Strengthening Life Span of Wireless Sensor Networks: A Review

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Abstract -A wireless sensor network (WSN) consists of geographically dispersed independent sensors that monitor physical or ambient parameters like humidity, vibration, heat and collectively transmit the data.They collect to their intended recipient across the network architecture. The significance of energy-efficient routing algorithms has grown since sensor nodes are energy-constrained devices. In order to control and manage the energy consumption of the nodes, a significant number of techniques have been proposed by various scholars. This review paperpresentpublished works that have been proposed for increasing the lifespan of the wireless networks in the very beginning of this paper, a brief overview of the Wireless networks, its architecture working and problems associated with it are discussed. After this, the detailed overview of the approaches that has been presented for overcoming various limitations of current wireless systems. Finally, the conclusion of the paper is given in the final section.

Key Words: WSN, Routing Algorithm, Network Architecture

1. INTRODUCTION

The WSN is a group of sensor nodes which are connected with each other, these interconnected nodes collect the data about the environment surrounding by the wireless communication. The individual nodes have low power and are divided in ad-hoc decentralized fashion. As the wireless sensor network is infrastructure-less network and this network is also extended in numerous wireless sensor networks in ad-hoc manner, this feature of wireless sensor network is used to monitor the physical environmental conditions of the intelligent interconnection systems [17].For sensing the network, the wireless sensor networks are able in both physical quantity and environmental conditions, the wireless sensor network are able to process the information locally, work cooperatively and communicate wirelessly. To understand the working structure of the WSN, see the figure 1. WSN carries three basic elements, computation unit, sensing unit and communication unit. The workings of these three nodes are as follows:

Sensing unit: - In sensing unit an analog signal is produced by sensing the physical phenomena to the ADC so to convert the analog data into digital data, which further transfer to the computation unit for next process.

Computation unit: - The computational unit works as a manipulator for the related data of the sensing unit, it manages the data, communicate and perform self-organization on the given instructions. Computation unit is made up of processor chip, a flash memory for the storage of the program instruction. An internal timer, an active short-term memory for storing the sensed data.

Communication unit: - This working unit is responsible for the rest work like transmission of data and reception of sensor nodes, these functions are performed by the transceiver circuitry.

The wireless sensor network uses the sink or the base station as an intermediate interface between the network and the user. The user can get the important or needed information from the network, the user needs to fire a query on the system and have to gather the results which were obtained by the sink. Basically, the WSN is made-up of group of hundreds of thousands of sensor networks [22]. By the use of radioactive signals the sensor nodes communicate among themselves. There are three basic components which is equipped by the wireless sensor networks, these are: - power components,

sensing and computing devices and radio transceiver. The wireless sensor networks nodes which are individual inherits the constraints of the resources. The inherited nodes have the limitations like: - storage capacity, processing speed, communication bandwidth. The wireless sensor network is responsible for an appropriate self-organized infrastructure having the multi-communication bandwidth [19].

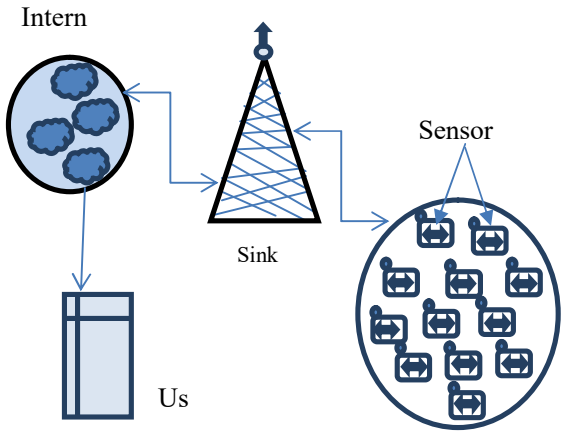

Fig 1: General structure of WSN

The sensors which are available on-board they start collecting the information of the interest. The queries which are sent from the control sites to the wireless networks are responded by WSN to outperform the sensing samples or any specific instruction. The WSN is made up of group of individual sensor networks.In any small sensor network the concept of single-hop communication works as the sensor nodes are placed near by the base station and don't have any need to communicate indirectly with each other, but on the other hand in most of the WSN applications where the coverage area of large and the sensor nodes are placed far away from each other and base stations.There is a need of multi-hop communication for the data sharing and communication [20]. The communication techniques are known from different names: the single-hop communication is called as direct and multi-hop is known as indirect communication. At very known and wide selection areas, the applications of the sensor networks are applicable. These areas are military applications, public safety, medical, environmental check, surveillance and business applications.All these sectors surround and follow the advance development of the micro-control technology, wireless communication and advancement of computers. As the demand of the WSN increased traffic of data also increased which lead to the various problems in the WSNs. The main reason of the problem was the hop-by-hop communication by the sink to the nodes and the limited energy for the CH. As a result of this problem the network suffered from the energy hole and hot-spots which consequently resulted in the congestion and network portioning.

