Optimization Technique to Improve the Energy Efficiency in WSN: LEACH-MGWO

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ABSTRACT

A wireless sensor network is a deployment of numbers of small, less expensive, battery powered devices that can sense, compute, and communicate with other devices for the purpose of collecting local information to make worldwide decisions about a physical environment. The Sensor nodes sense the changes in external environment and send the data to other nodes in the network called sink node or Base Station (BS). The performance of the wireless sensor networks gets affected by the limited battery lifetime of the sensor nodes [1]. Therefore, these results evidence high exploitation capability of the MGWO algorithm. In WSN in which the CH selection is performed using the proposed MGWO algorithm, which is a challenging and NP hard problem. It can be concluded that the proposed algorithm is able to outperform the current well-known and powerful algorithms in the literature. The results prove the competence and superiority of MGWO to existing metaheuristic algorithms and it has an ability to become an effective tool for solving real word optimization problems.

Keyword:- *Wireless Sensors Network, clustering algorithms, Energy Efficiency ,GWO*

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1. INTRODUCTION

Wireless sensor networks have wide range of applications area such as military applications, field surveillance, Automobiles and many more. Wireless sensor networks consist of various densely deployed sensor nodes inside the application area. Advanced micro-electro-mechanical-systems (MEMS) provides low cost small sized and powerful sensor nodes that are capable of data sensing, data processing and wireless communication and have a limited power battery. Sensor nodes work together to complete the task in time and to provide information accurately. Sensor nodes sense the external environment or application area and send the data to base station located inside or outside the network via single hop or multi-hop. Users access the collected data through some remote access. Sensor nodes work with some limited resources like battery power, memory and bandwidth etc. Wireless sensor networks lifetime depends upon battery power of nodes as every node operation consumes energy, hence node goes out of energy. And it is not possible to recharge or replace the battery of nodes. Therefore, an efficient energy consumption by the nodes is the prime design issue for wireless sensor network from the circuitry of sensor nodes to application level to network protocols. [2]

Clustering algorithms are considered energy efficient approaches for wireless sensor networks. Clustering divides the nodes into independent clusters and each cluster elect their own cluster heads. Nodes send the collected data to respective cluster head; cluster head (CH) applies data fusion/aggregation to reduce the collected data to some useful information and sends aggregated data to base station (BS). Communication between two nodes is the main energy consuming process that depends upon the distance between the two nodes. Clustering avoids long distance communication between two nodes and only cluster heads are communicating to base station (BS). To load balance the network, the cluster head is rotated among all nodes. [3]

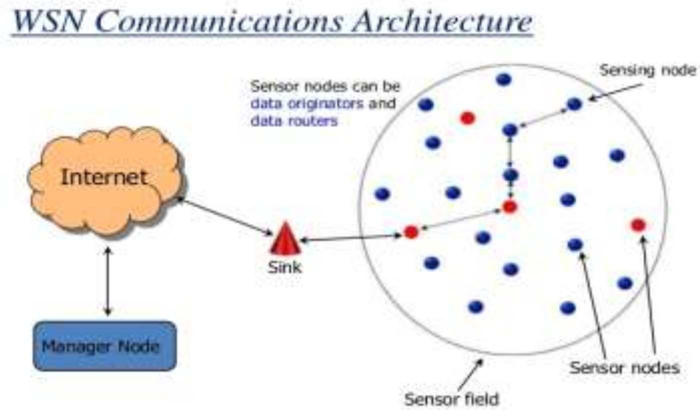

Figure.1: Wireless Sensor Network Architecture [4]

2. DESIGN FACTORS OF WSN

There are various challenges which affect the wireless sensor network (WSN) these are:-

1. **Node deployment:**

Node placement in WSNs is application-dependent and can be whichever manual or randomized. In manual placement, the sensors are manually allocated and data is routed across predetermined paths. Though, in random node placement, the sensor nodes are dispersed randomly, crafting an ad hoc routing infrastructure. The node deployment in wsn should in such way that the communication between nodes never failed. So to maintain the proper communication between these nodes an excellent routing protocol is required.

