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RESEARCH ARTICLE

COMPARISON OF DWT AND DFT FOR ENERGY EFFICIENCY IN UNDERWATER WIRELESS SENSOR NETWORKS

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Abstract: The data compression method is the energy efficient approach used for the wireless sensor networks. The data compression method reduces the data amounts which are being transmitted across the data paths. There are several data compression models available across the computing world. In this paper, we have verified DWT and DFT compression models for the underwater wireless sensor networks. The two compression techniques have been simulated and compared for better results in UWSN. The experimental results has been obtained and evaluated in the form of various concrete performance parameters.

Keywords: Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), Data Compression, Energy Efficiency, Underwater Sensor Networks (USWN).

1. INTRODUCTION

1.1 Wireless Sensor Network (WSN)

Wireless Sensor Network is a network of electronically small devices constituted together which is used for sensing any physical and environmental location on earth. WSNs are in a wide use these days due to their quick monitoring on any topographic location of earth. These are used for habitat monitoring, alerting swimmers, disaster management, for inspecting activities occurring in oceans. WSNs are easily available in market as they are inexpensive .Usage of WSNs doesn't not require much efforts .It needs a range of nodes or only two nodes. When the transmission of signals is done between two nodes then this is called direct transmission and this requires a base station for collecting the transmitted information. But in second case when a number of node are used for transmission then a specific base station is not needed, and this is called indirect way of transmission.

1.2 Underwater Wireless Sensor Networks

Underwater Wireless Sensor Networks have more complex design for transmission as compare to the terrestrial one. UWSN is to deploy the sensor nodes in sea water or in ocean. UWSN used to collect oceanographic data like temperature, salinity, disaster prevention etc. UWSN is major topic for researchers as UWSN face more complexity due to their transmission in the ionized water of the ocean. This ionized water poses the problem of energy loss due to the absorbing nature of the water. It loses the frequency and bandwidth of the transmitted signals also.

Although UWSNs are very useful in all aspects still they are facing some problems in their practical uses. One of the major problems is the limited battery life of sensors. Due to this, the sensors are incapable of transmitting the required signals via nodes, because the nodes become electrically dead.

Still technology has given a solution to this problem of power loss. Power consumption is measured in three constraints:-Processing, transmission and sensing. However, Processing and sensing doesn't consumes much, but 80% of the power is utilized while transmitting. The best solution to overcome the problem of power consumption is data compression. But data compression technique is more effective if applied compression algorithm before transmission. This technique reduces the bandwidth of the signal transmitted between nodes, hence the complete signal reaches the final collecting destination ,known as base station.

1.3 Data Compression

Data compression is a technique to minimize the number of bits required for data sending or transmitting. There are specifically two classes of compression:- lossless and lossy. Data compression techniques are divided into three methods:-Direct data compression,Transform data compression, parameter extraction Compression.

Direct data compression directly examines the data and compresses in the time domain .It is further of two types:- Predictive data compression algorithm and interpolation data compression algorithm .Predictive algorithm applies the knowledge of previous samples whereas interpolation algorithm applies the previous as well as future samples knowledge.

Transform data compression technique works from time domain to frequency domain or other domains also. This involves the processing of input signal by linear orthogonal transformation .When the signal has to be decoded then an inverse transformation is required and the data is finally recruited with some error. Discrete Fourier Transform (DFT), Morse code, discrete wavelet Transform (DWT) are the example of transform data compression technique.

Discrete Fourier Transform (DFT) and Morse code are both lossless compression techniques. Morse code basically needs a skilled listener in its transmission. This works on the principle of switching on/off the signal which is being compressed .Researchers face difficulties in decoding the compressed data by morse code because as written above this requires skilled and trained listener. Discrete Fourier Transform works on the principle of transforming the data from time domain to frequency domain, as in the later one it is easier to work. DFT is mostly used in mathematical modulations because it works faster in this process.

Discreet wavelet Transform (DWT) works both in time and frequency domain, that's why it is easy to use. It is also a better alternative to DFT. It is an efficient tool in applications like compression and coding.