As the sensor nodes are battery powered, it become the main challenge for the operational time due to its limited lifetime. Two factors become the reason for the difficulty of the replacing and recharging of the batteries [12]. The first reason was the cost, which is rising for the maintenance of the nodes for large quantities which usually deploy over a wide area. The second reason was that the inaccessible node which is deployed in regions like volcano, contaminated areas, embedded in building materials and deployed in hostile for the military applications. The coverage and the connectivity problem rise by some node's depletion, leading to isolating a part of the network or leaving a part of the monitored area uncovered. In order to overcome these limitations many protocols were developed. The developed protocols help in increasing the lifetime of sensor nodes.Among the developed protocols one is routing protocol which helps so much in increasing the lifespan of the network. To achieve the

ultimate energy efficiency and maximize the overall networks lifetime the routing protocols prove out to be much more effective and efficient. For the main aim of researchers design such an energy efficient routing algorithm in WNS, through which the lifetime of the WSNs would increase as for sure. Many different types of algorithms like flat, location-based clustering and hierarchical routing based algorithms were proposed for the WSN. From all the proposed WSNs algorithms the clustering-based algorithm performed very well.

In clustering-based algorithms there is a cluster head, responsible for the elimination of the correlated data and can also be able to decrease the final data volume [6]. After that, BS gets the data that is transmitted by the cluster head. The network is divided itself into various clusters, in cluster-based routing protocol, and each individual clusters decreased the energy consumption which was used for long distance communications. The workload of the nodes can be balanced by the help of the clustering via minimizing the entire consumption of the energy; the main reason of the work load was the large gap between the cluster nodes and cluster heads. Therefore, clustering is an energy-efficient solution for increasing network longevity and improving energy method efficiency.Also, the number of messages that needs to be transmitted to the sink node decreases. Many traditional cluster head selection approaches uses the schemes which includes the energy stabilization and network lifetime, these traditional approaches used the concept of Power Efficient Gathering in Sensor Information Systems (PEGASIS), Hybrid Energy efficient Distributed Clustering (HEED), Distributed energy-efficient clustering (DEEC) protocol , Low Energy Adaptive Clustering Hierarchy (LEACH), Threshold sensitive energy efficient sensor network (TEEN) PROTOCOL, which collects the data from its member variant, and then it aggregate the data and then further transfer it to the data collection center or to the sink.

Basically, LEACH can be defined as the distinctive representations of hierarchical protocols. The energy gets reduced significantly with the help of LEACH protocol to balance the constraints of energy consumptions SEP can be used. Apart from that, nodes with high energy than other nodes have to become the cluster heads more than once, as they have fairness restriction on energy use. The approach of TEEN operation applies when each cluster change its time during the function. The LEACH Protocol is only subjected for the PEGASIS. The PEGASIS is mainly focused on developing a chain between all the sensor nodes. This process comes in action due to the reason of energy nodes; via this the energy nodes can assemble a form and transfer to the closest neighbor node. The combination of the nodes which gets aggregated by moving from one node to another node, as the formation of the combination completed then the cluster head transfer it to the base station. For the sensor networks in term of power, the sensor node clustering algorithm can improve the efficiency. More expense id required by the clusters for the selection of cluster head and then for building of clusters. For extending the lifespan of the network, the proximately of the sensor and the means energy of the area employed and decide that if they allow to the individual node to send the data to the cluster head node or allow the interflow in the preceding round.

2. LITERATURE REVIEW

In past, huge number of techniques have been proposed by various scholars for enhancing the lifespan of the wireless sensor networks. Some of the proposed are discussed and reviewed in this section of paper.

