Compression based Energy aware routing algorithm for WSN

Priya
Department of CSE
CTIEMT,Jalandhar

Manoj Kumar
Department of ECE
CTIEMT,Jalandhar

Harjit Pal Singh
Department of ECE
CTIEMT,Jalandhar

ABSTRACT: - To enhance the lifetime of WSN is a key concern in Wireless Sensor Networks. In WSNs, energy and bandwidth of the sensors are valued resources and essential to consume competently. Therefore, energy consumption is the primary concern needs to be monitored. The major amount of energy in WSN is consumed during the communication. In order to reduce the energy consumption of the network, the numbers of bits to be transmitted are reduced by using data compression as it has the highest effect on the energy usage. This paper analyzes the performance of compression based energy aware routing algorithm for wireless sensor networks.

KEYWORDS: - WSN, ERA, COMPRESSION, THROUGHPUT, REMAINING ENERGY

1. INTRODUCTION

In recent years, Wireless Sensor Networks (WSNs) have gained worldwide attention due to the development of smart sensors. A smart sensor node consists of warning unit, Analog to Digital Converter (ADC), Central Processing Unit (CPU), power unit plus communication unit. WSN comprises of number of low-power multi-functional sensor nodes that work in an unattended environment and comprises of sensing, computation and communication capabilities. Sensor nodes are Micro-Electro-Mechanical Systems (MEMS) that create calculable reaction to modification of some physical conditions such as temperature and pressure [1]. The main function of sensor is to sense or calculate the physical data with the area to be monitored. The sensor sensed the repetitive analog signal which was digitized by an analog-to-digital converter and conveyed to controllers for further processing. In order to make sensors independent and adaptive towards environment, sensor nodes are made up of smaller size and they use external low energy and are operated in high volumetric densities. The spatial density of sensor nodes within the field could be around 20 nodes/ m^3. As wireless sensor nodes are generally smaller electronic gadgets, they may only be having a limited power source. Some reasons for power consumption in sensors are: (a) Sampling of signals and conversion of physical signals to electrical ones (b) signal conditioning (c) analog-to-digital conversion [1, 2].

In order to reduce the power consumption, there is a need to compress the sensed data inside the network. The aim of compression is reduce the quantity of the data size and to retain the quality of the original data. Data compression helps to optimize the resources.

2. RELATED WORKS

Amgoth et al [5] proposed power aware routing algorithm for cluster based WSNs. The algorithm depended on brilliant strategy of Cluster Head (CH) selection, residual energy of the CHs and the intra-cluster distance for cluster formation. To facilitate data routing, a directed virtual backbone of CHs was constructed which will be rooted at the sink. The constant message with linear time complexity was achieved with optimum lifetime. Yan-li et al [11] proposed an improved lossless data compression algorithm for WSN nodes where the span of data to be compressed was reduced by calculating increment between two adjacent data of sample sequence. The results of testing data compression showed that the improved Lempel-Ziv-Welch (LZW) algorithm had remarkable superiority in reducing dictionary length and increasing the compression ratio. Zhang et al [12] proposed two improved lossless data compression schemes based on LZW coding for wireless sensor networks. The schemes preprocessed numeric data in different ways to adapt the data characteristics. In order to increase the compression rate, the value span of data was decreased by calculating increment between the sample sequence and the base value. Xiang et al [13] proposed a novel data aggregation scheme that exploits Compressed Sensing (CS) to achieve both recovery fidelity and energy efficiency in WSNs with arbitrary topology. The diffusion wave implements to find a sparse basis that characterize the spatial (and temporal) correlations well on arbitrary WSNs, which enables straightforward CS-based data aggregation as well as high fidelity data recovery at the

ISSN: 2278 – 1323

sink. It was observed that compressed data aggregation scheme was capable of delivering data to the sink with high fidelity while achieving significant energy saving.

Saleem et al [16] proposed 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. It was observed that it was effective to apply data compression before transmitting data for reducing power consumption by a sensor node. Jancy et al [17] proposed packet level data compression technique to improvise sensor energy using compression techniques. Using this algorithm better compression ratio had been achieved.

.

3. COMPRESSION TECHNIQUES

Compression techniques reduce the amount of data which also lead to reduce the energy consumption of the network. There are two major categories of Compression techniques such as lossless and lossy compression.

