A Proposed Energy Efficient Data Compression Algorithm For Wireless Sensor Network-NK-RLE

Narinder Singh[1], Dr. Harmaninderjit Singh[2]
[1]Research Scholar, [2]Assistant Professor
Department of Computer Science, Desh Bhagat University, Mandi Gobindgarh, India.

***Abstract* -** In this paper, we propose NK-RLE a new data compression algorithm motivated from Run Length Encoding RLE and K RLE. The proposed algorithm increases the compression ratio compared to KRLE and RLE. In order to improve the compression results with diverse statistics of data sources it is essential to introduce efficient in-network processing technique in order to save energy by decrease of the amount of data to be transmitted. The well known technique is data compression and data aggregation. The proposed data compression algorithm efficiently enhance the data compression ratio and hence improving energy efficiency in wireless sensor networks

***Keywords* -** Data Compression, Lossy compression, Lossless compression, LZW, K-RLE

I. INTRODUCTION

Wireless sensor network is very vigorous research area .WSNs are very trendy now a days due to their broad range of application areas like Military ,Health Environmental, Home applications, Commercial applications area monitoring Health care monitoring, Environmental, Earth sensing, Air pollution monitoring, Forest fire detection, Landslide detection, Water quality monitoring, Industrial in, disaster management, and equipment diagnostics etc. a processing and communicating unit organized in such a way to perform specific task[1][2]. Sensor nodes are usually powered by batteries processor, wireless transceiver, and memory. Due to the limited capacity of the batteries, it is important to consider the energy (power) in the design and deployment of wireless sensor networks (WSNs). Since the sensor nodes are deployed in harsh location as they cannot be recharged. Due to unattended deployment and inability of recharging, the power consumption of the nodes should be optimal. [3].Hence conservation of energy is major concern in WSN. As transmission is the most energy consuming issue in WSN [4]. The common solution to conserve the energy by reducing the amount of transmission data by sensor nodes is Data Compression technique.

II. RELATED WORKS

Wireless sensor networks have limited power supply, bandwidth and memory. To maximize the power of limited resources some measures are required to increase the productivity of sensors. Compression is one best solution to reduce the sense data before transmit ion however the algorithms which are exiting are not as per requirement of WSN. In this paper video compression low compression and in network compression and coding by ordering is studied [5]. In this paper, author has proposed a effective framework for adaptive data compression based on prediction techniques to adapt to energy and power generation. Harvesting energy from the ambient environment has received increasing attention in modern research due to the fact that it can drastically extend the lifetime of sensor nodes. However, power management is still a critical issue because power generation rates are random and vary over time [6]. In this paper author has presented an energy-efficient protocol for the physical layer of the IEEE 802.15.4 standard that deploys the green modulation and Raptor coding in a realistic channel model inspired by the Gilbert-Elliott channel to minimizing the energy consumption in both circuit components and RF signal transmission in Wireless Sensor Network (WSN) and proposed an efficient LZW-based compression method namely the Sifted Dictionary-based LZW (SD-LZW) using the probability of occurrence of all strings present in output data The proposed data compression scheme is capable of adjusting to any type of data input and of returning output using the best possible compression ratio [7]. In this paper the main focus is on optimization of energy in terms of lightweight security and compression techniques which reduces the complexity of Wireless Sensor Network the Advance SET-IBS protocol for encrypting the data on the sensor node is proposed [8]. This paper proposed an enhanced DP data compression algorithm, that is, the collected data is transmitted after they are firstly compressed. And method of automatically setting the compression threshold value to reduce the influence of personal factor on the compression process; and use the best curve fitting algorithm to fit the curve to reduce the random error and increase the compression precision; use the step length and stack technologies to decrease the frequency of scanning of data point and reduce the energy consumption of node [9]. Energy efficiency is the major design issue in WSN. Clustering and routing are the most widely used energy efficient techniques [10]. DC compression techniques have been presented in [11]. The popular coding methods are Huffman coding, Arithmetic coding, Lempel Ziv coding, Burrows-wheeler transform, RLE, Scalar and vector quantization. K-RLE data compression algorithm on an LPC2138 is evaluated by compressing real temperature datasets. Due to difficulty in using S-LZW on a sensor platform with a limited memory, in this paper a algorithm inspired from RLE named K-RLE is implemented which increases the compression ratio compared to RLE. In this paper compression ratio is shown as 64.94%, 79.65% and 99.56% for K=1, 2 and 3 respectively [12]. However K-RLE data compression algorithm is a low power Compression algorithm presented in [13]. K-RLE is a lossy compression algorithm. at the user level, It chooses K considering that there is no difference between the data item d, d+k, d-k. The basic and proposed system architecture, design, complexity, and performance analysis is given in [14] for RLE and K-RL