2. **Fault tolerance:**

Some sensor nodes could blocked due to lack of domination, physical damage, or environmental interference. Individual nodes are liable to unexpected failure with a much higher probability when compared with other type of network. The network should keep alive information dissemination in spite of failure.

3. **Scalability:**

Sensor network is made up hundreds or thousands of nodes. The designed Protocol should be able to work to such high degree of nodes and take advantage of such high density of networks. So the routing protocol should not limit with the fixed nodes. But it should operate with large number of node and should be varies with the network size.

4. **Coverage:**

In WSNs, every single sensor node obtains a precise think of the environment. A given sensors think of the nature is manipulated in both scope and accuracy; it can only cover a manipulated physical distance of the environment. Hence, distance coverage is additionally a vital design parameter in WSNs.

5. **Power consumption:**

WSN is made up of thousands of nodes and these nodes are energy restricted and cannot replaceable and rechargeable. WSN lifetime depends on these nodes energy and every nodes operation consumed some energy. So an efficient energy consumption by the node is the main design issue in WSN.

6. **transmission media:**

In WSN the sensor nodes are wirelessly connected to each other so it is very important to maintain wireless connection between them. The transmission medium between sensor nodes is radio waves or infrared waves. The communication medium between these sensor nodes should be universally presents, it should not bound with any standards and should not require any license to operate [4].

3. APPLICATIONS

WSN is very useful in many applications some important applications of WSN are explain as:-

a) Military Applications:

Since wireless sensor networks are based on the dense deployment of expandable and low-cost sensor nodes, destruction of some nodes by warlike actions does not affect a military operation as much as destruction of a traditional sensors, which makes sensor networks concept a better. Some of the military applications of wireless sensor networks are approach for battlefields examples:-

1. Monitoring forces, equipment and inspect the area.
2. Battlefield surveillance
3. Activities of opposing forces and terrain
4. Biological, Nuclear and chemical attack detection and reconnaissance

b) Health Applications:

Some of the health applications of sensor networks are providing interface for the disabled; integrated patient monitoring; drug administration in hospitals; diagnostic; monitoring the internal processes and movements of insects or other small animals; monitoring the human physiological data; and tracking the location of doctors and patients inside a hospital.

c) Home Appliances:

As technology advances, smart sensor nodes can be engaged in appliances, such as, refrigerators, vacuum cleaners, micro-wave ovens, and VCRs. These sensor nodes inside the indoor devices can interact with each other and with the external networks via the Internet or Satellite. These sensors allow end users to manage home devices locally and remotely more easily.

d) Environmental Applications:

Some of the environmental applications of these sensor networks include tracking the movements of birds, insects and small animals; monitoring the environmental conditions that affect crops; chemical/ biological detection; disease detection; precision agriculture; biological, pollution, and environmental monitoring in sea, soil, and atmospheric contexts; forest fire detection; pressure monitoring; meteorological research such as; flood detection; bio-complexity mapping of the environment; and pollution study [4].

4. LITERATURE REVIEW

Fei Song *et al.* 2008 [5] Proposed a trust-based LEACH (low energy adaptive clustering hierarchy) protocol to provide secure routing, while preserving the essential functionalities of the original protocol. The decision-making of the scheme was based on the decision trust, evaluated separately and dynamically for different decisions by basic situational trust. The situational trust was maintained by a trust management module integrated with a trust-based routing module, having novel techniques in trust updated model and cluster-head-assisted monitoring control.

Suat Yang *et al*. 2009 [6] Discussed wireless sensor network consisting of large no. of low cost tiny sensing devices that had limited power source, computation and communication capabilities. Due to limited resources of the sensing devices, it was mandatory to control the transmission of data to a much lower extent so as to increase the lifetime of the network. Data aggregation is the process of summarizing and combining sensed data in order to reduce the amount of data transmission in the network. This scheme provides a detailed knowledge of secure data aggregation and its protocols.

