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Improved reliable energy efficient data aggregation in WSN

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Abstract: In wireless sensor networks, data aggregation is very important for reducing the quantity of data transmitted and prolonging the lifetime of wireless sensor networks. Data aggregation aims at eliminating redundant data transmission. Power consumption is an important aspect to be considered in the data aggregation which is a scarce resource and they are irreplaceable. In this paper, an improved reliable and energy efficient data aggregation technique in Wireless Sensor Network has been proposed which is based on clustering. Initially we form clusters and a coordinator node (CN) is selected near the cluster in order to monitor the nodes in the cluster. The CN selects a cluster head (CH) in each cluster based upon the energy level and the distance to the CN. The packets sent by the sensor nodes are aggregated at the CH and transmitted to the CN. The CN measures the loss ratio and compares it with a threshold value of loss ratio. Depending upon this value, the forward node count is incremented or decremented and the cluster size is adaptively changed, ensuring reliability and balanced energy consumption.

Keywords: Data Aggregation, Cluster Node, Cluster Head.

I. INTRODUCTION

In data aggregation, the aggregation processes are used to aggregate the sensor data effectively. Data aggregation techniques enhances the network lifetime by gathering and aggregating the data in an energy efficient manner. A striking method for data gathering in wireless sensor networks involves distributed system architectures and dynamic access via wireless connectivity. In the case of energy constraint wireless sensor networks, the data aggregation techniques intend to eradicate the redundant data transmissions thereby improving the lifetime of the network. [1] Due to that the sensor nodes are tightly packed in the sensor networks, there are possibilities for the nearby sensor nodes to overlap sensing ranges. Because of this, redundant or correlated data are collected by the sensor networks. In order to save the energy, the data correlation is subjugated which effectively reduces the amount of data transmitted in the network. In wireless sensor network routing, data aggregation proves to be an important aspect. The data originating from different sensor nodes aggregate together in the sink node during transmission. [2] The main purpose of the data gathering in wireless sensor network (WSNs) is to obtain valuable information from the operating environment. It has been proven that the data redundancy can be eradicated and the communication load can be reduced using the data aggregation techniques. Multiple data sources and a data sink are included in the typical communication patterns of data aggregation.

A data aggregation tree is constructed using the transmitted packet and this is similar to the reverse multicast structure. [3] Advantage of Data Aggregation: Robustness and accuracy of information acquired from the network can be improved effectively. The data aggregation requires the data fusion processing in order to reduce the redundant information which is present in the data collected from the sensor nodes. Traffic load is minimized and the energy in the sensors can be conserved with the help of data aggregation. Disadvantage of Data Aggregation: The cluster heads are also known as the data aggregator nodes which combine the data in order to send it to the base station. There are chances of malicious attackers in the cluster head or the aggregator node. The accuracy of the aggregate data sent to the base station cannot be guaranteed when the cluster head is compromised. The uncompromised nodes send several copies of the aggregate result to the base station which increases the power consumed at these nodes. [4].

In this paper, we proposed to develop A Cluster Based Reliable and Energy Efficient Routing Protocol for Wireless Sensor Networks which is energy efficient and reliable. This technique is based on cluster formation and the loss ratios of the clusters are measured so that the energy consumption can be effectively reduced. Reliable transmission can be provided in the clusters using a coordinate node. The reminder of this paper is organized as follows. In Section II, we introduce previous work related to our study. Section III gives description of proposed protocol. The simulation results in Section IV and in Section V paper conclusion is given.

II. RELATED WORK

Volker Turau et al [6] have presented the design and preliminary evaluation of a reliable data gathering service of periodic data in the face of poor link quality and frequent disconnects. The data is buffered by persistent storage provided by the nodes using services based on a packet-level, and hop-by-hop routing protocol. This design also provides an upper limit for sampling rate that is handled reliably.

Hemant Sethi et al [7] have proposed an Energy Efficient Interest Based Reliable Data Aggregation (EIRDA) Protocol for WSNs. Here each cluster considers the uniform distribution of sensor nodes using EIRDA which is a static clustering scheme. Beta-distribution function is used to provide reliability with the help of Functional Reputation concept. The overall impact of all measures taken at each phase of protocol implementation is clearly visible on the energy spent in the setup phase of the protocol.

