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Different Data Compression Algorithms in Wireless Sensor Networks

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Abstract: ***Wireless sensor Network (WSN), is new trending area of research which mainly concentrates on the monitoring of physical data which are spreading throughout an wide area or among the large number of people. In this type of application in WSN, energy consumption becomes a principal concern because in network all the nodes send's the sensed data to the sink node continuously longer period of time. Since the data transmission is the basic factor of for the energy consumption many research is going on compressing the data that has to be transmitted through the network so the energy consumption can be reduced. In this paper we are mainly concentrating on the Two compression techniques,1) Distributed source coding technique, and 2)Data Aggregation technique. Matlab is used to develop the algorithm. Discrete wavelet transform is used as a compression method. This compressed data is transmitted from one node to another node by using the above two compression technique.***

Keywords: data compression, distributed source coding, data aggregation, Slepian-wolf theorem, Wavelet transformation, wireless sensor network

1. Introduction

Wireless sensor network (WSN), is composed of many sink and source nodes which collects or monitors the data from the surrounding environment. The source nodes collect the data and sends to the sink node. The nodes which are used to construct an wireless network are composed of a battery which cannot be replaced or cannot be recharged and many WSN system prefer long term monitoring of the environment hence the energy conservation becomes the main key point in WSN system which will increase the lifespan of the system. So, while transferring large bits of data the energy consumption by the network is more and also it also requires more time for data transmission. As the energy consumption is increased it leads to the reduction in the lifespan of the network. So, when we transfer the compressed data through the network we can reduce the time, energy consumption and lifespan of the network can be increased. There are two methods to conserve the energy. One of the methods is by using the sensor node redundancy. The advantage of node redundancy can is considered by selecting the subset of the sensor nodes which has to be active and other nodes are put in inactive state or sleep mode to conserve the energy. The selected subset of active sensor nodes has cover the full monitoring area of network and has to maintain the connectivity of the network. Another method to conserve the energy is by reducing the sensing data transmission which is sensed by the sensor nodes, because major reason for the energy consumption is data transmission in the network. This type of method is very useful when the nodes has to report to the sink node continuously for longer period of time. Reducing the sensing data rate can be done by the data compression method within the network Depending on the recoverability of the data compression methods can be divided into three categories. They, are Lossless compression, lossy compression, technique.

2. Literature Survey

This paper 0, the author has explained about five different categories of data compression techniques in WSN. Which can be classified as:

1) Distributed source coding technique,
2) Data aggregation technique,
3) String based compression technique,
4) Image based compression techniques, and
5) Compressed sensing technique. In this paper they have also explained about the different techniques that come under the Aggregation technique and Image based compression technique.

This paper [2], they have considered about the problem of compressing the source which is correlated to the source which is available only at the decoder side. This problem has been studied under the name of "slepian-Wolf source coding" for lossless coding case, and as rate-"distortion with side information" for lossy coding case.

This paper [3], compression method is carried out by combining two compression algorithms Haar and Hadamard. Compression algorithms include Haar, DCT, Hadamard Quantization and Entropy encoding. The decompression is the inverse of the above process. For compression they have used Matlab tool and for designing of compression protocol in WSN they have used NS2 tool.

This paper[4],they have mainly discussed about the energy consumption and conservation. As we know that the energy consumption increases as the transmission bits increases. So, in this paper the author discussed about conserving the energy by compressing the sensing data which has to be transmitted from source to sink node.

This paper[5],it mainly concentrated on the major challenges in WSN like power scarcity and computational resource. To overcome this power scarcity problem they have applied the

encoding and decoding of correlated data strings by using Distributed source coding method which works on the Slepian-Wolf Algorithm.

3. Methodology

In this paper we will come across two different categories of data compression that are used in WSN. They are as follows:

1) The distributed source coding techniques compress the sensing data inside the network according to the Slepian-wolf theorem, which proves that the two or more data which are correlated such type of data streams can be encoded independently and then be decoded jointly at the receiver end. Therefore the distributed source coding supports the Lossless compression.
2) The data aggregation technique selects a subset of sensor nodes to collect and merge the sensing data sent from their neighboring nodes and then transmit small sized aggregated data to the sink node. Since the original data cannot be recovered from this technique this method is Unrecoverable data compression technique.

The below figure represents the block diagram for the DISCUS algorithm. Which uses Conventional encoder and Conventional decoder.

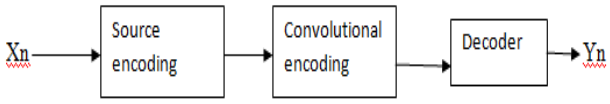

Fig.no.1 DISCUS method block diagram

Convolutional encoder can be defined as a error correcting codes which generates the parity symbols via the sliding application of Boolean Polynomial function to a data stream. The Output of the convolutional encoder is present either in the form of '0 and 1'.In this sliding application represent the convolution of the data stream. At the decoder side we will be using the convolutional decoder which can be named as a viterbi decoder. This algorithm is used to decode the bit stream which is encoded by using the covolutional encoder.

