A Study on Frameworks for an Energy Efficient Wireless Sensor Network

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ABSTRACT

Wireless sensor networks (WSNs) have found substantial notice due their use in multi-disciplinary domains. Main constraints faced by these networks are availability of less memory space, limitation in the power supply and bandwidth available for communication. The problem of energy management in Wireless Sensor Networks is vital in the stationing of the nodes. The energy issue shall be classified in to three main areas: (i) conserving the energy; (ii) Sharing of energy resources; and (iii) energy-harvesting techniques. In the paper, a survey is performed on the main contributions in methods for Wireless sensor networks to achieve competency in energy management.

Keywords: Wireless sensor networks, energy management, hierarchical routing.

1 Introduction

Wireless Sensor Networks (WSN) are sensors which are geographically or compactly disseminated to check on the various environmental conditions like pressure, sound, and temperature and so on. It has found wide applications in Intelligent home appliances, Disaster Management, Critical Military Mission, Precise Agriculture Production and Structural Health Monitoring. WSN comprises of sensor nodes of thousands in number for checking various processes. A sensor node is an electronic device which transform various physical parameters under consideration to signals that can be measured and analysed. The structure chart of wireless sensor network is depicted in Figure 1. In WSN, the set of sensor nodes are connected wirelessly with a central node known as the Base station. Base station is able to mutually govern the network in a constitutional way and connect with final users. Data gathering is a main task performed by the sensor nodes which are distributed geographically, will be able to sense changes in physical parameters. The changes sensed is processed before sending it to the Cluster Heads which further directed to central unit or sink node [1].

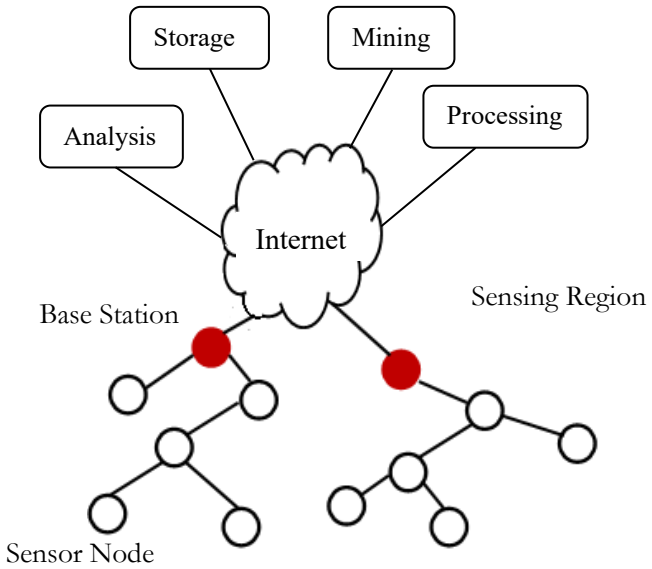

Figure 1: *Structure Chart of Wireless Sensor Network*

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In wireless transmission, the network nodes are branched into anchor nodes and unknown nodes. Anchor nodes are the sensor nodes whose location is known in the network, where unknown nodes are those nodes whose location details are obtained by computation [8].

In the wireless sensor network's battery operated sensor nodes are used. The amount of energy required to transfer or direct data to the sink node is different for different sensor nodes. The energy required depends on the position of sensor node with respect to the sink node. [3], [4].

Generally, sensor nodes have a finite power source and are usually set up in faraway areas. It is a tedious task to energize or change the battery of sensor nodes. So appropriate techniques have to be adopted to reduce the power intake of the nodes and for the improvement of the life expectancy of WSN [5].

The article is aimed to put forward a few methods that can be used for the implementation of a WSN which is energy efficient. The methods are briefly mentioned in the section III of the paper and the framework is depicted in Figure 2.

