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Evaluating Effectiveness of Data Transmission and Compression Technique in Wireless Sensor Networks

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Abstract*—Wireless sensor networks are resource constrain. They are limited power supply, bandwidth for communication, processing speed and memory space. The possible way of achieving maximum utilization of those resources is applying data compression on sensor data. Since processing data consumes less power than transmitting data in wireless medium. So it is effective to apply data compression before transmitting data fo reducing power consumption by a sensor node. In this we propose a LZW data compression algorithm particularly suited to be used on available commercial nodes of a WSN, where energy, memory and computational resources are very limited. Since processing data consumes less power than transmitting data in wireless medium. So it is effective to apply data compression before transmitting data for reducing power consumption by a sensor node. Among those proposed techniques, the data compression scheme is one that can be used to reduce transmitted data over wireless channels. In this article, a comprehensive review of existing data compression approaches in wireless sensor networks is provided. Finally, their performance, open issues, limitations and suitable applications are analyzed and compared based on the criteria of practical data compression in wireless sensor networks.

***Keywords*— Data compression, wireless sensor network, energy-efficient**

I. INTRODUCTION

W ireless sensor network is composed of a large number of sensor nodes, which are densely deployed in a terrain under monitoring. These sensors have the ability to communicate either among each other or directly to an external base-station. A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Each sensor node comprises sensing, processing, transmission and power units.

Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed better understand how the software interacts with the other parts of the system, and what needs to be further developed in a systematical way. A base-station which is also known as a sink may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data, applying data compression in each node before transmitting data for reducing total power consumption by a sensor node.

A. Data Compression technique

Two types of data compression: Lossless and Lossy compression. Lossless compression technique, as the name implies involve no loss of information. If data have been loss-lessly compressed the original data can be recovered exactly from the compressed data. Lossless compression algorithm usually exploit statistical redundancy in such a way as to represent the sender's data more concisely with fewer errors. Lossless compression is possible because most real- world data has statistical redundancy. Lossy compression techniques involve some loss of information and data that have been compressed using lossy technique generally cannot be recovered or reconstructed exactly. In return of accepting this distrotion in the reconstruction we can generally obtain much higher compression ratio than lossless compression. Some data compression techniques of wsn are coding by ordering, pipelined in- network, distributed compression etc.

II. RELATED WORK

Sebastian discusses that the low power sensor nodes are integral parts of large scale wireless sensor networks which find extensive application in domain such as military surveillance and environment monitoring. The author proposes a novel approach of energy consumption trade-off associated with lossless data compression in low power sensor nodes. The author specifically focuses on compression of acoustic signals. The possessing of acoustic signals in digital form and subsequent transmission of the signals across a network that involves significant energy consumption by the transceiver of a sensor node.

Raymond proposes that the Distributed wavelet processing in sensor network reduces communication energy and wireless bandwidth usage at sensor nodes. Sparsity can be leveraged for processing such as measurement compression, de-noising and query routing and the author also represents a simple wavelet transform for irregular sampling grid. Multi scale algorithms such as distributed wavelet processing hold much promise for sensor network applications. Measurement fields often exhibit high local correlation and more moderate global correlation, leading naturally to a paradigm of local processing at fine scales between spatially approximate nodes and global processing at coarse scales between more distant nodes. The distributed wavelet transform and data harvesting architecture for sensor networks. The transform adapts to irregular sampling grids and piecewise-smooth sensor measurement fields.

Yang proposes the constructing a data gathering tree over a wireless sensor network in order to minimize the total energy for compression and transporting information from a set of source node to the sink. The author also derives the optimal compression strategy for a given data gathering and investigates the performance of the structure for network deployed on a grid. The tunable compression that is capable of tuning the computation complexity of lossless data compression based on the energy availability. The gzip program supports up to ten levels of different compression ratio, with larger compression ratio resulting in longer compression time and hence to cost higher energy. The prior works have not considered the application of tunable compression together with routing techniques for data gathering in sensor networks. The construction of a data gathering tree spanning a set of source nodes and rooted at sink node.

Two data compression schemes have been previously investigated: distributed source coding and compression with explicit communication. While practical distributed source coding schemes for sensor networks are being developed, most existing works for data compression schemes are based on explicit communication. It focuses on joint data compression with side information via explicit communication. Therefore, a suitable energy model for tunable compression and a flow-based model to facilitate the tuning of compression over a data gathering tree and the techniques for determining the optimal flow for a given tree structure.

