A Spatio-Temporal Correlation Based Routing Technique for Wireless Sensor Network

Sushma K. M, Manjula Devi T. H

Abstract— this paper gives a routing technique for wireless sensor network. In WSNs, the old routing techniques of networking are not applicable because of the various challenges. Hence, many different methods have been devised. Proposed technique is the routing technique with spatial and temporal correlation of data aggregation. This is a technique based on Clustered Aggregation existing in WSN, which is a method to save energy significantly. Energy consumption must be low in WSNs because the sensor nodes are energy constrained devices.

Index Terms— Clustering, Data aggregation, Routing, Wireless Sensor Networks.

I. INTRODUCTION

Wireless Sensor Network consists of huge number of nodes deployed over a large area of interest. They are used for different applications, are application-specific in many cases. The nodes as called usually comprise of ADC, microcontroller, sensors and battery. The battery is the main source of power, and it's limited. Hence network life time of network depends solely on the nodes energy consumption. There are many methods devised to reduce the energy consumption of these sensor nodes. More is the transmission-reception., more is the energy consumed is a Simple logic. The amount of energy required for communication is significantly more than it is required for processing the data. Therefore, if it's possible to reduce the number of communication without affecting the information quality, energy can be saved. One approach towards this is Data Aggregation. Data Aggregation helps to remove redundancy in the data sensed by the nodes. There are mainly two approaches of data aggregation based on the network structure. They are: Hierarchical aggregation, Cluster-based aggregation. In hierarchical approach, as the name says, the routing structure is hierarchical, aggregation happens when data is gathered from the child node by a parent at the next level of tree. An example for this kind is Shortest Path Tree (SPT). Cluster-based approach is one where groups of nodes are formed and one particular node within the group becomes a head. There are many techniques recently developed in this approach. Our proposed method is also one such. There is also one more approach, which is not based on any particular structure though. An example is DAA, Data Aware Anycast Routing. Here, data is forwarded to any next node of interest. Spatial and temporal correlation based data aggregation helps to reduce the transmission of redundant data.

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Over a particular region, the densely deployed sensor nodes sense mostly similar readings. Hence it may be transmitted avoiding redundancy. The grouping of nodes can be managed to have groups based on sensor readings, thus nodes which carry same data will be in one cluster and redundant data is eliminated with cluster head transmitting a single value for each cluster. The chance of having same data transmission over a time is also possible. Hence, temporal correlation of data aggregation leads to elimination of redundancy over a time

II. PROCEDURE OF THE ROUTING TECHNIQUE

It has following steps:

- Configuration step
- Clustering state along with head identification
- Route Establishment
- Data Transmission

Algorithm of the proposed method

1: Network Configuration Process;
2: **if** event occurs **then**
3: start Cluster Formation Process and Leader election;
4: Route Formation starts;
5: start Data Transmission;
6: once at stretch interval;
7: go to step 2;
8: **end**

A. Configuration Stage

This stage is to set up the network. This starts by sending a message called Hop Configuration Message (HCM). Sink starts sending this message which has two fields. One consists of node ID; another consists of hop count, HTT. Sink keeps HTT value as 1. All other nodes keep that value as infinity. Each node compares its HTT value with the one which it stores. The lesser value is stored. ID field is changed with the node ID, HTT is incremented and forwarded. This process goes on till whole network knows the next node and hop distance to sink.

Algorithm for Configuration Stage

1: node u receives HCM
2: **if** HTT (u) < HTT(HCM) **then**
3: next Node (u) = ID(HCM);
4: HTT(u) = HTT(u) +1;
5: ID(HCM) = ID(u);
6: HTT(HCM)= HTT(u);
7: forward to next Node;
8:**else** discard HCM
9: **end**

B. Clustering Stage

For exploiting spatial and temporal correlation, Clustering of nodes happens based on the sensor readings. A Cluster

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Formation message (CFM) is sent by the node that senses the event first and calls itself a leader. Then the node that receives this will check the Head Reading sent in that CFM message. If its local reading comes below the head reading then the node becomes member. And forwards the CFM .Else it's a leader of its own and starts sending CFM in its Head Reading. The node later checks for HTT number, if it's HTT is lesser than the HTT of node that sent CFM, it becomes a Cluster Head. And forwards the CFM. Likewise, nodes with almost similar sensor values come in one group. The leader does aggregation of the data from nodes in cluster and sends to next node in the path.

Algorithm for Clustering

1: u is leader;
2: sends CFM message;
3: node w receives CFM;
4: if LR(w) < HR(CFM) then
5: w is member;
6: send CFM;
7: if HTT(w) < HTT(u) then
8: w = leader;
9: else HTT(w)==HTT(u) and ID(w) < ID(u)
10: w is leader;
11: else if discard the CFM
12: else LR = HR
13: w is leader;
14: send the CFM;
15: end if
16: end

C. Route Formation

Here, a route to sink to forward the data is found out. This starts by sending Route establishment message. The node that receives the REM, will make its HTT value as zero and becomes a part of the route being formed. This node further forwards the REM. Along with this hop updating starts. The node that received REM will also send a HCM with HTT equal to one. The node upon receiving will follow the Hop Configuration Procedure explained in section 2.1. This helps later finding an existing path to attach that increased the data aggregation.