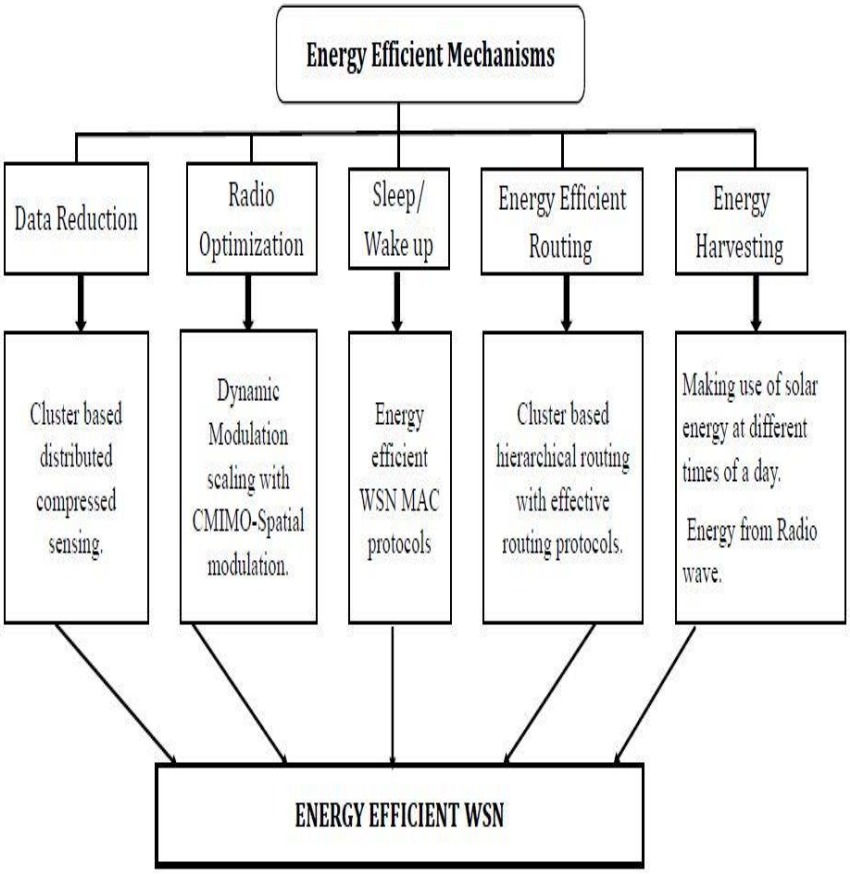

Figure 2: *Framework for Energy Efficient WSN*

2 Related Work

The technology for WSN is on the rise. Many protocols have been put forwarded for effective routing of WSNs. These protocols count on energy preservation and extension of the network lifespan.

Reference [1] proposed an innovative routing algorithm with a fitness function is well used. In the proposal, normalization of all the parameters in the fitness function assured equal contribution from each of the parameters. [2] proposed a technique of particle swarm optimization, that is based on LEACH protocol with fuzzy logic. It applies hybrid particle swarm optimization along with clustering algorithm for cluster arrangement. The primary and secondary cluster heads are selected using fuzzy logic.

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Reference [3] presented ultra-low power methods intended for extending the overall lifespan of sensor network by making noteworthy savings in energy level. The development of Dynamic Power Management practices shall be put forwarded to improve the lifespan and functioning of an energy collecting wireless sensor network. [6] recommended a structure for energy level efficient grouping by means of employing an energy balancer in wireless network. Initially, an n level of grouping is granted which resulted in the drop of the energy utilization by the cluster heads. Then by focusing on the difference between the energy remaining in the cluster heads, an energy balancer is employed so as to lessen the energy unused to the maximum possible level.

Reference [7] presented the application of the LEACH procedure in WSNs and development of an improved methodology for choosing the cluster head. [8] put forward a grouping plan using a matrix with adjacency. It encodes the neighbourhood and connectivity of nodes in a network.