Parameter extraction compression technique extracts the parameters like frequency, amplitude, bandwidth of the signal. Then a classification of particular parameter is done on the basis of prior knowledge of the signal.

Huffman encoding: This algorithm is also a lossless data compression algorithm. In this encoding the data that occur frequently have smaller symbol than those which occur rarely. The data Is converted to binary representation with the help or analog to digital convertor. This is a two pass procedure, in first pass statistics is collected and in second pass data is encoded. Adaptive Huffman encoding is more reliable than simple Huffman encoding as in it neither sender nor receiver doesn't know anything about the statistics.

PREVIOUS WORK

Kunal goel et. al.[2014 performed survey on power related issues in underwater sensor network. The major challenge in underwater sensor networks is retaining the energy of sensor nodes which have limited battery life as sensors do not have the capability of rejuvenation .The main objective of this survey is to design a energy efficient cartography pattern which in turns can reduce the energy utilization by the nodes which overall will increase the network lifetime. Author defines two types of designs:-Static UWSN and Mobile UWSN. Static UWSN means the sensors are fixed to the surface or berthed to the surface of the ocean, and Mobile UWSN means self-organized surface or sensors are free. On AQUANODE (sensor node), two types of network frames are applied: one is cluster head and other is HOP to HOP communication. So, in cluster based scheme network life propagation is more .Also, in now a days, in terms of battery technology Li-Ion battery is more efficient.

Gongliang liu et. al.[2014] proposed a creative energy proficient multi-hop routing scheme for sensor nodes in three dimensional surroundings based on compressed sensing. In this paper, Distributed Random Multi-hop Compressed sensing (DRMCS) routing algorithm is applied on sensor nodes. During each tour, a set of nodes are randomly selected for transmitting the data to the sink node ,instead of all nodes discharge their battery in sensing data to the sink node. Randomly selected node for data sensing broadcast the data to open routes and determines the best next hop and so on till the base node or the sink node comes within the range of the source node. At the sink node, the data is decompressed to the original form ,and the data obtained contain negligible error .This paper shows that the DRMCS design is better than of a traditional design. DRMCS consumes less energy than conventional design, as the distance increases the routing consumes much energy as the source node require much power to transmit the data to the sink node but still DRMCS is more reliable.

Rajib Rana et. al.[2014] proposed a robust lossy compression algorithm based on compressive sensing for mobile sensor networks. Mobile Sensor networks (MSN) provides more facilities than simple nodes, one of the example is Virtual Fencing (VF), but VF operates as a delay tolerant network, so for the limited storage we need trajectory compression .In this paper, proposed algorithm has two creative elements .At first ,this method uses the dictionary learning. Secondly proposed a new approach for the mobile nodes to enumerate a projection matrix from the dictionary. A support vector regression (SVR) method is proposed which can permit the MSN to choose the number of projections according to their speed. This algorithm uses 6 datasets which proves that this proposed method is 10-60cm more accurate than the state-of-the-art trajectory compressing algorithm [SQUISH].This algorithm has less calculation requirements and can be used on poor sensor stage.

Wafa Elmannai et. al.[2014] focused on the major issue of power consumption and short battery life of underwater sensor networks. Thus to overcome this problem ,author proposed a novel technique of data compression while data transmission from one sensor node to other .Compressed data consumes less power which in turn improves the end user experience as the battery life of sensors are increased. For compressing the data, Morse code and Discrete Fourier Transform (DFT) algorithm is used. Morse code is used to convert text to series and DFT is used to compress the sound signal which works best in the frequency domain and work over many mathematical calculations .This algorithm also overcomes the problem of some hurdles occurred due to ionized nature of sea water, as this scheme works in frequency domain which in turn increases the travelling distance without increase in power consumption.