3.1 *Lossless Compression*: In this technique, the original data and the data produced after compression and decompression are exactly the same as the algorithms used for compression and decompression are exact inverse of each other. Lossless Compression preserves the integrity of data. Redundant data is removed in this type of compression but there is no loss of data as shown in Fig.1. Different schemes are available in lossless compression such as Run length encoding, Huffman coding, Lempel Ziv Encoding [4].

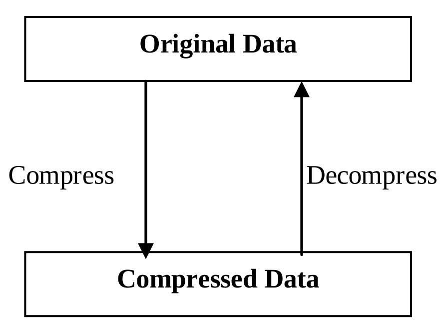

Fig.1: Lossless Compression [4]

3.2 *Lossy Compression*: In this technique, after decompression original data is not retrieved means Lossy compression does not guarantee to reproduce the original input as shown in Fig.2. JPEG Encoding and MPEG Encoding are of lossy Compression.

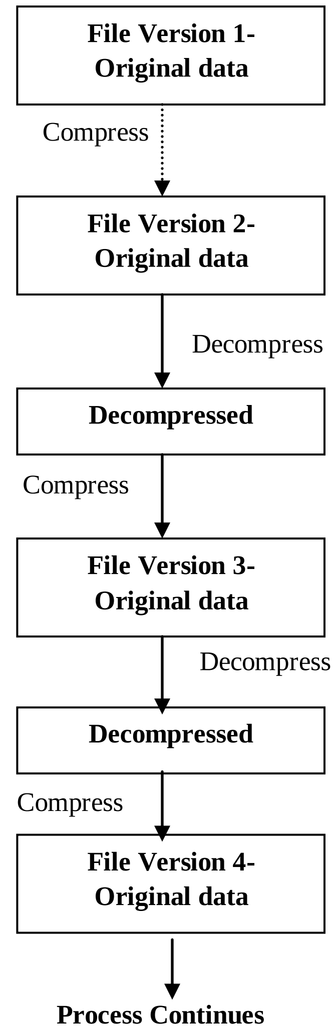

Fig.2: Lossy Compression [4]

4. Energy Aware Routing Algorithm (ERA)

Energy Aware Routing is a routing protocol for prolonging the lifetime of a WSN. The algorithm is based on clever strategy of cluster head (CH) selection, residual energy of the CHs and the intra-cluster distance for cluster formation. To facilitate data routing, a directed virtual backbone of CHs is constructed that is rooted at the sink. ERA uses multiple paths between source nodes to the information sink with a certain probability so the duration of the entire work is increased. [5].

The algorithm includes two phases,

- **Clustering**: Sensor nodes are grouped into clusters as follows. Each sensor node sets its own timer independently before it starts the campaign for CH selection.
- **Routing**: To route the information to the sink, a Directed Virtual Backbone (DVB) of the CHs rooted at the sink is constructed. Initially, the sink sends a

ISSN: 2278 – 1323

Route Request Message (RREQ) to the CHs in the number *2R* where *R* is communication range. [5].

5. PROPOSED METHOD

It is proposed that a homogenous set of sensor nodes are deployed in the target area. All the sensor nodes become static once they are deployed and the target area is completely covered by them. The sink is also static and located outside the target area. All the sensor nodes are initially provisioned with equal amount of energy. Each sensor node has given a unique identification number *ID*, sensing range, denoted by *r*, and communication range *R*. To enhance the throughput of ERA, lossless compression is implemented. With the help of lossless compression, every bit of data remains same even after the file is uncompressed. It restores all the information. As the compression ratio is increased, throughput and remaining energy will also be increased and then the optimal compression ratio is chosen. The Fig.3 presents the flow chart of proposed method.