A simpler form of lossless data compression coding technique is RLE [15].It represents the sequence of symbols as runs and others are termed as non-runs. The run consists of two parts: data value and count instead of original run. It is effective for data with high redundancy Due to the limited resources available in tiny sensor nodes, to apply data compression in WSNs requires specifically designed algorithms. Two approaches have been followed:• to distribute the computational cost on the overall network [16], Huffman coding [17] is the most popular coding technique which effectively compresses data in almost all file formats. It is widely employed in lossless Data Compression. It is based on two observations: (1) In an optimum code, the frequent occurrence of symbols is mapped with shorter code words when compared to symbols that appear less frequently. (2) In an optimum code, the least frequent occurrence of two symbols will have the same length. The basic idea is to allow variable length codes to input characters depending upon the frequency of occurrence. The output is the variable length code table for coding a source symbol. It is uniquely decodable and it consists of two components: Constructing Huffman tree from input sequence and traversing the tree to assign codes to characters. It is commonly used in text compression.

III. DATA COMPRESSION

Data compression is uses a formula to determine how to shrink the size of the data needed to represent ,saves storage capacity, increases the speed of file transfer, and decrease hardware and network bandwidth .Data Compression can be a lossless or lossy. Lossless compression enables the restitution of a file to its original state, without the loss of data, when the file is uncompressed. Lossless compression is the typical approach used for text and spreadsheet files, where the loss of words or data would change the information [18]. Lossy compression permanently changes bits of data that are redundant, insignificant or unnoticeable. Lossy compression is useful with graphics, audio, video and images [19].

Difference between Lossy Compression and Lossless Compression

Table 1

Basis of comparison	**Lossy Compression**	**Lossless Compression**
Algorithms	Transform coding, DCT, DWT, fractal compression, RSSMS.	RLE, LZW, Arithmetic encoding, Huffman encoding, Shannon Fano coding.
Used in	Images, audio and video.	Text or program, images and sound.
Data-holding capacity of the channel	More	Less as compared to lossy compression

IV. RUN LENGTH ENCODING

RLE is simple technique to compress digital data. It represent consecutive runs of same value in the data as the value followed by the count (or vice versa) .Run length is defined as number of consecutive equal values .the objective is to reduce the amount of data needed for storage transmit ion. The central idea behind this algorithm is, If a data item d occurs n consecutive times in the input data we replace the n occurrences with the single pair nd. [20]

Run-Length Encoding (RLE) is a basic precision algorithm. It is very useful in case of repetitive and slowly varying data items most useful basic compression algorithm on data that contains many such runs. RLE is a lossless data compression algorithm used for slowly varying sensor and image data.

It is not useful with files that don't have many runs as it could double the file size.

This is basic compression algorithm on data that contains many such runs- for example, relatively simple graphic images .For example, consider a screen

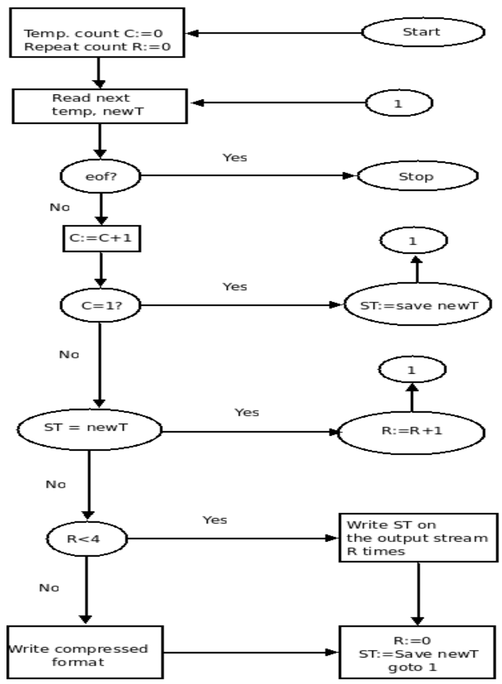


Figure 1

Containing plain black text on a solid white background. There will be many long runs of white pixels in the blank space, and many short runs of black pixels within the text. Let us take a hypothetical single scan line, with B representing a black pixel and W representing white:

WWWWWWWWWWWWWBWWWWWWWWWWWW
BBBWWWWWWWWWWW
WWWWWWWWWWWWWWWBWWWWWWWWWWWW
WWWW

Apply the run-length encoding (RLE) data compression algorithm to the above hypothetical scan line, the encoded text is as follows:

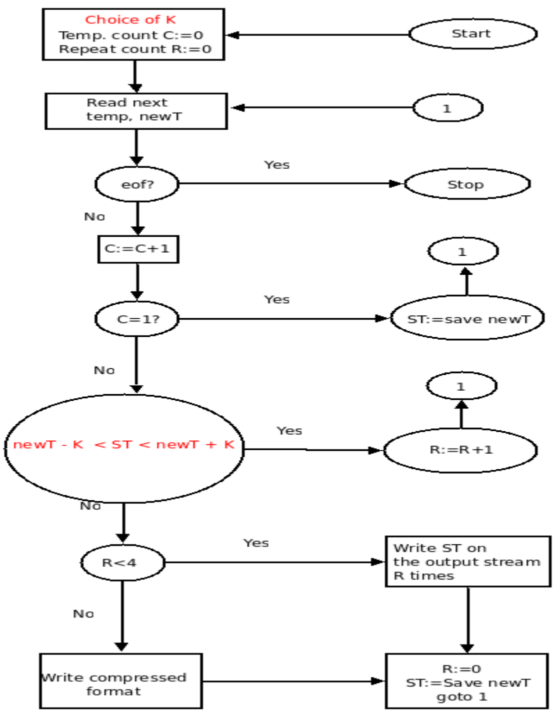
13W1B12W3B24W1B15W Interpret this as twelve W's, one B, twelve W's, three B's, etc.

The run-length code represents the original 69 characters in only 20. The principle remains the same The graphical representation of the RLE algorithm can also be applied on temperature readings.

V. K-RLE (K-RUN LENGTH ENCODING)

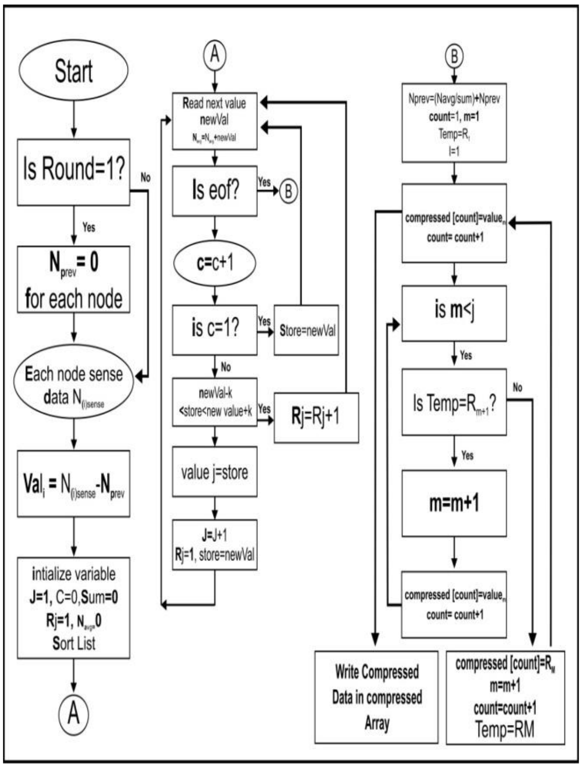
It is a high precision algorithm. Here the parameter K denotes precision. K K is defined as:

- $\delta = \frac{K}{\sigma}$ with σ a minimum estimate of the allan standard derivation i.e. σ is a representative of the instrument measurement noise below which the precision is no longer significant.
- K has a range of values say 0, 1, 2, 3 . . . If K=O then K-RLE becomes RLE [21].



let K be a number, If a data item d, d+K or d-K occur n consecutive times in the input stream, we replace the n occurrences with the single pair nd. RLE is lossless but KRLE is lossy. The unit of K depends upon the datasets used. If temperature data set is used, K will be in degrees. However, the data will be modified by change on RLE using the K precision. At the user level this algorithm may be lossless as he/she selects considering that there is no difference between the data item d, d+K or d-K according to the application [20].