Hanady *et al.* 2010 [7] proposed W-LEACH which was capable of handling uniform as well as non-uniform network by not affecting the lifetime of the network. On the basis of sensor weights (based upon its surrounding cluster) cluster heads were chosen. The proposed scheme overcomes the drawback of energy dissipation in LEACH and increased its network's lifetime, first node dies and the last node dies in the network

Bilal and Leszek *et al.* 2011 [8] Proposed LEACH-SM protocol, a spare selection phase was added to LEACH. During this phase, each node was having power to decide whether it should become a spare node (go asleep) or an active node. The spare ones were awakened when the primary node's energy was below threshold. This scheme reduced the energy consumed by cluster head, as they don't have to receive messages from the spare nodes which overall increased the lifetime of the power source.

Xuejun Song *et al.* 2012 [9] The Convergence speed and scale bottlenecks of evolutionary design of circuits, explored a new evolutionary method on the basis of genetic algorithm. Several optimization methods including fitness sharing, exponential weighting, double selection population, "Queen Bee" mating, module crossover and optimal solution set were proposed to improve genetic algorithm. The new algorithm improved fitness evaluation method and genetic strategies. The experiment showed that the new evolutionary algorithm accelerated evolution convergence greatly, improved the adaptability effectively and expands the scale of evolved circuit obviously

Sunkara vinodh Kumar *et al.* 2013 [10] Presented Assisted LEACH (A-LEACH) achieved lessen and uniform distribution of dissipated energy by separating the tasks of Routing and Data Aggregation. It introduced the concept of Helper Nodes which assist Cluster Heads for Multi-hop Routing. A new algorithm had been formulated to facilitate energy efficient Multi-hop Route Setup for helper nodes to reach base station. The proposed protocol extends the lifetime of the network, minimizes overall energy dissipation in the network.

Richa Garg *et al.* 2014 [11] Presented genetic algorithm was Search and optimization techniques that generate solutions to optimization problems using techniques inspired by natural evolution. Optimization was the central to any problem involving whether in engineering or economics. All evolutionary algorithms including Genetic Algorithm could find near optimal solution. A set of test functions including unimodal and multimodal benchmark functions was employed for optimization.

Marwa sharawi et al. 2017 [12] GWO is applies as the grey wolf optimization. The optimization of WSN cluster head greatly influences the network lifetime. GWO is recently proposed optimizer that has a variety of successful applications. Suitable fitness function was employed to ensure coverage of the WSN and is fed to the GWO to find it optimum. Node information are send to the sink node with details about individual node position, remaining energy. The information fed are passed to the GWO clustering module to optimally cluster the nodes into a predefined number of cluster heads. Then for individual cluster a node is selected from the cluster such that it has the maximum remaining energy. This node called the cluster head. All the nodes send their information to their cluster head. Each cluster head compressed and aggregate the data packets and forward it to the base station.