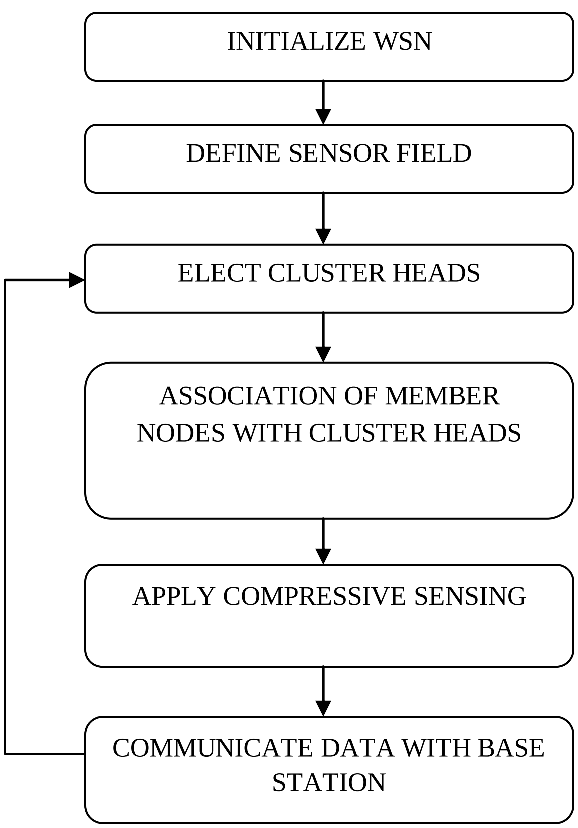

Fig.3: Flow chart of proposed method

Step 1:- Initialize the network with the various characteristics

Step 2:- Define sensor field with the respective placement of the sensor nodes and also the base station

Step 3:- Cluster head selection technique come in action to elect some of the sensor nodes as cluster heads

Step 4:- The association of the member nodes with the cluster heads will be done by using the minimum distance formula between the member nodes and the respective cluster heads.

Step 5:- Apply lossless compressive sensing technique to fuse data from the cluster heads and compress it before sending to the base station.

Step 6:- Now communicate the from the cluster head(s) to the base station.

6. SIMULATION RESULTS

For experimental analysis, the Initial Energy of each sensor is set to 0.5 joules and sensors nodes are deployed in target area of size 100*100 meter square. The performance of proposed compression based ERA is evaluated through throughput and remaining energy. The simulations are performed for various compression ratios such as 0, 3, 5, 8 and 18. The simulation results are presented in Fig.4-Fig.13 through different cases.

Case I: For Compression Ratio 0, the results are shown in Fig.4 and Fig.5.

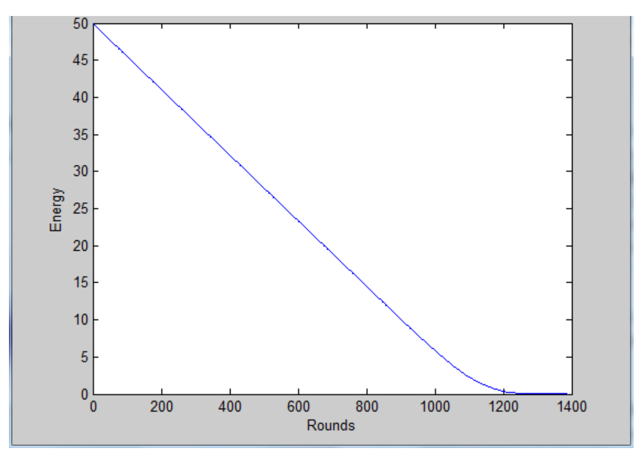

Fig.4: Remaining Energy

ISSN: 2278 – 1323

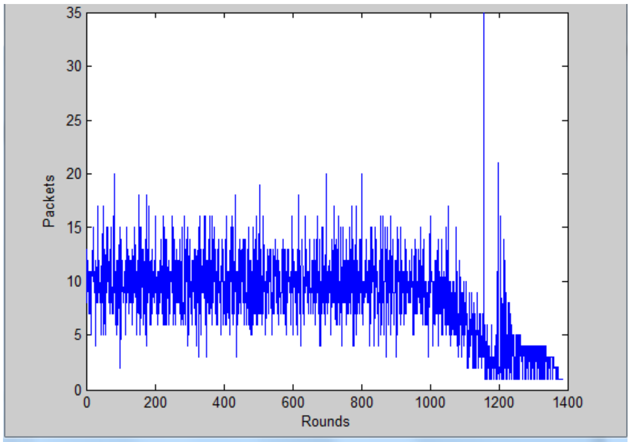

Fig.5: Throughput

Case II: For Compression Ratio 3, the results are shown in Fig.6 and Fig.7.