Padmavathy. T.V et al have proposed an energy efficient and reliable routing protocol (EERR), which uses hierarchical clustering and to develop it we introduce a set of cluster heads and headset in which two phases namely election phase and data transfer phase are considered. During the election phase a head-set consisting of several nodes is selected and in the data transfer phase the headset member receives data from the neighboring nodes and transmits the aggregated results to the distant base station, which is done on a rotation basis. The results showed that the energy consumption can be decreased and the lifetime of the network is also increased.

III. PROPOSED WORK

To overcome our previous certain issues on data aggregation, we provide an efficient energy based and reliable data aggregation technique in the wireless sensor network. This technique is based on cluster formation and the loss ratios of the clusters are measured so that the energy consumption can be effectively reduced. Reliable transmission can be provided in the clusters using a coordinate node. Clustering has been proved to be an effective method to increase the lifetime of WSN.

In this dissertation, we propose to develop a data aggregation technique which is energy efficient and reliable. Initially a cluster is formed and the cluster head is selected based upon the cost value. The nodes in the cluster maintain a Neighbor information table (NIT) containing Node id, Distance and Cost. This NIT information is sent to the cluster head. Each cluster selects a coordinator node (CN) randomly in the network which is closer to the cluster and monitors the operations of the sensor nodes and commands them for specific operations. The cluster head aggregates the data and sends it to the CN.

The CN calculates the loss ratio which is the ratio of number of packets dropped and total packets broadcast from the source. Based upon the loss ratio, the cluster size can be modified and the forward node count of each node can be incremented or decremented. Once the cluster size is changed, the CN gathers the information again from the cluster head compresses it and sends it to the sink. Since the loss ratio is measured at the CN itself, the energy consumption can be effectively reduced. Also the reliability can be increased due to altering the cluster size before the data is transmitted to the sink.

Cluster Head Selection

- Initially the sensor nodes are arranged into clusters and the CN selects the cluster head for each cluster.
- Numbers of neighboring nodes M are determined by the CN based upon the node density.
- The sensor nodes transmit the M number of nearest neighbors to the CN.
- Received signal strength indicator (RSSI) estimates the distance to the nodes.
- The CN selects the candidate set of cluster heads (SCH) in each cluster.
- The request for the candidate set of cluster heads is sent by the CN and the sensor nodes reply their cost value (CV).
- Each candidate cluster head node calculate it’s own CV based on residual energy, and distance to coordinator node, and send it to CN. Calculation of cost value.
- The coordinator node selects a node as cluster head among candidate set of cluster heads for each cluster based on CV. The higher the CV a node has; greater the chances of being cluster head. The CN confirms each cluster about their CH.

In this figure 1, we assume a cluster with three sensor nodes. The CN sends a request for the nodes in the cluster. The cost value of the sensor nodes 1, 2, and 3 are sent back to the CN. The node having higher CN becomes the Cluster head. Here the node 1 has CV value as 7 and it is elected as the CH for the cluster and the CN sends this information to other Clusters.

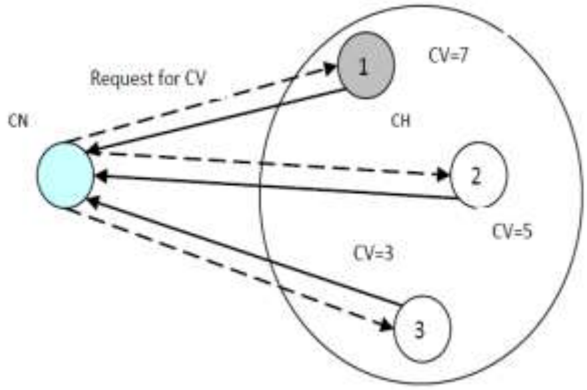

Figure 1: Selection of Cluster Head

Cost Value Calculation:
The Cost value (CV) is calculated based on following criterion:

Residual energy (E) :
The residual energy of a node preferably is greater than the approximate energy dissipated in previous round by the cluster head.