- **Pathak, Aruna et al. [8],** proposed work techniques based on the artificial bee colony algorithm namely (PBC-CP) proficient bee colony-clustering protocol. In this work, for the selection of heads the authors used variety of factors like; - nodes energy, distance from base

station to nodes, degree of nodes. To transmit the data from the cluster head to base station, an energy efficient path was chosen which helps in minimizing the consumption of energy in sensor network. The results showcased the effectiveness and efficiency of proposed approach over existing approaches in terms of network lifespan

- **William, P., et al. [1],** stated that wireless sensor networks are used to monitor the changes in the dynamic environments which occur over time to time. The wireless sensors networks use the resources efficiently, for considering the various applications energy efficient data transmission was needed. The study which the author proposed in this work named Strong Clustering Algorithm and Data Aggregation (SCADA). To accomplish the scalability with minimal cost in SCADA-ML and QoS optimization the researchers developed a new routing protocol utilizing the machine learning. While applying the technique of the machine learning to different sizes of WSNs, the two factors: - cluster head selection and data aggregation were focused. the artificial neural network (ANN) is another name of neural network machine learning approach which helps to increase the entire cluster-head yield and cluster formation. There are some characteristics for the sensor nodes such as distance from base station, residual energy and allotted bandwidth.All these characteristics used to give instruction the ANN architecture that for cluster which CH was best. In the next phase, the other given term elaborated the use of machine learning for the reduction of the usage of cluster energy for each cluster by applying the effective data aggregation on the CH nodes. This was the reason for machine learning to know how to reduce the cluster energy by the effective data aggregation for each cluster on CH nodes. For grouping the data aggregation in controlled testing, the machine-learning based solutions was beaten by the SCADA-ML method.

- **MP Kumar, et al. [9],** In such techniques, to maintain the network lifetime and load balance the efforts of the maintenance are often required. In some aspects like chemical process control and disaster prevention it is difficult and expensive to change and recharge the nodes battery. This arising problem becomes the reason for the developers to develop an alternative energy-efficient solution for the power nodes and during the network performance to reduce the energy consumption. Along with the cost reduction and energy consumption, the networks stability and performance were essential to maintain by the energy aware techniques. The energy dissipation sources were studied for finding new solutions for save the energy usage in the network, in this study. Along with that the elaborated optimization and conservation techniques for the available energy of WSN is presented.
- **Sharma, Himanshu et al. [10],** The techniques of the wireless sensor networks were used in various sectors like smart agriculture, smart cities, smart buildings and online industrial monitoring applications are used for the implementation of the real-life internet of things. Usually, there is limited powered capacity was available in the traditional WSN also the batteries were of non-rechargeable type. On various aspects the life time of the WSN was based like duty cycle, battery state of charge level and type of application. The authors proposed for the WSN nodes battery charging an ambient solar energy harvesting technique by applying this technique the on the limited energy solar design the solution for the innovation was presented. And alsomany challenges like intermittency of power, solar energy prediction, thermal issues and other solar environmental issues were raised in the solar energy harvesting. The motive of this proposed work is to work on the maximizing the WSN networks lifetime by using the technique of the solar harvesting. From the simulated result of the authors work, the life time of the sensor network is increased from 5.75 days to 115.75

@23% duty cycles, up to the infinite networks lifetime. Along with this improvement the network throughput from 100k bits to 160 k bits is increased in SEH-WSNs.