Distributed source coding technique mainly works on the slepian-Wolf theorem. It compresses the data within the network. Slepian-Wolf states that one or more data streams which are correlated can be encoded separately and can be decoded jointly at the receiving end with a rate equal to their joint entropy. Therefore the distributed source coding technique can support lossless compression.

One more technique that we are mainly concentrating in this project is Data Aggregation method. Here we are using Cluster head based data aggregation technique. The general network diagram for Data aggregation based on cluster head method is shown in below fig, no2

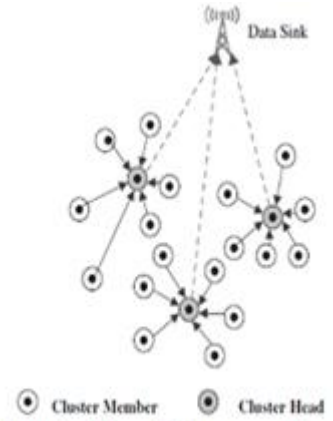

Fig.no.2 Cluster head based data aggregation method

The main objectives of this method is

- Extension of the network lifetime
- Reduced energy consumption by each network sensor node
- Use of data aggregation to reduce the number of communication messages

In data aggregation technique it selects the subset of sensor nodes to collect the data and combine the data collect from there neigbouring nodes and transmit it to the sink node or the destination node.In Cluster head based technique Mainly involves three task, they are as follows,

1) The first task consists of periodic collection of data from the members of the cluster. Upon gathering the data, the cluster head aggregates it in an effort to remove redundancy among correlated values.
2) The second main task of a cluster head is to transmit the aggregated data directly to the base station. The transmission of the aggregated data is achieved over a single hop.
3) The third main task of the cluster head is to create a TDMA-based schedule whereby each node of the cluster is assigned a time slot that it can use for transmission.The cluster head advertises the schedule to its cluster members through broadcasting.

In this method selection of cluster head selection is very importet task.Each cluster head is slected based on the threshould value T(n) which is expressed as followes

$$T(n) = \begin{cases} 0 & \text{if } n \notin G \\ \dfrac{P}{1 - P(r \bmod (1/P))} & \forall n \in G \end{cases}$$

The random number which is generated by the node is compared with T(n) if it less than the tresholud then it is selected as the cluster head.

Node deoloyment statergy and routing protocol is same for both the Data aggregation technique and distributed source coding techniques.Way of transfering the data is different.In data aggregation technique data is transmitted to the base station as group of packets and in Distributed source coding the data is transmitted one by one as packets.

4. Results and Analysis

In this part of the paper lets study about the results that are optainead by using the matlab tool.Here we have optained three different graphs for both Distributed source coding technique and data aggregation technique.One graph is to analyse the No of alive nodes,another one is for analysing no of packet transmitted,and last one is the power analysis graph.

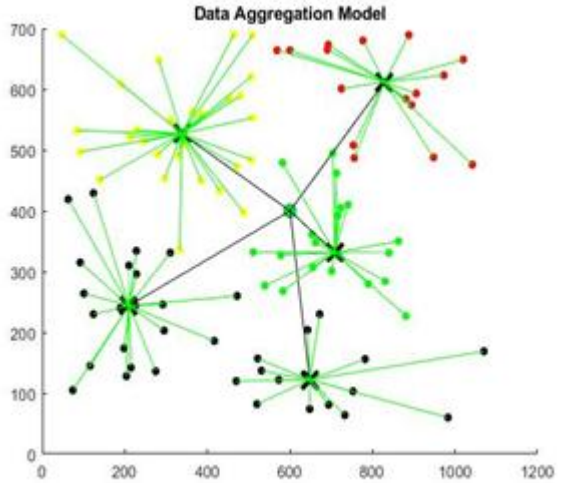

Figure 3: The above fig represents the Node deployment statergy for Data aggregation technique.It includes a cluster head,base station and neighbouring nodes for the cluster head.

As we can observe in the above figure the nodes are deplyed by using random deployment process, in which the position of the nodes changes with respet to application.As mentioned before the node deployment for both the technique is similer**.**

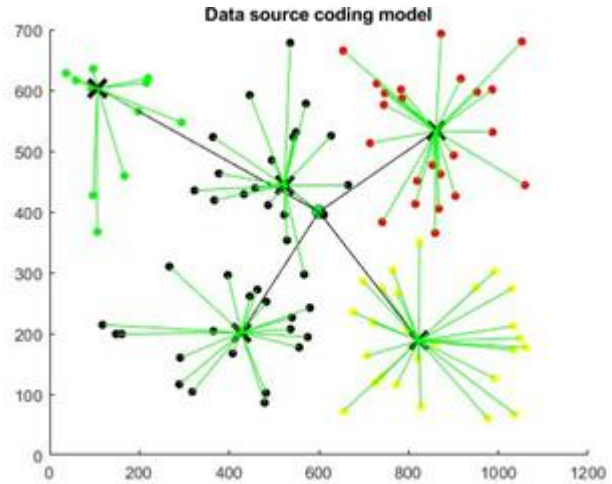

Figure 4: The above figure represent the node deployment statergy for Distributed data source coding technique.