5. PROPOSED ALGORITHM

Finding the global minimum is a mutual, challenging task among all minimization methods. In population-based optimization methods, commonly, the necessary way to converge towards the global minimum can be divided into two basic phases. In the early stages of the Modified Grey Wolf Optimization (MGWO), the individuals should be stimulated to scatter throughout the entire search space. In other words, they should try to discover the whole search space instead of clustering around local minima. In the latter stages, the individuals have to exploit information gathered to converge on the global minimum. In MGWO, with fine-adjusting of the parameters a and A, we can balance these two phases in order to find global minimum with fast convergence speed. Although different enhancements of individual-based algorithms encourage local optima prevention, the literature shows that population-based algorithms are better in handling this issue. Regardless of the differences between population-based algorithms, the common approach is the division of optimization process to two incompatible milestones: exploration versus exploitation. The exploration encourages candidate solutions to change abruptly and stochastically. This mechanism improves the diversity of the solutions and causes high exploration of the search space. In contrast, the exploitation aims for improving the quality of solutions by searching locally around the obtained promising solutions in the exploration. In this milestone, candidate solutions are obliged to change less suddenly and search locally. Exploration and exploitation are two conflicting milestones where promoting one results in degrading the other. A right balance between these two milestones can guarantee a very accurate approximation of the global optimum using population-based algorithms. On the one hand, mere exploration of the search space prevents an algorithm from finding an accurate approximation of the global optimum. On the other hand, mere exploitation results in local optima immobility and again low quality of the approached optimum. In MGWO (Modified Grey Wolf Optimization), the transition between exploration and exploitation is generated by the adaptive values of a and A. In this, half of the iterations are devoted to exploration ($|A| \geq 1$) and the other half are used for exploitation ($|A| < 1$), as shown in Figure 1(a). Generally, higher exploration of search space results in lower probability of local optima stagnation. There are various possibilities to enhance the exploration rate as shown in Figure 1(b), in which exponential functions are used instead of linear function to decrease the value of a over the course of iterations. Too much exploration is similar to too much randomness and will probably not give good optimization results. But too much exploitation is related to too little randomness. Therefore, there must be a balance between exploration and exploitation. In M-GWO, the value of a decreases linearly from 2 to 0 using the update equation as follows:

$$a = 2\left(1 - \frac{t}{T}\right) \tag{1}$$

where T indicates the maximum number of iterations and t is the current iteration. Our MGWO employs exponential function for the decay of a over the course of iterations. Consider

$$a = 2\left(1 - \frac{t^2}{T^2}\right) \tag{2}$$

as shown in Figure 1(c). Using this exponential decay function, the numbers of iterations used for exploration and exploitation are 70% and 30%, respectively. The pseudocode of MGWO is given in Algorithm.

6. PERFORMANCE EVALUATION

The simulation results are shown in the Table.1 and various comparison graphs. The comparison is made between number of nodes and number of rounds. The comparion is made between network performance in the presence of proposed algorithem with the existing scheme. Table.2 shows the first node dead and half node dead comparison of Grey Wolf Optimization (GWO) with proposed Algorithm MGWO. Here in GWO first node is dead at 648th round where in MGWO first node dead achieved later at 1176th round. Similarly half nodes are dead in GWO at 1104th round but in MGWO half nodes of the network dead at 21209th round which clearly shows that MGWO performed much better than GWO. Thus provide more optimal cluster head solution than Genetic Algorithm improves and the lifetime of wireless sensor network.

RESULTS AND ANALYSIS

In this section proposed scheme MGWO is simulated on matlab for the comparison of energy efficiency and node death rate with genetic algorithm. And proved that MGWO perform much better than GWO .

Results With Heterogeneous Nodes

Above results are based on heterogeneous nodes because the existing algorithm is only applicable for heterogeneous nodes but our purpose to show the proposed algorithm is applicable for both homo and hetero nodes. So that’s why we evaluate the proposed results on both homo and hetero nodes. Now results comparison of GWO and MGWO for homogeneous nodes. It Mean all the nodes have same energy.

Graph.1: Fig.5.6 shows the first node dead comparison of GWO and MGWO for homogeneous nodes and shows that MGWO performing much better than GWO.

Graph.2: fig.5.7 shows the half node dead comparison of GWO and MGWO. In case of half node dead MGWO again proved better than GWO.