Sayood discusses the compression technique, mathematical preliminaries, information and coding, Huffman coding, Dictionary coding quantization, differential encoding, mathematical preliminaries for transform, sub bands, and wavelet.

Znati discusses the basic of sensor network, network protocols, data storage and manipulation in sensor networks, security features in sensor networks, localization and management, application of wireless sensor network.

III. DIFFERENT DATA COMPRESSION TECHNIQUE IN WSN

Data Compression technique used in wsn are coding by ordering, Pipelined in-Network Compression, distributed compression etc.

A. Coding by Ordering data compression

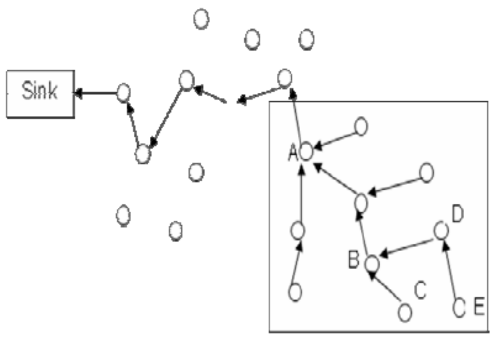

Fig.1. Coding by Ordering data compression

The Coding by Ordering data compression scheme is introduced in [12] as part of Data Funneling Routing. The compression scheme is works as follow. First, a data pass from sensor nodes in the interested region to a collector node is set up as shown in Figure 1. In Data Funneling Routing, some of sensor nodes work as a data aggregation node. For example, node A, B, and D are a data aggregation node. At an aggregation node, sensing data collected by other nodes is combined, and the aggregated data is sent to its parent node. At node D in Figure1, data collected by node E is combined with data collected by node D itself. Then, the aggregated data is transmitted to node B. In coding by ordering 44% data is loss during compression.

B. Pipelined In-Network Compression

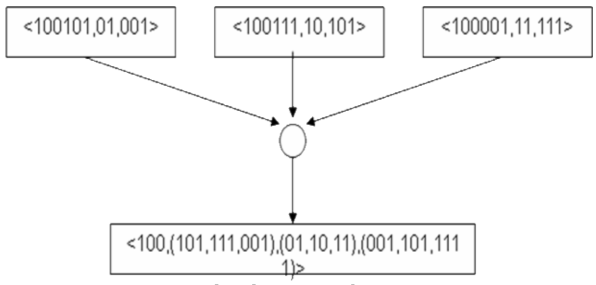

Fig.2. Pipelined In-Network Compression

C. Distributed Compression

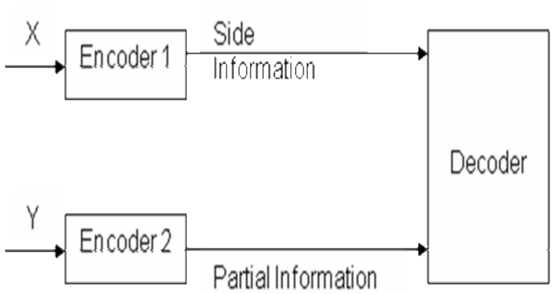

Fig.3. Distributed Compression

The basic idea behind the Distributed Compression scheme, introduce by [13] [4] is using a side information to encode a source information. For instance, there exist two sources (X and Y) as shown in Figure. They are correlated and discrete-alphabet independent identically distributed. Since in a sensor network, sensor nodes will be densely populated in a sensor field, this correlation condition can be satisfied easily. In this data compression technique if we compress 3 bit of data, then only 2 bit of data comes as an output. On the basis of study we can say that there is some disadvantage of the data compression technique.

IV. DATA COMPRESSION ALGORITHM CLASSIFICATION

Figure 4 illustrates the relationships between aggregation and data compression techniques. The aggregation techniques are usually adopted in dense sensor networks with multi-hop topology which require routing algorithms. Therefore, the data aggregation function, denoted by Set A in Fig. 4, is drawn on top of the routing algorithm. This aggregation function in existing literature was usually performed by extracting maximum, minimum and average values of aggregated data.