Geoffrey A. Hollinger et. al.[2012] analyzed the issue of utilizing autonomous underwater vehicle(AUV) to collect the data from underwater sensor nodes. The main aim for AUV is to plan a route that maximize the information collected from the sensor nodes while minimizing its travel time and energy. In underwater sensor networks, sensor nodes are outfitted with acoustic modems which provide noisy and range bounded communication .As the information collected from the sensors are from the noisy channels, so the data reliability decreases with distance and thus have to deal with the problem of Traveling Salesperson problem (TSP) with probabilistic neighborhoods. To over the problem of communication constrained data collection problem(CC-DCP),AUV path designing new algorithms for TSP. While executing these methods, the AUV can maximize the performance by communication with many other nodes at a time in the network,this multi-nodes communication requires an set up protocol for selecting an appropriate path for maximum data collection. Thus, this paper shows that appropriate designing and scheduling protocols maximize the data collection by choosing appropriate path algorithms.

Fatehmeh Fazl et. al.[2011] proposed Random Access Compressed Sensing(RACS) scheme which maximizes the network lifetime which obviously a major issue for underwater sensor network. RACS eject the need of any scheduling protocol .This paper proposed a networking scheme which combines idea of random channel access and compressed sensing, thus forms RACS.RACS puts main focus on energy efficiency and bandwidth reliability ,so this scheme is suitable for long term implementation of larger underwater sensor networks which in turns is useful for monitoring some slow environmental activity. In each turn, participating set of nodes are randomly selected for data transmission, then sense data is passed on to other set using random access. Thus, due to the nature of random access probability of collision at fusion center (FC) may increase which results in packet loss at fusion center. To overcome the problem of packet loss due to collision, RACS gives a concepts of sufficient sensing probability by which reconstruction of the packets is possible based on compressed sensing.

EXPERIMENTAL DESIGN

We have implemented the discrete wavelet transform (DWT) for the data compression for underwater wireless sensor networks. There are steps for the execution of the improved data compression using the DWT scheme has been defined below:

Algorithm 1: WSN data compression method using DWT

Step 1: First we consider the network compatible to sensor nodes in water

Step 2: Placing sensor nodes randomly in water.

Step 3: Applying DWT scheme on nodes.

Step 4: Consecutive samples of the data are observed from nodes deployed in underwater.

Step 5: Calculate the quantization differences of the samples.

Step 6: Compression is achieved by encoding the calculated differences between these samples.

Step 7: Decoding is performed in the same aspect but in a reverse procedure

Step 8: We compute significant compression ratios, signal to noise ratios and error rate.

Step 9: Quantization complexity is calculated.

Algorithm 2: WSN data compression method using DFT

Step 1: First we consider the network compatible to sensor nodes

Step 2: Placing sensor and sink randomly in water.

Step 3: Applying DFT scheme.

Step 4: Consecutive samples of the data are under observation.

Step 5: Calculate the quantization differences of the samples.

Step 6: Compression is achieved by encoding the calculated differences between these samples.

Step 7: Decoding is performed in the same aspect but in a reverse procedure

Step 8: We can calculate significant compression ratios, error rate.

Step 9: Signal to Noise ratio is considered optimally.

RESULTS- Both DWT and DFT are simulated in underwater WSN. Following results are shown for compression ratio, PSNR, Error bits and Received bits.