Distance to coordinator node (D):
The nodes having less distance from coordinator node should have higher probability to become cluster head. As energy consumption is directly proportional to the square of distance. Cost value is based on the residual energy and the distance to the coordinate node. The cost is maximum when the residual energy is high and the distance to the coordinator node is less.
$CV = (a \times E) + (b \times (1/D))$ ………. (1)
Where a and b are normalization constants.

3.3 Loss Ratio Calculation

QoS is a set of service requirements to be met when transporting a packet stream from the source to its destination. Quality of service (QoS) is defined as "the capability to provide resource assurance and service differentiation in a network". Quality of Service (QoS) in WSN aims at providing better networking services over current technologies such as ATM, Ethernet and others. The main three parameters for QoS are latency (delay), jitter and loss. Other QoS parameters include reliability, responsiveness, mobility, power efficiency network availability and bandwidth . Qos Parameter we have considered are Delay, Loss Ratio, Reliability. Each node maintains a forward node count (CFN), which denotes the broadcast or rebroadcast probability. Initially CFN [Nk] = CFNmin, for all nodes Nk, k=1, 2……. CFNmin is the minimum number of forwarding nodes. Without loss of generality, we can assume that CFNmin =1. The steps involved in the adaptive energy efficient forwarding phase are given below:

- Suppose N wants to send the collected data to the sink, it attaches its cost to the data packet and broadcast the packet to the nearest neighbors.
- When a neighbor N1 receives the packet from N, it first checks its cost is less than that of N. If it is less, it further forwards the packet. Otherwise it drops the packet, since N1 is not towards the direction of the sink.
- When the packet reaches the destination D, it measures the loss ratio (LR), which is the ratio of number of packets dropped and total packets broadcast from the source.
- Then D sends this LR value as a feed back to the source N.

When N receives this value, it checks the value of LR. It then modifies the value of CFN as $CFN = CFN + \gamma$, if $LR > LRmax$. ………. (2) Where γ is the minimum increment of decrement count and LRmax is the maximum threshold value of loss rate. It then rebroadcast the data packets with the incremented CFN, so that increasing the reachability of the sink. The total power required to reach the sink is thus calculated based on the cost field of all the nodes in CFN. For example, if CFN =4, then the minimum required power will be 4 * cost of each neighbor node in the NIT. When the rebroadcast packets reach the destination D, it again calculates the loss ratio LR and sends back to N. It then reassigns the value of CFN, depending on the value of LR. Once LR < LRmax , then CFN = CFN - γ, until CFN >= CFNmin ……….. (3) In figure 2, the calculation of loss ratio is explained. The nodes in cluster 1 send their data to CN1. The CN 1 calculates the loss ratio as explained in section 3.3. Similarly the loss ratio of clusters 2 and 3 are calculated. The loss ratios for all the clusters are calculated in the CN. We assume that the loss ratio for the cluster 1 is greater than the threshold value, the loss ratio for the cluster 2 is same as the threshold loss ratio and the loss ratio in the cluster 3 is less than the threshold value. In figure 3, the forward count of the node is reassigned based upon the loss ratio. In cluster 1, since the loss ratio is greater than the threshold value, the forward node count can be increased and thus one more node is included in the cluster. In cluster 2, the forward count value is maintained as the same. In cluster 3, the loss ratio is lesser than the threshold value and the forward node count is decremented. One sensor node is excluded from the cluster.