- **Orumwense, Efe Francis et al. [2],** proposed an algorithm which gives the priority to the sensor nodes for charging and also helps in the improvement of the available charging scheme; overall this whole scenario helps to increase the lifespan of the WRSN. At first, to inspect the sensor nodes in network and also to visit the nodes in network, an inspection algorithm was developed through which the charging the sensor nodes can be determined. Next, to identify the shortest travel distance use by the WCV a greedy charge algorithm was presented and in the end, a stopping point for the energy for nodes algorithm was proposed when by the base station return the WCV is requires. To determine the performance of author's scheme the simulated experiments were also conducted. The simulated experiments prove that the authors work made efficient improvements as compare from the other literature schemes using several matrices.
- **Bangotra, Deep Kumar, et al. [3],** proposed an effective routing algorithm wherein they compared two opportunistic routing protocols with two NIO algorithms. The two opportunistic algorithms were intelligent opportunistic routing protocol (IOP) and trust-based secure intelligent opportunistic routing protocol (TBSIOP), that were compared with NIO algorithms for improving the energy efficiency and prolong network lifespan. The performance is accessed by an artificial algorithm on MATLAB and the obtained results were compared in term of energy efficiency, end-to-end delay, average risk level and packet delivery ratiofrom the existing ACO-based and PSO-based routing algorithms. All the arguments under consideration were recorded in the maximum 50% malicious nodes for the test case of 25, 50 and 100. The TBSIOP performances were affected significantly by the increasing size network, as 100% packet delivery ratio was there. As the results defines that the TBSIOP, during the routing process can avoid the malicious nodes. As compared to other protocols the life time of the TBSIOP protocol was improved via this process. As long as the applications work is involved, this proved to be beneficial for the smart health care services. By giving the energy-efficient services the communication during the data sharing can also be improved, this can help in keeping alive the network for a longer period by providing energy efficient services.
- **Babu, Vasim, et al. [4],** proposed the concept of LEACH algorithm. The enhanced (LEACH) low energy adaptive clustering hierarchy algorithm achieved the clustering approach and formed the Advanced Efficient Low-Energy Adaptive Clustering Hierarchy (AE-LEACH) algorithm. In this paper the authors displayed that in clustering process the cluster heads were chosen by the firm descriptors randomly like residual energy and a maintained distance from the base station. In this approach, the cluster head predicts the target destination and selectively activate the continuous track of next round sensor node by using the practice filter algorithm. This whole activation approach make a route from clusters to the base station by taking the cluster heads as their backbone. To access the energy of clustering algorithm efficiently the Gini index approach was used. Respectively, this whole experiment stated an efficient work performance on the concepts of network timespan, residual energy, energy consumption, and Gini index for remaining energy and achieves significantly lower Gini index of up to 78.38%, 86.11% and 85.92% as compared to K means clustering, HEED clustering, and LEACH clustering algorithm. Apart from that the network lifetime and energy consumption were directly comparable to the time accuracy.
- **Chand, Satish et al. [18],** reviewed the HEED algorithms implementation for a heterogeneous network. The heterogeneity of the different levels were able to be defined by

the type of nodes level-1, level-2, level-3 on the basis of the levels the HEED implementation is referred from level to hetHEED-1, hetHEED-2, hetHEED-3. In this approach the authors stated that as the hetHEED level helps to increase the network ten the lifetime of the nodes was also increased eventually and the rate of energy was decreasingly diffused. By using the heterogeneity level for nodes the life time was increased and also this helps in the sending of more packets to the base station. The manifold network lifetime was increased as the network energy increased. Although, it is seen as advantage that the Fuzzy logic helped in the increasing of the network lifetime with 114.85% of the original HEED without any network energy increased. Thus, the final stage of the heterogeneous network, the hetHEED-3 helps in achieving the longest time of the network with 387.94%as the network lifetime was increased at the cost of 19% increase in network energy, the packet sending to the base station was also increased with having the minimal rate of energy loosen.

- **Sharma, Tripti, et al. [16**], proposed an adaptive duty cycle and encoding technique for the consuming the minimum energy in the bottle neck zones. Both the adaptive combination of duty cycle and encoding techniques helped in the adoption of the efficient communication technique. In the bottle neck zone the energy efficiency would increase as the more volume of data was transmitted to the sink having the same number of transmissions. Hence, this resulted in the increase of the WSNs lifetime. This proposed work records the energy efficiency enhancement in bottleneck zone, which leads in the total improvement of the network lifetime by considering the network coded adaptive duty cycle WSN. In this article the authors concluded that the linear network does not rely on the information which was provided by the packets, the SNs take numerous packets and combine them together for the transmission and then this transmission was applicable on the bottleneck zone. The above technique helps in the achievement of the overall increased network lifetime of the nodes. This whole proposed concept investigated the approx. methods of the improvement of the lifetime of the nodes.
- **El-Sayed, et al. [7],** compared the work of different algorithms and try to find-out the best parameter of the network. At first various techniques like Distributed Energy Efficient Clustering (DEEC), Developed DEEC (DDEEC), Enhanced DEEC (EDEEC), Threshold DEEC (TDEEC)and Improved DEEC Protocol (IDEEC) were tested under different cases. Then based on this test it is considered that the performance based on stability period network lifetime and throughput. EDEEC and TDEEC perform better in all scenarios in term of network lifetime. Then, it is concluded that TDEEC was the best technique for the stability of the network. However, in term of overhead the IDEEC was found better than the DDEECbut TDEEC was best among all. Along with that the changing in the heterogeneity parameters of the network of DEEC and DDEEC was highly affected.
- **Wang, Jin, et al. [13],** proposed the (EPEGASIS) Enhanced Power Efficient Gathering in Sensor Information Systems to reduce the four main problems from four aspects. In first aspect during the transmission the use of energy was at high rate so the optimal communication distance was determined to reduce it. In second aspect, the use of threshold value was proposed for the protection of the about to dead nodes and to balance the energy consumption among the nodes the mobile sink technology was used. In the third aspect, EPEGASIS algorithm helps to adjust the distance to sink nodes based on the communication range. At the fourth aspect, a large experiment was conducted to showcase the efficiency of the authors EPEGASIS in term of lifetime, energy consumption and network latency.
- **Anastasi, Giuseppe, et al. [21],** proposed a breakdown of the energy consumption for the component of the typical sensor nodes, and discussed the important routes for saving the