1. Compression Ratio

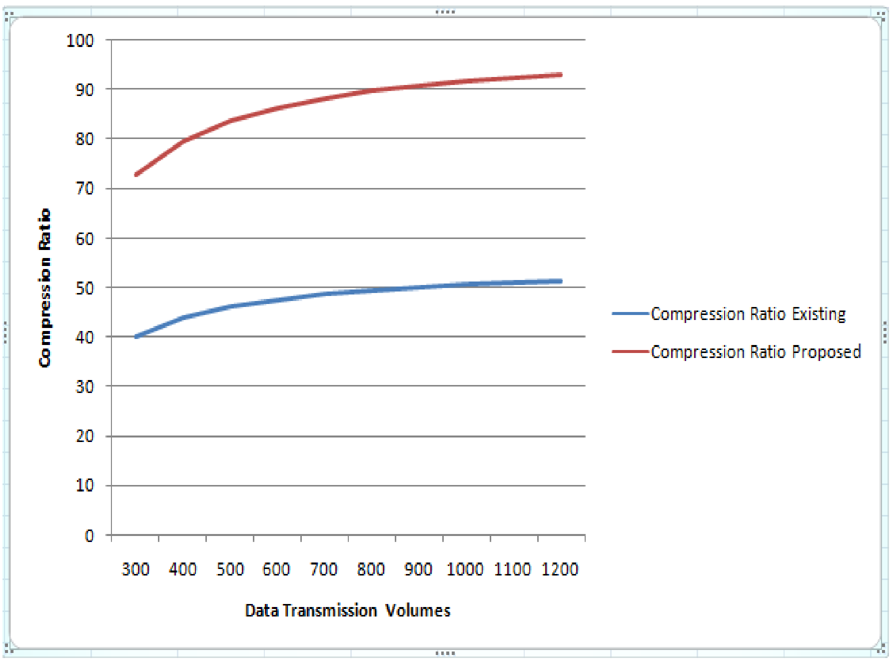

Figure 1: Compression Ratio for DWT and DFT obtained from the simulation model

The compression ratio is the ratio calculated from the size of the data transmitted (in bytes) with respect to compression ratio before and after the application of DWT and DFT compression on the UWSN data. The compression ratio represents the effectiveness of the data compression model. Higher the compression value, better is the technique. As shown in figure(1) the results obtained from the proposed data compression model using DWT are showing that the proposed model has significant difference than the existing models.

2. Peak Signal To Noise Ratio (PSNR)

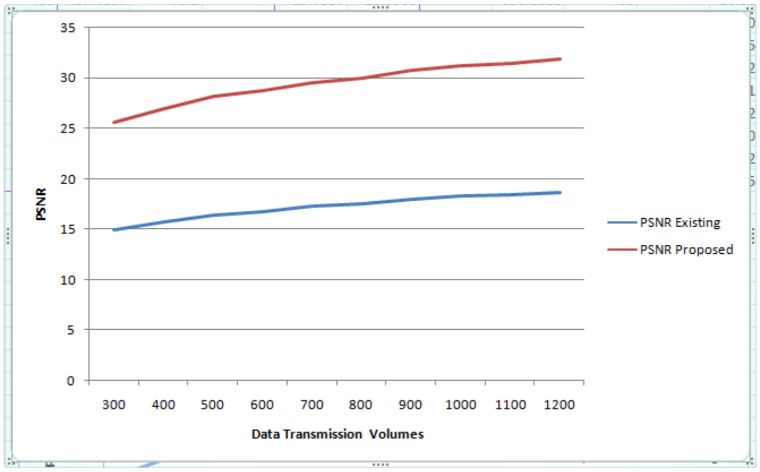

Figure 2: Graph of PSNR values collected from the UWSN simulation model

The PSNR values have been calculated on the data transmission (in bytes) before compression and after de-compression. The PSNR value represents the quality of the signal after the decompression. The higher is the PSNR value, better is the quality. Thus in figure (2) PSNR values are shown in graph which represents that DWT gives better results than DFT.

3. Error rate

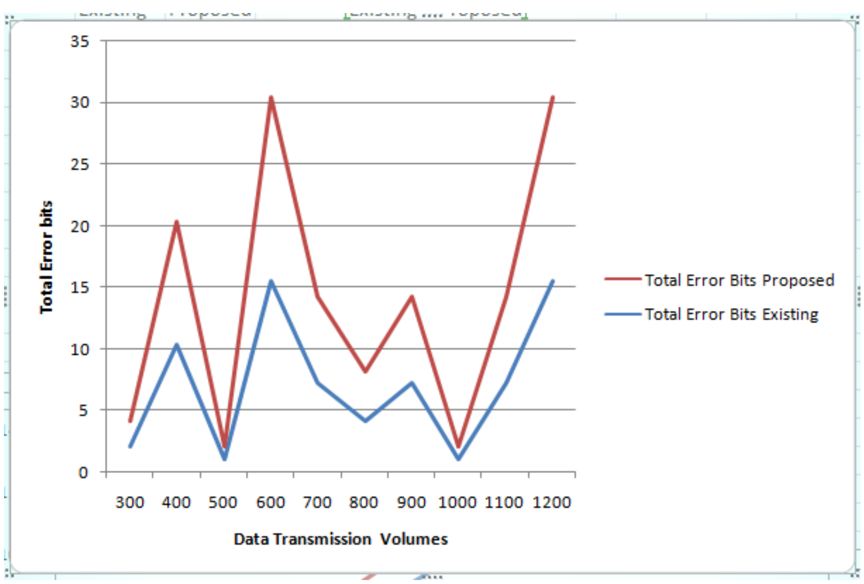

Figure 3: Graphical Representation of Total error bits during the communication in the simulation model.