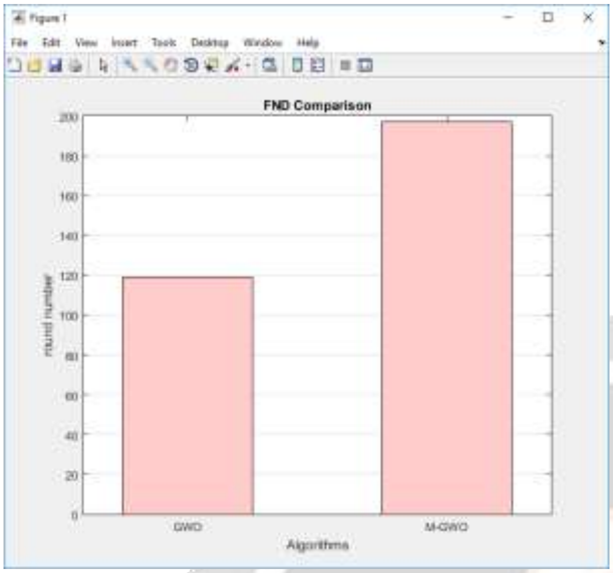

Fig.2 First node dead comparison

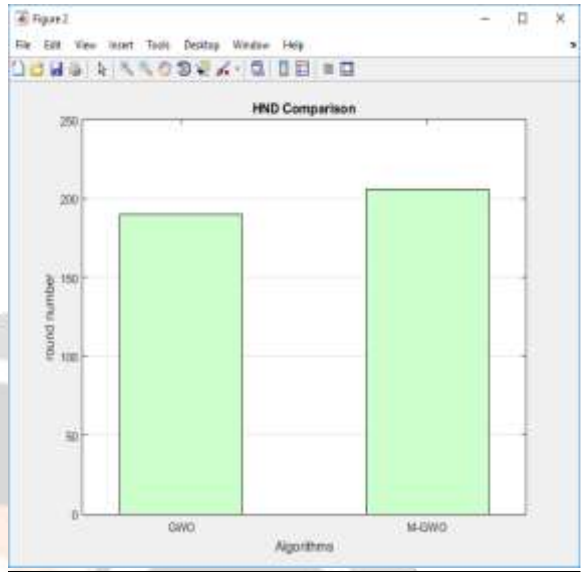

Fig..3 Half node dead comparison

Graph.3: Fig.5.8 shows the comparison of network remaining energy.

Graph.4: fig.5.9 shows the total dead node comparison between existing (GWO) and proposed (MGWO). Nodes start to dead at 700th round in GWO where in MGWO node start to dead from 1100th rounds.