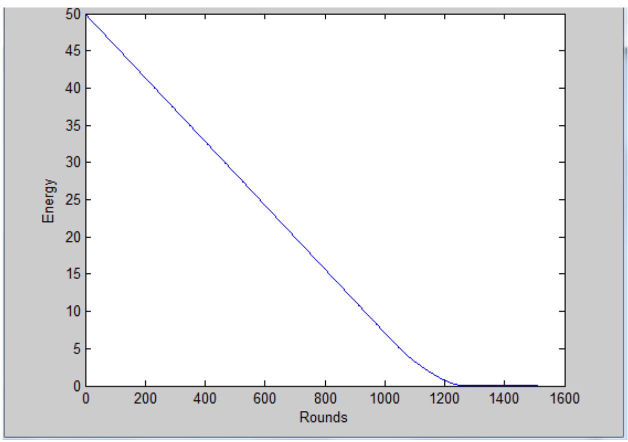

Fig.6: Remaining Energy

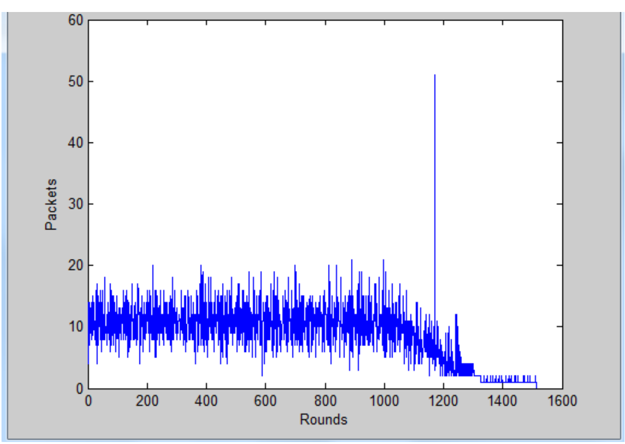

Fig.7: Throughput

Case III: For Compression Ratio 5, the results are shown in Fig.8 and Fig.9.

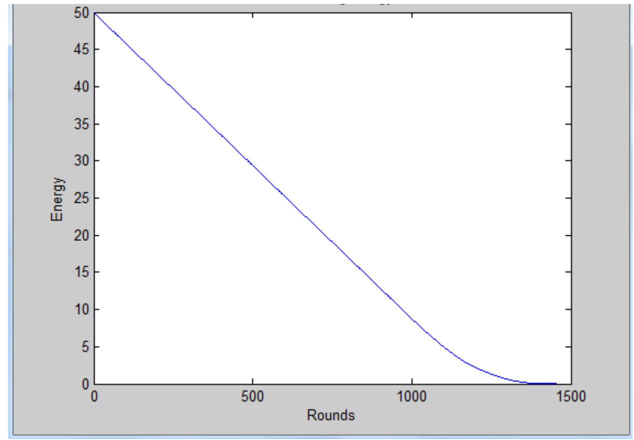

Fig.8: Remaining Energy

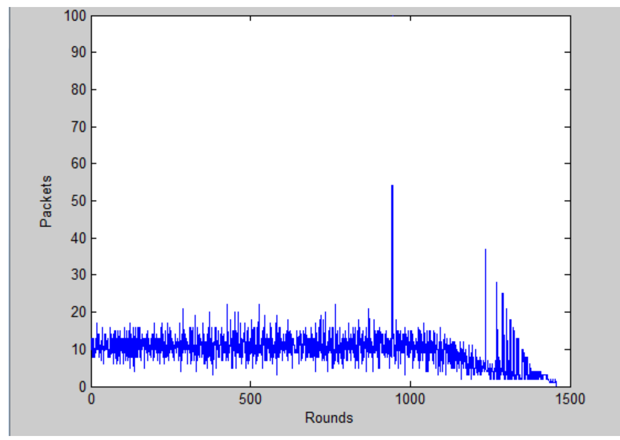

Fig.9: Throughput

Case IV: For Compression Ratio 8, the results are shown in Fig.10 and Fig.11.