Algorithm for Route Formation

1: Cluster head, v of new event region sends REM
2: u = Next node (v) receives REM;
3: u = relay;
4: HTT= 0;
5: send REM to next Node;
6: start hop update with HTT = 1;
7: **if** next node(u) == sink||old route **then**
8: start data transmission;
9: else goto 3
10: **end**

D. Data Transmission Stage

The data transmission includes forwarding the aggregated data or data to the sink node. The cluster head will aggregate the data from its member nodes. The aggregation function considered is MAX. An aggregation function can be any function that has got two inputs like sum, average etc. Whenever the node has data, it checks if any child node present for that node. It waits for the child node to send the data and aggregates the collected data and sends to next hop. After some time, if it does not receive any data from the child node it will forward its sensed data. Every time the data is sent, an Acknowledgment is received from the next node. If the Acknowledgement is not received before a timeout, then the node sending the data will assume the next node to be dead. In that case, a next node with lower HTT value must be chosen. In case a tie occurs, then node ID or energy is considered. After a Stretch time, the new clusters with new sensor readings are formed. Thus, correlated data within the Stretch time are removed. As said, to insert images in *Word*, position the cursor at the insertion point and either use Insert | Picture | From File or copy the image to the Windows clipboard and then Edit | Paste Special | Picture (with "Float over text" unchecked). The authors of the accepted manuscripts will be given a copyright form and the form should accompany your final submission.

III. PERFORMANCE ANALYSIS

Network Simulator 2 is used for simulation of algorithm. The proposed technique is compared with the existing methods DRINA, InFRA, SPT.