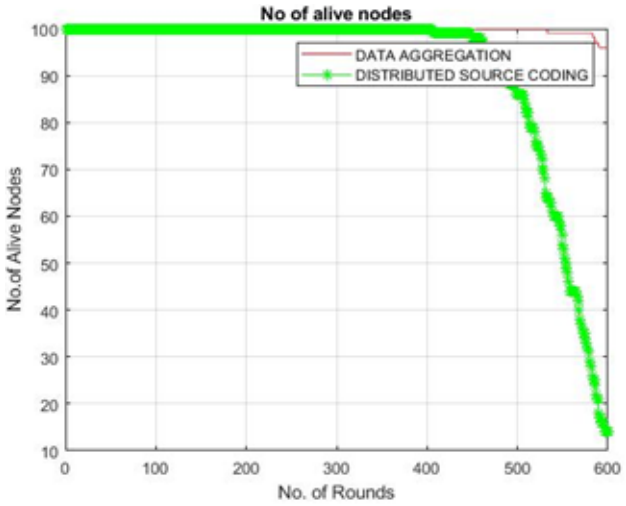

Figure 4: The graph represents the number of nodes that are alive at the end of 600 iteration

In above graph green color represents Distributed source coding and red color represents data aggregation method. Here we have considered 100 nodes(n=100) which generates 100 random data. Entire network under go 600 iteration. As iterations increase the live nodes decrease in DISCUS Algorithm and in Data aggregation method the live nodes are still high even after 600 iteration.

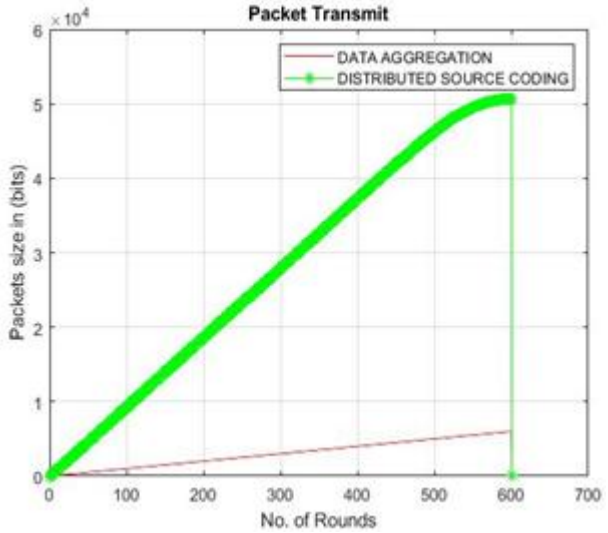

Figure 6: The above graph represents the number of data packets transmitted within 600 iteration

As we can observe in the above graph the data packet transmitted in distributed source coding technique is more when compared to data aggregation technique. It is more in DISCUS because the data packet is sent one by one. Where in aggregation the is sent in the form of group.

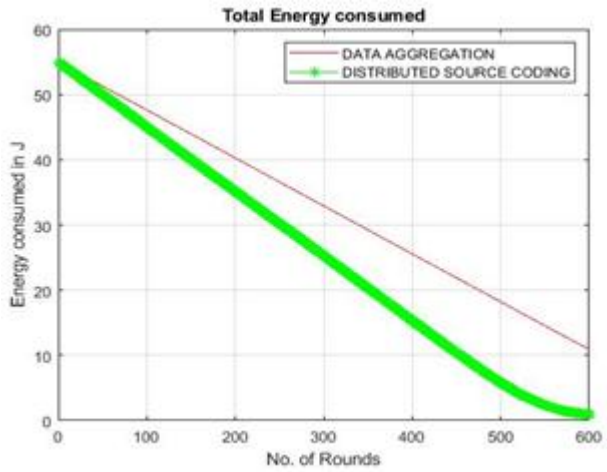

Figure 7: The above graph represents the energy consumed during 600 iteration.

Main of this implimentation is to reduce the transaction energy.So,by viewing at the above graph we can conform that at the end of 600 itteration the energy consumed by the system is reduced.

5. Conclusion and future work

At the beginning of this project our main aim was to reduce the data transaction energy that is consumed by the total system either by moking the non-active nodes or by using the compression techniques which are present in WSN.In this paper we have mentioned about two methods of compression they are Distributed source coding technique and Data aggregation technique.So,by using this technique we have reduced the power consumed by the entire system.By observing above results we can conclude that the energy has been reduced at the end of the simulation

In future we can use other compression techniques in wireless sensor network like, String based compression technique,Image based compression technique, and compressed data sensing technique, for reducing the total energy consumed by the network.We can also use a method of mocking the non-active nodes to reduce the energy consumption of the system.

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