VI. PROPOSED ALGORITHM



In the proposed algorithm enhancement of compression in wireless sensor network at node level is proposed. In our proposed NK-RLE algorithm node send the difference between the previous sense data and new data rather than sending the original new data as compare to previous RLE and K-RLE based existing algorithm ie

val_i =N(i)sense- N prev

where vali is the result value to be send by node and N prev is the average of the previous saved value and N (i) sense is the new value .

Further as in KRLE K is supposed as a number, If a data item d or data between d+K and d-K occur n consecutive times in the input stream, we replace the n occurrences with the single pair nd. if we consider k= 0 it means RLE and KRLE are same . Modification in k precision make the difference ie k =1 , k=2 moreover it consider no difference between the data item d,d+k , d-k. In proposed NK-RLE for sending nd1,nd2,nd3 repeating value n is send once ie nd1,d2,d3 which further enhanced the energy and life time of the network .

The detail working of algorithm is shown in flowchart as follows we assume that in beginning at each node level previous value will be N prev= 0 and in each round vali =N(i)sense- N prev where vali is the result value to be send by node and N prev is the average of the previous saved value and N (i) sense is the new value . now to check the repetitive value in list of data we will check the element if it lies between new val-k<store<newval+k if yes it will initialize the counter Rj=Rj+1 and it will store the value j in store variable now to calculate nprev divide nprev by c + nprev and initialize count =1 m =1 and temp r1 =0 and intilize compressed array to count repetitive value and m pointer type variable will check until end of list and val of temp r1 will be compared with r1+1 if both are equal it will increase the counter m and stored the value in compressed array and go on .which will gives us count of repetitive value with value ie 3d1,3d2,3d3 will be send as 3 d1,d2,d3.

VII. PROPOSED DIFFERENCES IN K-RLE AND NK-RLE

Table 2

	Compressed size	**Compression ratio**	**Energy efficiency**	**Compression time**	**Decompression time**
NK-RLE	Low	High	High	Low	Low
K-RLE	High	Less	Low	High	High
RLE	High	Less	Low	High	High

VIII. CONCLUSION AND FUTURE WORK

The paper presented a new compression algorithm for data compression. This data compression algorithm is a low power Compression algorithm. NKRLE is a lossy compression algorithm. It is lossless at the user level, This algorithm inspired from RLE and KRLE which increases the compression ratio compared to RLE and KRLE. With this algorithm efficient transmission of data with minimum power consumption is possible which increases the life span of wireless sensor network . This proposed algorithm NK-RLE implemented an efficient compression process. NK-RLE uses less energy and high Compression efficiency compared to RLE and KRLE. Future work of this paper is implementation of algorithm to prove compression efficiency and low power consumption

IX. REFERENCES

[1]. D. S. Bhadane and S. Y. Kanawade, *"Comparative study of RLE & K-RLE compression and decompression in WSN,"* 3rd International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, 2016, pp. 1-5.

[2]. R. Rani, R. Manro, *"Improved Watermarking Leach protocol using node level Integrity and Confidentiality in WSN",* International Journal of Computer Sciences and Engineering, vol. 6, Issue 11, pp. 597-601, Nov-2018.

[3]. S. Naik, N.Shekokar, *"Conservation of Energy in Wireless Sensor Network by Preventing Denial of Sleep Attack",* Procedia Computer Science, vol. 45, pp. 370-379,2015.

[4]. Reinhardt, D. Christin, M. Hollick and R. Steinmetz, *"On the energy efficiency of lossless data compression in wireless sensor networks,"* IEEE 34th Conference on Local Computer Networks, Zurich, 2009, pp. 873-880.

[5]. Naoto Kimura and Shahram Latifi, *"A Survey on Data Compression in Wireless Sensor Networks"* Proceedings of the International Conference on Information Technology: Coding and Computing (ITCC'05).