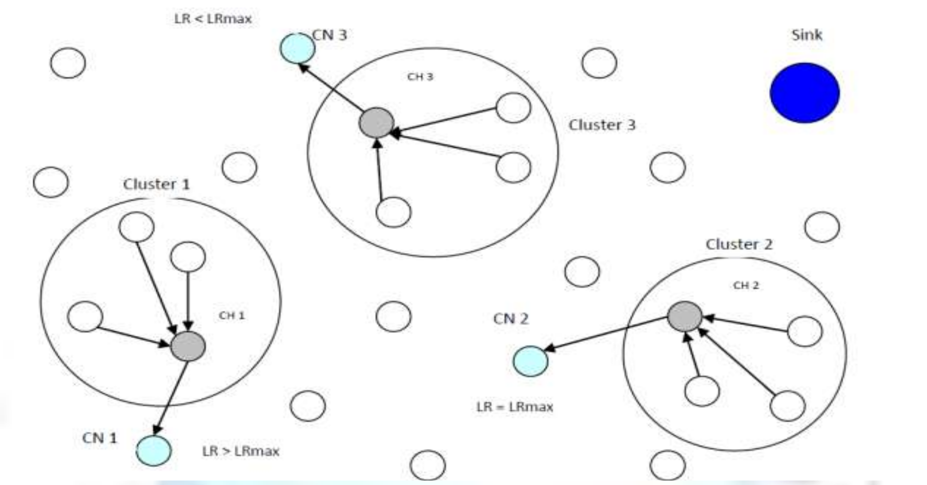

Figure 2: Calculation of Loss Ratio for Clusters

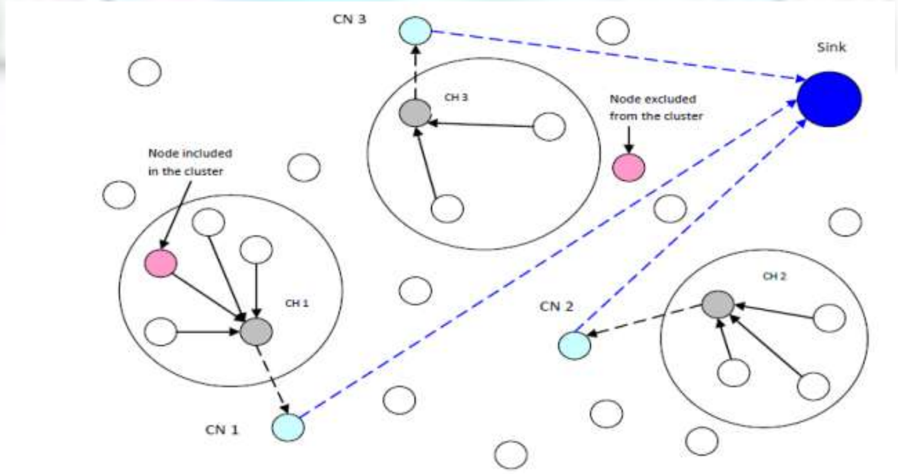

Figure 3: Reassigning the value of Forward node count

IV SIMULATION RESULTS

Simulation Setup:

The simulation of proposed work is performed in MATLAB. The simulated results are provided in Figures discussed below. Reliabilty and Energy Efficiency is evaluated by considering the performance metrics like Data Packets Sent, Data Packets Received, Packet Loss Ratio,First Dead Node.We considered a Random Network deployed in an area of 100 X 100 m. Intially the nodes are placed randomly in a specified area.

Performance Parameters:

1) Packet Loss Ratio:

It is the ratio of the number of packets lost successfully and the total number of packets transmitted.

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Packet Loss Ratio = Number of Packets Lost / Number of sent packets

2) Energy Consumption:

It is the average energy consumption of all nodes in sending, receiving and forward operations.

3) Packet Loss:

Packet loss is where network traffic fails to reach its destination in a timely manner. Most commonly packets get dropped before the destination can be reached. Packet Loss = Number of packets send – Number of packets received

RESULTS

Figure 4 shows packet loss ratio.
Figure 5 shows the packet loss ratio in existing and proposed system