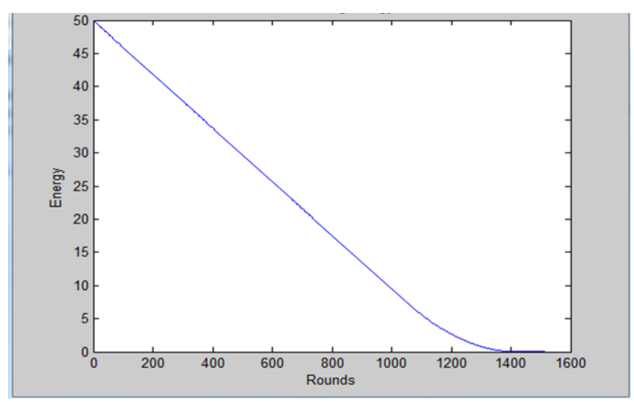

Fig.10: Remaining Energy

ISSN: 2278 – 1323

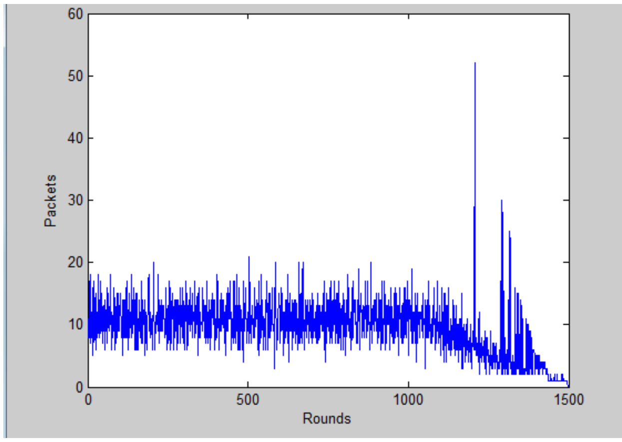

Fig.11: Throughput

Case V: For Compression Ratio 18, the results are shown in Fig.12 and Fig.13.

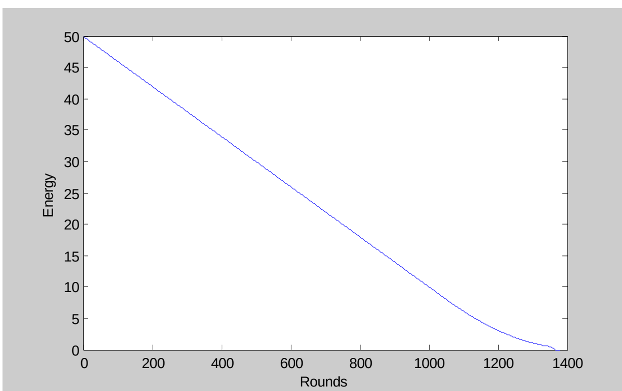

Fig.12: Remaining Energy

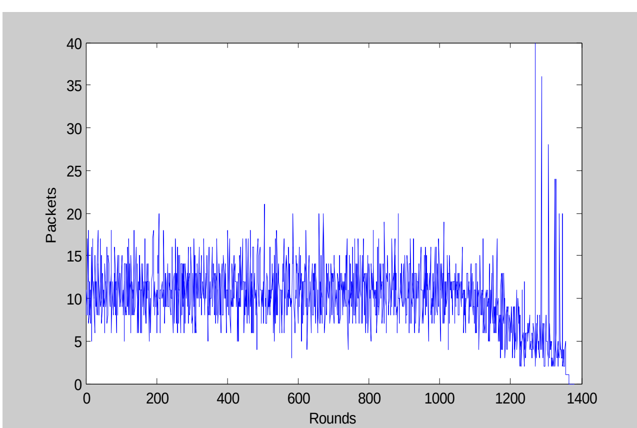

Fig.13: Throughput

7. DISCUSSION

The simulations were performed for energy aware routing algorithm with different compression ratios. The results for various simulations are presented in Fig.4 to Fig.13. The compression based ERA worked well and throughput and network life time was enhanced with the proposed scheme but as the compression ratio increased, the throughput and network lifetime decreased.

8. CONCLUSION

As we know that the most of the existing techniques has neglected the use of the effects of compressive sensing i.e. data fusion to remove redundant data from sensor nodes. Therefore we proposed compressive sensing based ERA in which lossless compression is used to enhance the efficiency of ERA. As we increase the compression ratio, throughput and remaining energy is increased and we choose the optimal compression ratio.