energy in WSNs. Next, the authors presented an organized and universal taxonomy of the energy conservation scheme which was discussed in depth later on. A special attention has been directed towards the promising solution for energy efficient data acquisition which hadn't gained a wide attention in the literature. Finally an intuition on the research of insight direction about energy conservation in WSNs was concluded by the researchers of this paper.

- **Zhang, Yao et al [5],** proposed some ley features for the WSNs in IOT were key techniques, some specific applications. Next, the authors of this paper proposed an analyzed study on the cell membrane algorithms and its characteristics. In this paper the authors proposed an energy equilibrium clustering algorithm for the problem of energy constraint in WSN, the solution was based on the cell membrane optimization algorithm in order to realize the energy balance of nodes and distribution network cluster head. By conserving the energy factors this algorithm divides the nodes and then by combining the distance factors this proposed solution divide the nodes globally, this division factor was able to solve the problem of the uneven distribution of cluster heads and unbalanced global power usage in SNs. In this paper the author proposed a paper which presents the QoS model, which is based on routing protocol, data fusion scheme, clustering protocol. This is proven in this study by various experiments that the proposed method achieves the flexibility by 78% and improves the energy consumption and performed better in all aspects as compared to previous studies.
- **Firdaus, Tuba, et al. [15],** showed the effectiveness of the WSNs in computing environment for crucial and critical ways for numerous applications. The limited energy is considered as the limited energy in the WSNs. Having the feature of energy saving attribute the WSN plays a vital role in computing environment. In such computing environment the collection of sensor nodes are required which were able to work independently and were unattended. For utilizing the nodes in an efficient manner the approach of clustering algorithms were used. The clustering approach also helps in getting the better distribution of loads in network. In this paper, the researches taken a survey and discussed various dimensions and approaches for clustering. This paper also presents a comparative study of various clustering algorithms and discussion about the potential research areas and the challenges of clustering in WSNs
- **Reddy, D. Laxma, et al. [14],** This paper is based on the improvement of the wireless sensor networks set of connection by the energy depletion methods. In this paper the data was convoked by each sensor and then was broadcast across the system to process the centermost feature which all the communicated data to see the individual setting. To cut down the restricted energy capability the message travelling method should be pre-calculated. All the cluster heads were grouped in order to be in touch information on to CH, so that the CHs can exchange the collective information at one time and can save energy. The center of attraction in this study was the conjoint cluster parameters and clustering algorithms to report in the literature of WSN. In addition to enhance the working the energy efficient clustering algorithm was also proposed in this paper.

3. CONCLUSION

WSNs have a finite amount of resources yet the most crucial element is energy since the longevity of the system depends on the survival of the sensor nodes, and energy is what keeps sensor nodes functional. A through analysis of the literature revealed that the majority portion of the node energy is utilized during the communication phase. Hence, the most crucial factor in reducing energy consumption during communication is an effective routing strategy. In this review paper, we have reviewed and discussed the work of some recent publications in order to observe their techniques and

approaches for reducing the energy consumption of nodes and increasing the network lifespan. It has been observed from the survey that clustering is one of the effective routing protocols that has been widely utilized. However, the efficiency of the wireless network in this case, depends on the energy of CH node. Therefore, it is extremely crucial to optimize the energy consumption in CH nodes so that overall lifespan of the network is enhanced. A number of protocols have been developed already in this context, however, there still is a scope of improvement in these approaches.

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