4. Received bits

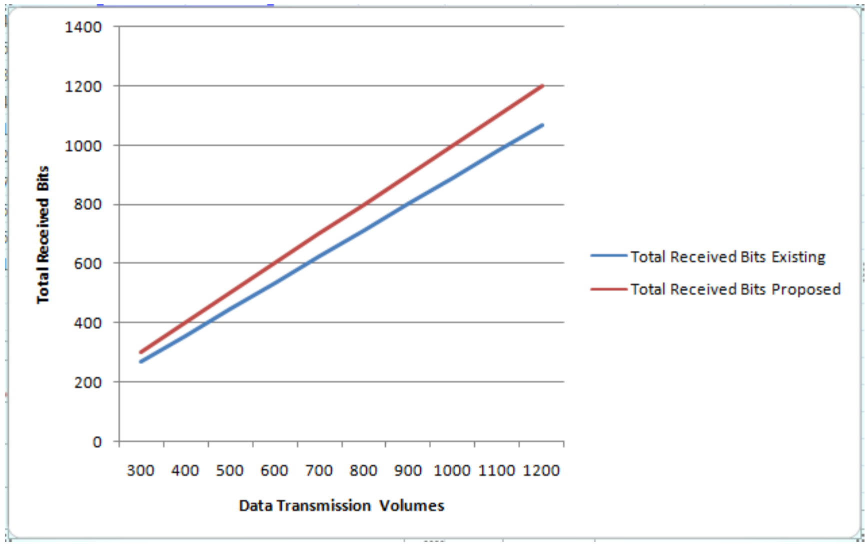

Figure 4: Graphical Representation of Total received bits during the communication in the simulation model

In figures 3 and 4, total number of error bits and total number of received bits has been shown in the graphical form. The total number of the sent bits and total number of received bits can be used to measure the intensity of the lost bits. The higher number of lost bits can adversely affect the performance of the UWSN cluster. The UWSN cluster may fail to reach its expectations, if there is the increased number of lost bits in the WSN cluster. The number of received bits (Figure 4) and number of error bits (Figure 3) are representing the difference based on the lost bits. The graphical form of the number of error bits is displaying the number of the bits which are affected by the signal interference during the communication channel. The communication channel may contain signal interference and many other forms of elements which may cause a significant amount of the errors in the bits during the transmissions.

The results of the proposed algorithm are showing the effectiveness of the proposed model. The proposed model has proved its capability of sending the quality signal to the other nodes. The received and sent bits are recorded for the minimal losses, which show a least possible number of lost bits during the transmission.

CONCLUSION

Dynamically linkable modules can be distributed in wireless sensor networks at a lower energy cost if they are compressed, and thus the lifetime of the sensor network is extended. The best overall energy-efficiency is achieved using improved Discrete Wavelet Transform (DWT). The proposed simulation is prominent to the existing UWSN compression techniques, where it has been observed that other techniques are capable of performing data compression for UWSN data up to 65 percent overall maximum. The results for compression ratio, PSNR, error rate and received bits using DWT technique on USWN are achieved optimally. The energy savings are nevertheless strongly dependent on the algorithm of choice, the execution speed of the implementation, and the energy cost of radio traffic in relation to the energy cost of micro-controller activity on the sensor nodes. The simulation implementation has been done using the MATLAB simulator. When the energy cost for radio communication is relatively high, as is the case with the existing, improved DWT algorithm saves more energy because it has a clearly higher compression ratio, while the execution time is also the best in the class.