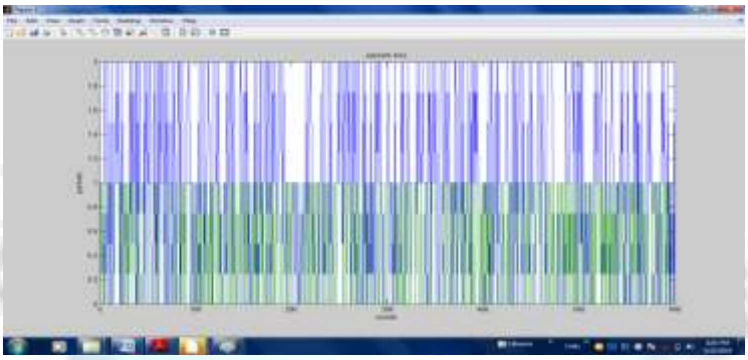

Figure 4 Packet Loss Ratio

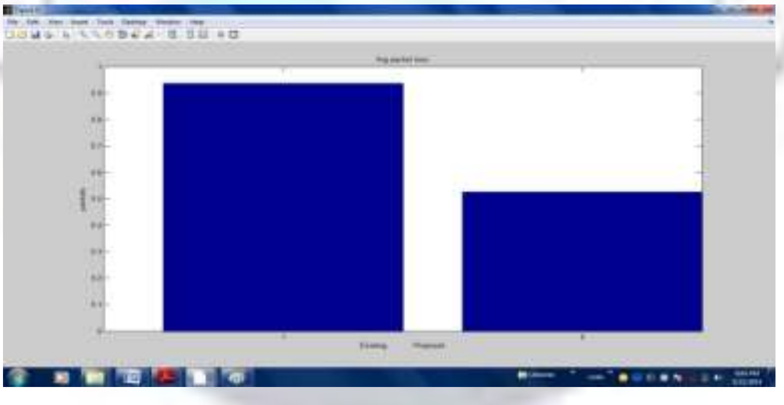

Figure 5 Comparison of Packet Loss

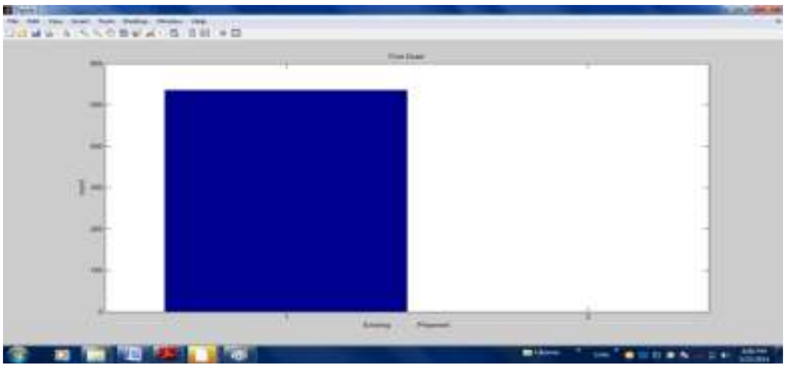

Figure 6 Comparison of First dead Node

CONCLUSION

We have provided efficient data aggregation technique which considers both energy and reliability. Initially, the network is partitioned to various clusters .Each cluster selects a coordinator node (CN) randomly in the network which is closer to the cluster and monitors the operations of the sensor nodes and commands them for specific operations. In each cluster, the cluster head is selected based upon the cost value. The nodes in the cluster maintain a Neighbor information table (NIT) containing Node id, Distance and Cost. This NIT information is sent to the cluster head.. The cluster head aggregates the data and sends it to the CN. The CN calculates the loss ratio which is the ratio of number of packets dropped and total packets broadcast from the source. Based upon the loss ratio, the cluster size can be modified and the forward node count of each node can be incremented or decremented. Once the cluster size is changed, the CN gathers the information again from the cluster head compresses it and sends it to the sink. This technique proves to be efficient since the delay is reduced due to that the loss ratio is measured in the CN itself. Energy is reduced effectively and reliability is maintained when the size of the cluster is altered based upon the loss ratio. From our simulation results we prove that this technique is efficient in energy consumption and reliability.