Reference [9] analysed the features of various homogeneous protocols and a few heterogeneous protocols. The features of Low Energy Adaptive Clustering Hierarchy, Improved Energy Balanced Routing Protocol and Modified Stable Election Protocol are analysed. [10] proposed to employ agility for joint energy restock and data collection. An entity named SenCar is put forwarded. It served as a movable information gatherer that wander in the field to collect information through short range communication. It also served as a carrier to energize sensors in its movement by making use of wireless energy transmissions.

Reference [11] suggested the low-energy adaptive hierarchical clustering protocol. The roles are to casually setup clusters and transmission of data between cluster members and cluster heads, along with transmission between cluster heads and base station. Unsystematic choice of heads in the cluster caused a rise in the energy intake and an earlier death. [12] attempt to lessen the energy intake of Cluster Heads in WSN by considering remaining energy, length of buffer, and power of received signal influences for cluster head selection procedure.

Reference [13] put forward an improved energy optimization channelling protocol for WSNs for lengthening the networks' lifespan by dropping and harmonizing energy intake. The paper endorses selection of cluster head by an algorithm based on grid and announces both energy weight as well as weight factors to ease the energy intake in the variation of cluster heads.

Reference [14] proposes a protocol in which cluster head is carefully chosen from the centroid location and from each cluster gateway nodes are being nominated. Gateway node is for reducing the information contents from cluster head nodes and sending the same to the base station.

Reference [15] presented a multiple hop routing procedure established on the grid grouping to overcome the elevated energy intake by the cluster heads in the network. The election process of serviceable nodes is enhanced through merging various factors so as to minimize the energy consumption. The parameters chosen are energy lasting in nodes, their position, and levels of the network area. The communicating nodes are engaged to hand-pick the cluster heads besides transmitting packets of data among clusters by multi hop routing and thus dropping the amount of work of cluster head nodes.

Reference. [16] proposed a routing protocol which merges the methods of grouping and sink mobility to achieve an energy efficient network. Each node is assigned with a weight. The weight is calculated based on the left over energy in the node along with the separation of the respective node from the other nodes. The node having highest magnitude is chosen as cluster head in each of the clusters. The heads are connected to each other for communicating in the inter cluster. This is achieved by greedy algorithm that make a chain to join the cluster heads to each node.

3 Key Methods

In the section, various methods and modern research aspects which focus to enhance the lifespan of the wireless sensor network by downsizing the consumption of energy for the usual process associated with the sensor is presented.

3.1 Data Reduction

The energy can be saved by reducing the size of data to be transferred to the sink. Aggregation, compression, and prediction are methods used for Data reduction [17], [18].

3.2 Radio Enhancement

Radio unit is the key element that pushes the drainage of battery-operated node. Various techniques like modulation optimization, cooperative communication, directional antenna, and cognitive radio are implemented to minimalize the energy used by the radio.

3.3 Energy Efficient Routing

In the WSN applications information will flow from sensor nodes to Base Station and occasionally data redundancy may occur. Clustering supports reduction in data by spatial correlation. Based on these features, hierarchical routing protocols are preferred for the energy efficient WSN. Hierarchical routing protocols are classified based on cluster, tree, grid, and area [6], [8].

3.4 Energy Harvesting

Usually, Sensor nodes are energized by batteries with finite capacity. Energy harvesting methods may be used to recharge these batteries. Energy harvesting from radio frequency signals has proposed as a promising solution for recharging the sensor nodes [3], [5].

4 Conclusion

WSN is a self–regulating wireless network comprised of geographically distributed sensor nodes. The application of WSN has been spread across multi-disciplinary areas. Sensor nodes possess the capabilities of sensing, computing, and transmission of information. Wireless sensor network brought a transformation in perception of information and compilation in the extensive fields such as military, environmental disasters and structural health monitoring.

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References

[1] Kamaruzzaman Md.and Abhijit Chandra, "A new energy efficient routing scheme with normalized condition parameters for wireless sensor network ". International Conference on Wireless Communications Signal Processing and Networking, 2022, pp.79-83.