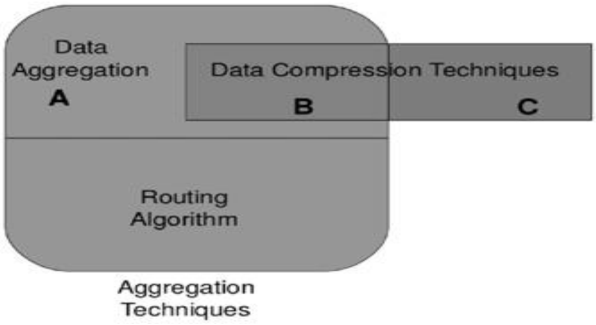

Fig. 4. The relationships between aggregation and data compression techniques

In such a way, it can reduce the amount of communicating data in the dense sensor networks which affect the power consumption. However, this technique can lose much of the original structure in the extracted data because it provides only coarse statistics without local variations such as data distribution over an area. A number of papers solved this issue by using rules or factors to tune the degree of aggregation. This means that the aggregation is considered to operate based on the network's information, such as the differences of consecutive data, location of nodes and network capacity . However, these improved schemes have the possibility of losing their original data structure when there is a high degree of aggregation.

The data compression schemes, which is shown as Set B in Fig. 4, have been applied to solve original data structure loss problems. Since these second sets of data compression algorithms were extended from aggregation techniques which operate on multi-hop net- work topology, they usually distribute a compression algorithm throughout the network. By analyzing the relationship among various data compression algorithms described above, we can classify them into two categories: distributed data compression approach and local data compression approach. Figure 5 shows a taxonomy of our data compression algorithm classification in WSNs. How to classify the subcategories of each approach is explained in its respective section.

V. DATA COMPRESSION ALGORITHM IN WIRELESS SENSOR NETWORKS FOR REAL WORLD REQUIREMENTS

This section describes two sets of requirements in real-world WSN applications. The first set contains the common constraints of wireless sensor networks that should be considered in designing a data compression algorithm. The second set identifies the unique requirements related to the data compression designed for each particular existing real-world application.

A.Common requirements in real-world WSN applications

Since the communication unit on a wireless sensor node is a major power consumer, a data compression scheme can be used to reduce the amount of information being exchanged in a network resulting in a saving of power. The higher the ratio of data compression, the higher the percentage of power saving. However, when applying a data compression algorithm, the sensor node's processing unit requires more power to operate the algorithm. The PDA was used for data collection in a similar manner to a wireless sensor node. Although the results of this experiment might not be readily applicable for WSNs, they still provided significant insights into the power consumption of data processing and transmission. The results showed that even with well-known algorithms—such as the scheme called prediction with partial match using Markov modeling followed by arithmetic coding which has an impressive compression ratio—it still required more power than the non-compression system. This is due to the complexity of the data compression algorithm which requires tremendous time and memory. Therefore, an efficient data compression algorithm needs to be designed by considering the trade-off between the computational cost and the power saving from compression ratio. In other words, the power consumed by performing additional instructions to compress data has to be less than the power saved from transmitting the compressed data.

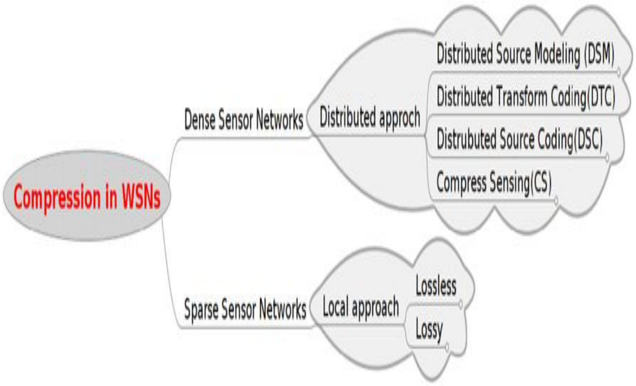

Fig. 5. Taxonomy of data compression classification in WSN

VI. CONCLUSION

It has been proved that people are discussing wide range of application areas for wireless sensor network. In this project data compression schemes LZW were presented. The experimental results indicates that their compression ratio and power reduction. They are one possible method to diminish resource constrain of wireless sensor node. The proposed work has been concluded with LZW algorithms. In future we can use the same algorithms with merging with effective routing protocols so that it can achieve more energy efficiency. Thus, no data compression approach is the most suitable for all WSNs. The reason that supports our observation is that the local approaches do not exploit any benefits of network routing and topology. The effectiveness of data compression algorithms for a particular application is still an open issue requiring further investigation in WSNs. This article summarized and compared details, performance, suitable applications and limitations of recently developed schemes in this interesting research topic.

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