Control Overhead

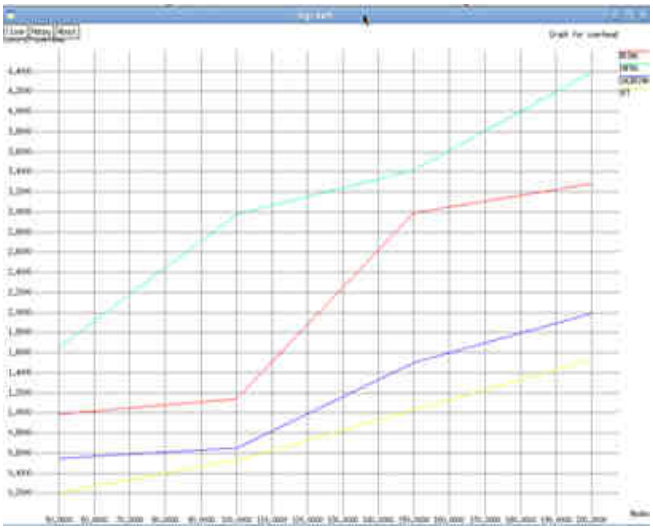

Fig. a: Graph for Overhead vs Network Size

Data Packets

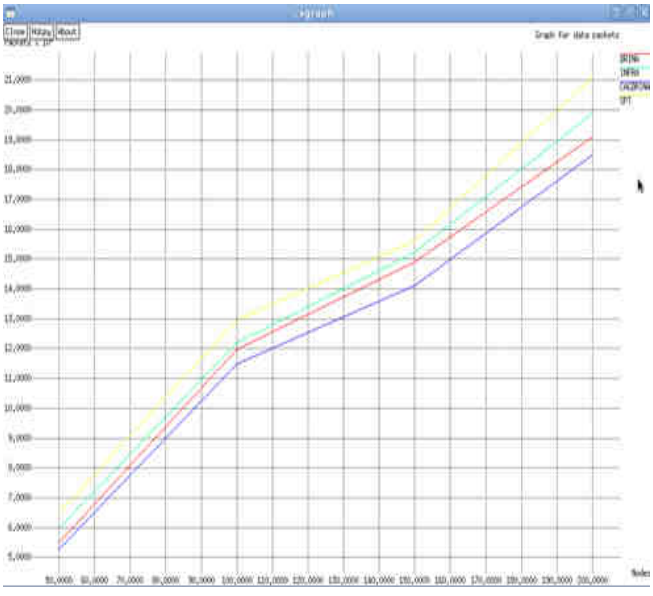

Fig. b: Data packets vs Network Size

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Efficiency

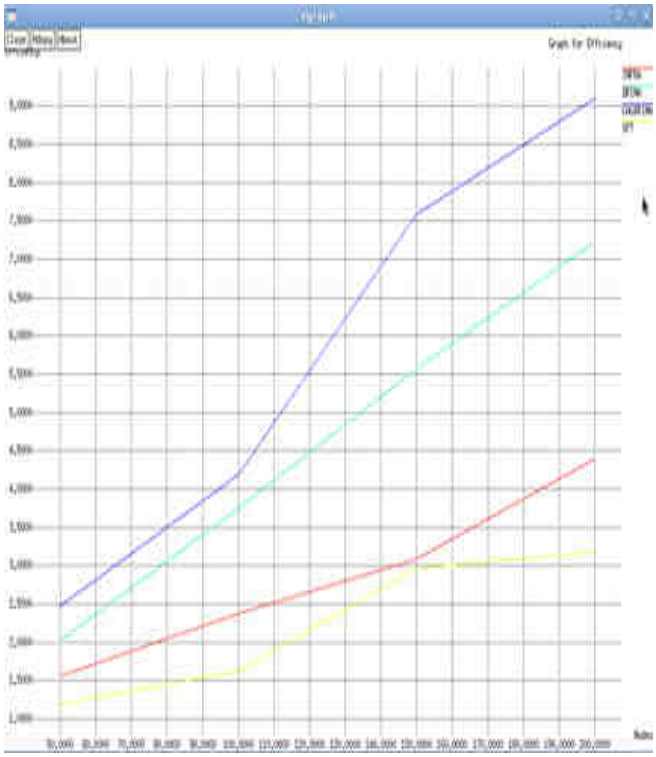

Fig. c: Graph of Efficiency vs Network Size

The figures, a,b,c show performance of the proposed method for parameters like overhead, data packets, efficiency. The algorithm is compared with existing methods like DRINA, InFRA, and SPT. Fig a, shows that overhead is reduced in the proposed compared to other methods. This is due to lesser control message transmission. Though SPT has lesser overhead than the proposed method, the performance is improved compared to DRINA. Other metrics like efficiency and data packets are improved than SPT and other two existing methods

Data Packets

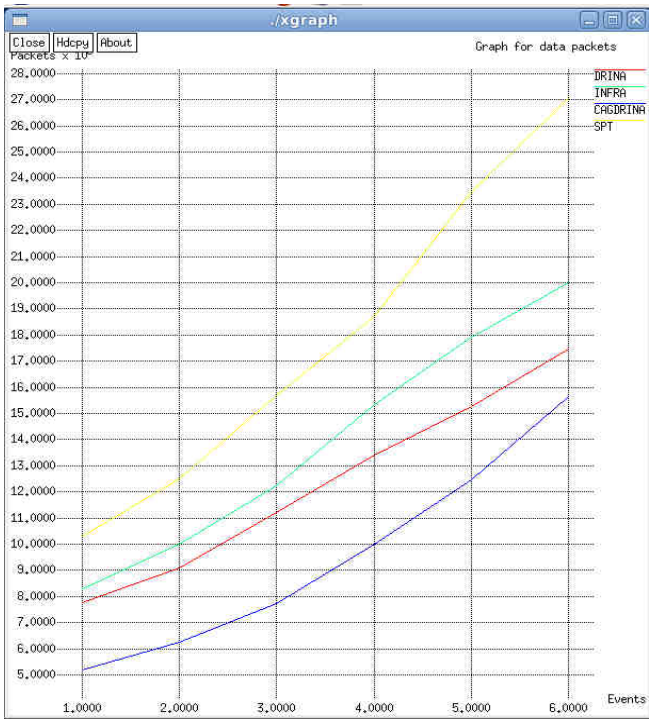

Fig. d: Graph for data packets vs # events.

Overhead

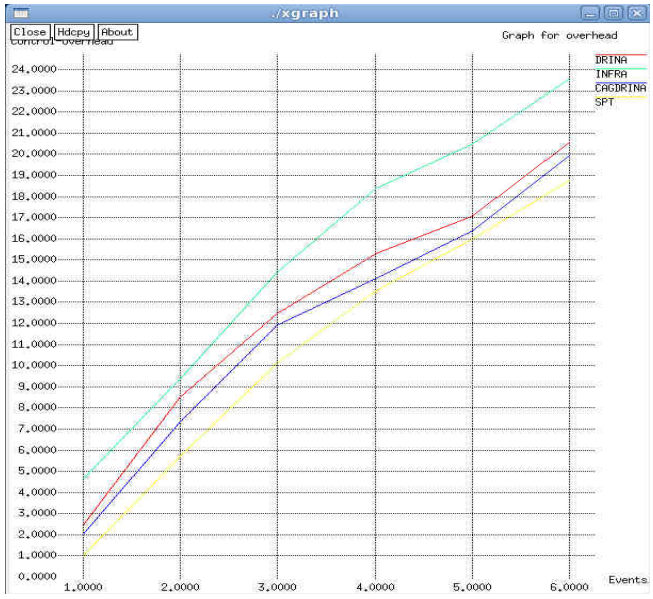

Fig. e: Graph of Overhead vs # of events.

Fig d, e gives the graph for data packets and overhead with respect to number of events. The proposed technique has improvements in parameters even with increase in traffic.

IV. CONCLUSION

This paper gives a method to include spatial and temporal correlation in a possible manner. This kind of aggregation is needed to reduce the energy requirements in Wireless Sensor Network. Aggregation reduces redundancy of data present over a region. Since, the control message transmission is stopped till the stretch time completion, overhead is also reduced. The data within this stretch time is correlated. Hence, redundant data is removed. This routing technique can be improved by considering security issues. This is although reliable by using Acknowledgement based route repair mechanism. There can be further inclusion of cryptography methods, to provide more security. There can be real time experiments of this to check with any issues when using measured data.

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