REFERENCES

[1] IF Akyildiz, W Su, Y Sankarasubramaniam,ECayirci “Wireless sensor network : survey ” . Computer Networks ,volume 52, 2008, pp: 2292–2330 .

[2] Karlof, Chris, and David Wagner. "Secure routing in wireless sensor networks: Attacks and countermeasures." Ad Hoc Networks, Volume 1,Issue 2, 2003, pp: 293–315.

[3] Sushruta Mishra, Hiren Thakkar. “Features of WSN and Data Aggregation techniques in WSN: A Survey”, In Proceedings of the International Journal of Engineering and Innovative Technology, Volume 1, Issue 4, 2012, pp: 264.

[4] Naoto Kimura, Shahram Latifi,” A Survey on Data Compression inWireless Sensor Networks”, In Proceedings of the International Conference on Information Technology: Coding and Computing,Vol. 2, 2005,pp. 424-451.

[5] Tarachand Amgoth and Prasanta K. Jana, “Energy-aware routing algorithm for wireless sensor networks, In Proceedings of the International Conference on Computers and Electrical Engineering, 2014, volume 41, pp: 357-367.

[6] David Hasenfratz, "Analysis, comparison, and optimization of routing protocols for energy harvesting wireless sensor networks”, In Proceedings of the International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 2010, pp: 19 - 26.

[7] Raju, G. T., "Wireless sensor network lifetime optimization”, In Proceedings of the International

ISSN: 2278 – 1323

Conference on Advances in Recent Technologies in Communication and Computing , Volume:28 , Issue: 7, 2011, pp: 1127 - 1137.

[8] Eu, ZhiAng, and Hwee-Pink Tan. "Adaptive opportunistic routing protocol for energy harvesting wireless sensor networks." In Proceedings of the International Conference on Communications, 2012, pp: 318 - 322.

[9] Dnyaneshwar Mantri, Neeli R Prasad and Ramjee Prasad, "BHCDA: Bandwidth Efficient heterogeneity aware cluster dependent data aggregation for wireless sensor network", In Proceedings of the International Conference on Advances in Computing, Communications and Informatics, 2013.

[10] Javaid, Nadeem, S. N. Mohammad, K. Latif, U. Qasim, Z. A. Khan, and M. A. Khan , "HEER: Hybrid Energy Efficient Reactive protocol for Wireless Sensor Networks." In Proceedings of the Electronics, Communications and Photonics Conference, 2013.

[11] Zhou Yan-li, Fan Xiao-ping, Liu Shao-qiang, XiongZhe-yuan, "Improved LZW Algorithm of Lossless Data Compression for WSN", In Proceedings of the International Conference on Computer Science and Information Technology, Volume 4 , 2010, pp: 523 - 527.

[12] Zhang Huan, Fan Xiao-ping, Liu Shao-qiang, ZhongZhi"Design and Realization of Improved LZW Algorithm for Wireless Sensor Networks", In Proceedings of the International Conference on Information Science and Technology,2011,pp: 671 - 675.

[13] Liu Xiang, Jun Luo and Catherine Rosenberg, "Compressed Data Aggregation: Energy Efficient and High Fidelity Data Collection", Networking, Volume:21 , Issue: 6 ,2011, pp: 1722 - 1735.

[14] Guangsong Yang, Shuqin Zhang "Data Aggregation Scheme based on Compressed Sensing in Wireless Sensor Network", In Proceedings of the Journal of Networks , Vol. 8,Issue 1, 2013,pp: 55-561.

[15] Shahina Sheikh, Hemlata Dakhore, "Data Compression Techniques for Wireless SensorNetwork", In Proceedings of the International Journal of Computer Science and Information Technologies, Vol. 6, 2015,pp: 818-821.

[16] S.Mohamed Saleem, P.Sasi Kumar, "Evaluating Effectiveness of Data Transmission and Compression Technique in Wireless Sensor Networks", In Proceedings of the International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 3, Issue 1, 2013,pp: 70-73.

[17] S. Jancy, C. Jaya Kumar, "Packet level data compression techniques for Wireless Sensor Networks", In Proceedings of the Journal of Theoretical and Applied Information Technology, Vol.75, Issue 1, 2015,pp: 36-42.

ISSN: 2278 – 1323