FUTURE SCOPE

There may be better energy efficiency technique better than DWT. That could be interesting is to test the DWT algorithm for data compression for similar platforms other than USWN which is left for future scope. Since the similar networks have very different characteristics, it is probably worthwhile to reset the statistical model when a section border is passed.

REFERENCES

[1] Goel, Mr Kunal, and Mr Amit Bindal. "Energy Issues in Underwater Wireless Sensor Network: A Survey Report." (2014).

[2] Liu, Gongliang, Wenjing Kang, Bo Li, and Ya Liu. "Distributed Random Multi-Hop Compressed Sensing in 3-D Underwater Sensor Networks." *Information Technology Journal* 13, no. 5 (2014): 941-947.

[3] Rana, Rakesh, Mingrui Yang, Tim Wark, Chun Tung Chou, and Wen Hu. "SimpleTrack: Adaptive Trajectory Compression with Deterministic Projection Matrix for Mobile Sensor Networks." *Sensors Journal, IEEE* 15, no. 1 (2015): 365-373.

[4] Hollinger, Geoffrey, Sunav Choudhary, Parastoo Qarabaqi, Christopher Murphy, Urbashi Mitra, Gaurav S. Sukhatme, Franz Milica Stojanovic, Hanumant Singh, and Hover. "Underwater data collection using robotic sensor networks."*Selected Areas In Communications, IEEE Journal on* 30, no. 5 (2012): 899-911.

[5] Khanam, Ruqaiya, and Syed Naseem Ahmad. "ECG signal compression for diverse transforms." In *Information and Knowledge Management*, vol. 2, no. 5, pp. 1-9. 2012.

[6] Fazel, Fatemeh,Maryam Fazel, and Milica Stojanovic. "Random access compressed sensing for energy-efficient underwater sensor networks."*Selected Areas in Communications, IEEE Journal on* 29, no. 8 (2011): 1660-1670.

[7] Elmannai, Wafa, Khaled Elleithy, Ayush Shrestha, Mohamed Alshibli, and Reem Alataas. "A new algorithm based on discrete fourier transform to improve the lifetime of underwater Wireless Sensor Networks

communications." In*American Society for Engineering Education (ASEE Zone 1), 2014 Zone 1 Conference of the*, pp. 1-5. IEEE, 2014.

[8] Sayood, Khalid. "Data compression in remote sensing applications." *IEEE Geosci. Remote Sensing Newsletter* 84, no. 2 (1992): 7-15.

[9] Murphy, Chris, and Hanumant Singh. "Human-guided autonomy for acoustically tethered underwater vehicles." In *OCEANS 2008*, pp. 1-8. IEEE, 2008.

[10] Xuangou Wu, Yan Xiong, Wenchao Huang, Hong Shen, and Mingxi Li, "An efficient compressive data gathering routing scheme for large-scale wireless sensor networks", Computers and Electrical Engineering, vol. 39,2013, pp. 1935-1946.

[11] Francesco Marcelloni and Massimo Vecchio, "A Simple Algorithm for Data Compression in Wireless Sensor Networks", IEEE Communications Letters, vol. 12,2008,pg. no. 6.

[12] Sandra Sendra, Jaime Lloret, Miguel García, and José F. Toledo, "Power saving and energy optimization techniques for Wireless Sensor Networks", Journal of Communications, vol. 6, 2011,pg. no. 6.

[13] Wen-Hwa Liao and Hung-ChunYang, "A power-saving data storage scheme for wireless sensor networks", Journal of Network and Computer Applications, vol. 35,2012, pp. 818-825.

[14] Bulent Tavli, Ibrahim E. Bagci, and Onur Ceylan, "Optimal Data Compression and Forwarding in Wireless Sensor Networks", IEEE Communications Letters, vol. 14,2010,pg. no. 5.

[15] Jau-Yang Chang and Pei-Hao Ju,(2012) "An efficient cluster-based power saving scheme for wireless sensor networks", Journal on Wireless Communications and Networking.

[16] Giuseppe Anastasi, Marco Conti, Mario Di Francesco, and Andrea Passarella, "A survey on energy conservation in wireless sensor networks", Ad Hoc Networks, vol. 7, 2009,pp. 537-568.

