protocol.

VI. Conclusion and Future Scope

The survey concludes that the GSTEB has shown significant results over the available WSNs protocols to a certain extent. But it has ignored the use of the three things, as is known the tree based routing need shortest path among the source and the sink, but shortest path problem is NP-Hard in nature. Therefore the Artificial bee colony is necessary to improve the GSTEB protocol to find shortest way. The use of clustering has also been ignored in GSTEB routing protocol, so clustering is necessary to decrease the redundant data. GSTEB has simply applied on the small networks; the effect of dense network has been ignored in the GSTEB protocol. Therefore in near future, to overcome these issues, a new clustering and artificial bee colony based protocol may be proposed.

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