[2] Marwa Gamal, N. E. Mekky, H. H. Soliman, And Noha A. Hikal, "Enhancing the lifetime of wireless sensor networks using fuzzy logic LEACH technique-based particle swarm optimization," IEEE Access, vol.10, pp.36935-36948, April 2022.

[3] Felix Mazunga, Action Nechibvute, "Ultra-low power techniques in energy harvesting wireless sensor networks: recent advances and issues," Scientific African 11 (2021) e00720 Elsevier, pp.1-14,2021.

[4] Waltenegus Dargie and Christian Poellabauer "Fundamentals of wireless sensor networks theory and practice". Wiley, 2010.

[5] Q. Ren and G. Yao, ``An energy-efficient cluster head selection scheme for energy-harvesting wireless sensor networks," Sensors, vol. 20, no. 1, p. 187, Dec. 2019.

[6] Aliaa M. Alabdali, Niayesh Gharaei, and Arwa A. Mashat, "A framework for energy-efficient clustering with utilizing wireless energy balancer," IEEE Access, vol.9, pp.117823-117831, August 2021.

[7] Saad Talib Hasson and Salar Essa Hasan, "An improvement on LEACH protocol for wireless sensor network," 7th International Conference on Contemporary Information Technology and Mathematics (ICCITM-2021), 2021, pp.130-134.

[8] Waltenegus Dargie and Jianjun Wen, "A simple clustering strategy for wireless sensor networks," IEEE Sensors Letters, vol. 4, no. 6, June 2020.

[9] Debabrata Singh and Binod Kumar Pattanayak, "Analytical study of an improved cluster based routing protocol in wireless sensor network," IJST, vol.9(37), pp.1-8, October 2016

[10] Miao Zhao, Ji Li, and Yuanyuan Yang, “A framework of joint mobile energy replenishment and data gathering in wireless rechargeable sensor networks”, IEEE Transactions On Mobile Computing, vol.13, no.12, pp.2689-2705, December 2014.

[11] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, ``Energy- efficient communication protocol for wireless micro sensor networks," in Proc. 33rd Annu. Hawaii Int. Conf. Syst. Sci., 2000, p.10

[12] D. N. Kanellopoulos and P. Gite, ``A probability-based clustering algorithm with CH election for expanding WSN life span," International Journal of Electronics Communications and Measurement Engineering, vol. 9, no. 1, pp. 1-14, 2020.

[13] X. Ren, J. Li, Y. Wu, Y. Chen, H. Sun, and Z. Shi, ``An enhanced energy optimization routing protocol for WSNs," Ann. Telecommun., vol. 76, pp. 1-12, Mar. 2021.

[14] K. N. Qureshi, M. U. Bashir, J. Lloret, and A. Leon, ``Optimized cluster-based dynamic energy-aware routing protocol for wireless sensor networks in agriculture precision," Journal of Sensors, vol. 2020, pp. 1-19, Jan. 2020.

[15] J. Huang, Y. Hong, Z. Zhao, and Y. Yuan, ``An energy-efficient multi-hop routing protocol based on grid clustering for wireless sensor networks," Cluster Computing, vol. 20, no. 4, pp. 3071-3083, 2017.

[16] J. Wang, Y. Gao, W. Liu, A. K. Sangaiah, and H.-J. Kim, ``Energy efficient routing algorithm with mobile sink support for wireless sensor networks," Sensors, vol. 19, no. 7, p. 1494, Mar. 2019.

[17] Shahina Sheikh and Hemlata Dakhore, “Data compression techniques for wireless sensor network”, International Journal of Computer Science and Information Technologies, Vol. 6 (1), 818-821, 2015

[18] A.Y. Tuama, M.A. Mohamed, A. Muhammed, Z.M. Hanapi, R.R. Mohamed, and K.A. Abu Bakar, “Recent advances of data compression in wireless sensor network”. Journal of Engineering and Applied Sciences, 13(21), 9002–9015, 2018.