[6]. M. 1. Mohamed, W. Y. Wu, and M. Moniri, *"Adaptive Data Compression for Energy Harvesting Wireless Sensor Nodes",* ICACT Transactions on Advanced Communications Technology (TACT) Vol. 5, Issue 4, July 2016.

[7]. Hamidreza Asgarizadeh and Jamshid Abouei, *"An Energy-Efficient SD-based LZW Algorithm in Dynamic Wireless Sensor Networks".*

[8]. Mr. Akshay S. Nagdive *"An Implementation of Energy Efficient Data Compression & Security Mechanism in Clustered Wireless Sensor Network",* International Conference on Advances in Computer Engineering and Applications (ICACEA) 2015.

[9]. Deyu Zhang, Zheng Li, Yanhui Lv, Zhiwei Qu, *"An Improved DP Compression Algorithm of Wireless Sensor Network",* Sixth International Conference on Instrumentation & Measurement, Computer, Communication and Control 2016.

[10]. W. R. Heinzelman, A. Chandrakasan and H. Balakrishnan, *"Energy-efficient communication protocol for wireless microsensor networks,"* Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Maui, HI, USA, 2000, pp. 3005-3014

[11]. T. Srisooksai, K. Keamarungsi, P. Lamsrichan,and K. Araki, *"Practical data compression in wireless sensor networks: A survey,"* J. Netw. Comput. Appl., vol. 35, no. 1, pp. 37–59, 2012.

[12]. R. S. Pisal, *"Implementation of Data Compression Algorithm for Wireless Sensor Network using K-RLE ",* International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), vol. 3, Issue 11, November 2014.

[13]. V.KRISHNAN1, MR. R.TRINADH, *"A low power new data compression for wire/ wireless sensors network using KRLE"* International Journal of Electronics Signals and Systems (IJESS), ISSN: 2231-5969, Vol-3, Iss-2, 2013.

[14]. P. Suneel Kumar, Patibandla Swapna, *"Performance evaluation of K-RLE compression algorithm Technique for Text data"* International Journal of Advanced Research in Computer and Communication Engineering, Vol. 4, Issue 6, June 2015.

[15]. J. Capon, *"A probabilistic model for run-length coding of pictures,"* IRE Trans. Inf. Theory, vol.100, pp. 157–163, 1959.

[16]. Ganesan, D., Estrin, D. and Heidemann, J., *" DIMENSIONS: why do we need a new data handling architecture for sensor networks?",* SIGCOMM Comput. Commun. Rev., 33, pp.143–148, 2003.

[17]. Huffman DA. "*A Method for the Construction of Minimum Redundancy Codes*". 1098–1102, 1952.

[18]. S. Mahumad, *"An Improved Data Compression Method for General Data",* International Journal of Scientific & Engineering Research, vol. 3, Issue 3, March -2012.

[19]. Renu Sharma Er. Matish Garg, *"Comparative analysis of JPEG DCT, Haar & Daubechies Wavelet, Fractal for Image Compression"* International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 1, January 2014 ISSN: 2277 128X.

[20]. D. Salomon, "Data Compression the Complete References", Third Edition. Springer-Verlag New York, Inc, 2004.

[21]. E. P. Capo-Chichi, H. Guyennet and J. Friedt, "K-RLE: A New Data Compression Algorithm for Wireless Sensor Network," Third International Conference on Sensor Technologies and Applications, Athens, Glyfada, 2009, pp. 502-507.

Mr. Narinder Singh had done Master of computer application from Maharishi dayanand university, Rohtak in 2004 and M.phil from choudhary Devi Lal university in 2008. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Computer Sciences, Guru Nanak College, Budhlada since 2007. He is a member of computer society of India since 2010. He has published more than 10 research papers in national and international reputed journals and published three books. His main research work focuses on Data compression wireless sensor network, Network Security, Cloud Security and Privacy. He has 11 years of teaching experience and 5 years of Research Experience.

Dr. Harmaninderjit singh is an Assistant Professor and has more than 12 years of academic experience. He has done MCA degree from Punjabi University Patiala, Punjab and received the PhD Degree in Computer Science from Desh Bhagat University, Mandi gobindgarh, Punjab. He has published more than 17 papers in different Journals and conference proceedings. His research interest is in the areas of Open Source Software and Algorithm Design and is presently working on it.