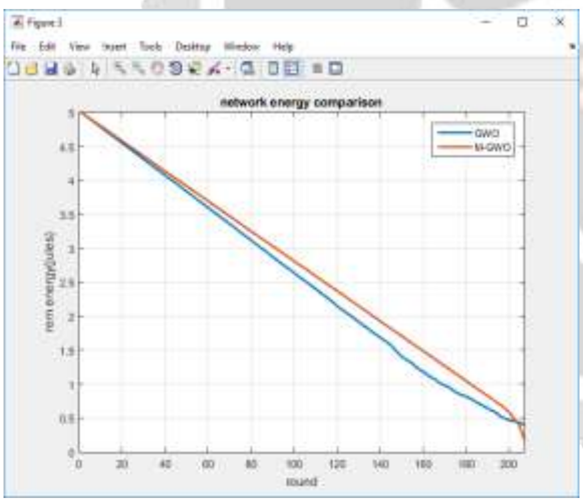

Fig..4 Energy comparison of network

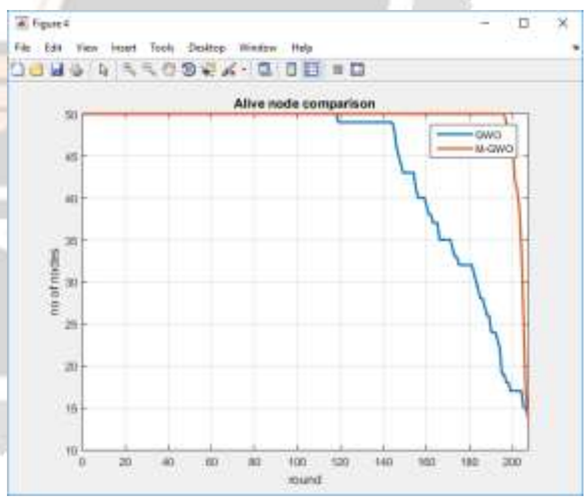

Fig..5 Dead node comparison

CONCLUSION

After having gone through different literatures published on the topic of energy conservation in WSN. Most of energy consumption in CH is due to its sending and receiving and data aggregation operations. LEACH is the protocol which used the clustering to maintain the energy load evenly through the network. LEACH-GWO (Grey Wolf Optimization) is one of these algorithms which provide optimal cluster head solution. Although LEACH-GWO provides optimal cluster head solution for the selection of CH but there is some drawback of GWO i.e it is very time consuming and complex process hence it needs to improve. Here we implemented a technique called MGWO (Modified Grey Wolf Optimization) is the improvement of GWO. Which not only provides more optimal cluster head selection but also reduce the complexity and time consumption by Genetic algorithm and increases the lifetime of Wireless Sensor Network. Here results are implemented on MATLAB.

REFERENCES

[1]. Wendi B. Heinzelman and P. Chandrakasan*,"* An Application specific Protocol Architecture for WSN", IEEE transactions on wireless communication, vol. 1, No.-4, pp. 660-670, 2002.

[2]. Parul Khurana and Inderdeep Aulakh," Wireless Sensor Network Routing Protocols: A Survey", International journal of computer applications, vol. 75, No. 15, 2013.

[3]. Md. Faruqul Islam, Yogesh Kumar , saurabh *,"* Recent Trends in Energy Efficient Clustering in WSN", International Journal of Computer Applications, vol. 95, No.-20, pp. 44-48,2014.

[4]. Pankaj Chauhan and Tarun Kumar," Power Optimization in Wireless Sensor Network: A Perspective", International Journal of Engineering and Technical Research (IJETR), vol. 3, issue-5, May 2015.

[5]. Fei Song and Baohua Zhao," Trust Based LEACH Protocol For Wireless Sensor Network, IEEE 2nd International Conference, Vol. 1, pp. 202-207, 2008.

[6]. Suat Ozdemir and Yang Xiao, "Secure Data Aggregation in Wireless Sensor Network: A Comprehensive Overview", *Elsevier Computer Networks*, pp. 2022-2037, 2009.

[7]. Hanady M. Abdulsalam and Layla K. Kamel, "W-LEACH Weighted Low Energy Adaptive Clustering Hierarchy Aggregation Algorithm for Data Streams in Wireless Sensor Network", *IEEE International Conference on Data Mining Works*, pp. 1-8, 2010.

[8]. Bilal Abu Bakr and Leszek Lilien, "Extending Wireless Sensor Network Lifetime in the LEACH-SM Protocol by Spare Selection", *Fifth International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing*, pp. 277-282, 2011.

[9]. Xuejun Song, Yanli cui, Aiting Li "Optimization Algorithm of Evolutionary Design of Circuits Based on Genetic Algorithm", *IEEE 5th international conference on computational intelligence and design*, pp. 336-339, 2012.

[10]. Sunkara Vinodh Kumar and Ajit Pal "Assisted-Leach (A-Leach) Energy Efficient Routing Protocol for Wireless Sensor Networks", *International journal of computer and communication engineering*, Vol. 2, No. 4, pp. 420-424, 2013.

[11]. Richa Garg and Saurabh Mittal Marwa Sahrawi, Eid Emary*,"* Impact of Grey Wolf Optimization On WSN Cluster Formation And Lifetime Expansion*", IEEE 9th International Conference On Advanced Computational Intelligence (ICACI),*, pp. 157-162, 2017.

[12]. Marwa Sahrawi, Eid Emary*,"* Impact of Grey Wolf Optimization On WSN Cluster Formation And Lifetime Expansion*", IEEE 9th International Conference On Advanced Computational Intelligence (ICACI),*, pp. 157-162, 2017.