REFERENCES

[1] Nandini. S. Patil, and Prof. P. R. Patil "Data Aggregation in Wireless Sensor Network", IEEE International Conference on Computational Intelligence and Computing Research, 2010.
[2] Kevin Yuen, Baochun Li, and Ben Liang "Distributed Minimum Energy Data Gathering and Aggregation in Sensor Networks," IEEE International Conference on Communications ICC' 06, Vol. 8, pp. 3536-3541, June 2006.
[3] Yang Yu, Bhaskar Krishnamachari, and Viktor K. Prasanna "Energy-Latency Tradeoffs for Data Gathering in Wireless Sensor Networks," proceedings of International journal of Sensor Networks, Volume 4 Issue 1/ 2, pp. 48-54, July 2008.
[4] Kiran Maraiya, Kamal Kant, and Nitin Gupta, "Wireless Sensor Network: A Review on Data Aggregation", International Journal of Scientific & Engineering Research Volume 2, Issue 4, Pp. 1-6, April -2011.
[5] Hu¨ seyin Ozgu¨r Tan, Ibrahim Korpeoglu and Ivan Stojmenovic "Computing Localized Power-Efficient Data Aggregation Trees for Sensor Networks", IEEE Transactions On Parallel And Distributed Systems, VOL. 22, NO. 3, PP. 489-499, MARCH 2011.
[6] Nicolas Burri, Pascal von Rickenbach, and Roger Wattenhofer "Dozer: Ultra-Low Power Data Gathering in Sensor Networks," proceedings of 6th international conference on Information proceeding and sensor networks, pp.450-459, April 25-27, 2007.
[7] Jonathan P. Benson, Utz Roedig, Andre Barroso, and Cormac J. Sreenan. "On the Effects of Aggregation on Reliability in Sensor Networks", in proceedings of the 65th Vehicular Technology Conference VTC 2007, 2007.
[8] Jae-Joon Lee, Bhaskar Krishnamachari and C.-C. Jay Kuo "Impact of Energy Depletion and Reliability on Wireless Sensor Network Connectivity" , in proceedings of SPIE 2004, pp. 5440, 169, 2004.
[9] Vamsi Krishna Venkata Naga Nandanavanam "Energy-Efficient Reliable Sensor-To-Sink Data Transfer For Wireless Sensor Networks," 2010 – Scholar works. boisestate.
[10] Ren P. Liu, John Zic, Iain B. Collings, Alex Y. Dong, and Sanjay Jha "Efficient Reliable Data Collection in Wireless Sensor Networks," in proceedings of IEEE 68th Vehicular Technology Conference, VTC2008 , 2008.
[11] Volker Turau and Christoph Weyer "Long-term Reliable Data Gathering Using Wireless Sensor Networks," proceedings of 4th International conference on networked Sensing Systems INSS '07, pp. 252-259, June 6-8 2007.
[12] Hemant Sethi, Devendra Prasad, and R. B. Patel "EIRDA: An Energy Efficient Interest based Reliable Data Aggregation Protocol for Wireless Sensor Networks," in proceedings of International Journal of Computer Applications, Volume 22– No.7, May 2011.
[13] David Gugelmann, Philipp Sommer, and Roger Wattenhofer "Poster Abstract: Reliable and Energy-Efficient Bulk-Data Dissemination in Wireless Sensor Networks," in proceedings of SenSys'10, November 3–5, 2010.
[14] Mingming Lu and Jie Wu "Utility-Based Data-Gathering in Wireless Sensor Networks with Unstable Links," proceedings of the 9th international conference on Distributed Computing and Networking ICDCN' 08, pp. 3-24, 2008.
[15] Dazhi Chen and Pramod K. Varshney, "QoS Support in Wireless Sensor Networks: A Survey" International Conference on …, 2004 - adams.kwangwoon.ac.kr.
[16] Mohamed A. el-Gendy, Abhijit Bose, Kang G.Shin, "Evolution of the Internet QoS and Support for Soft Real-Time Applications", In proceedings of IEEE, Vol.91, No. 7, pp. 1086-1104, 2003.
[17] S.Muthukarpagam, V.Niveditta, S.Neduncheliyan, "Design issues, Topology issues, Quality of Service Support for Wireless Sensor Networks: Survey and Research Challenges' International Journal of Computer Applications (Volume 1 – No. 6, pp.1-4, 2010.