Application of Wind Driven Optimization Algorithm for Clustering in WSN to Achieve Energy Efficiency

Sukhpreet Kaur[1] Arun Kumar[2]
[1,2]Department of Computer Science & Engineering
[1,2]MMEC, MM University, Mullana, Ambala, India

Abstract— This thesis aims at reducing energy consumption in wireless sensor networks. To achieve this, we considered Wind Driven Optimization algorithm (WDO) in the selection of Cluster Head (CH) in such a way so that its energy is used uniformly with delayed disintegration of network. For this purpose, the LEACH algorithm random clustering approach has been replaced by WDO clustering. The WDO based LEACH protocol has been compared with random LEACH, LEACH-C and K-MEANS algorithm. Various factor taken for comparison are network life in the form of number of rounds, no of dead nodes and no of packet sent to BS affect performance of routing algorithm in WSN. The performance of cluster based routing protocol shows some differences by varying life pattern among nodes and number of dead nodes. LEACH-C perform better in network disintegration criterion but it give less network life as compared to WDO based LEACH. In WDO which is made of both types of search capabilities performs better than other methods.

Key words: WSN, Clustering

I. INTRODUCTION

During development of a wireless sensor node, it is ensured that there is always adequate energy available to power the system. Power is stored either in batteries or capacitors. Batteries used for power supply can be both rechargeable and non-rechargeable. sensor nodes can use up their limited supply of energy performing computations and transmitting information in a wireless environment. As such, energy-conserving forms of communication and computation are essential. Sensor node lifetime shows a strong dependence on the battery lifetime. In a multipath WSN, each node plays a dual role as data sender and data router. The malfunctioning of some sensor nodes due to power failure can cause significant topological changes and might require rerouting of packets and reorganization of the network. Clustering protocols are best suited for routing purpose.

According to the clustering protocol, the total area is divided into numbers of clusters. Each and every cluster has a cluster head (CH) and this cluster head directly communicates with the BS. All nodes in a cluster send their data to their corresponding CH. LEACH is the simplest hierarchical protocol which possesses clustering approach. It is a protocol that tends to reduce energy consumption in a WSN. However, LEACH uses single-hop routing in which each sensor node transmits information directly to the cluster-head or the sink. Therefore, it is not recommended for networks that are deployed in large regions. In **LEACH**, a node becomes a cluster-head using a stochastic mechanism. This is prone to producing unbalanced energy level reserves in nodes and, thus, to increasing the total energy dissipated in the network.

The problems of LEACH Algorithm:

- Because the election strategy of cluster head is random, may to be misdistribution of cluster head, the number of members of cluster also has a bigger difference, make each cluster head load is not balanced, and individual cluster head early death.
- LEACH agreement can only be used for small wireless sensor networks. Between base station and cluster head use the single route choice model, so cluster head and base station must decorate in the range of communication can be reach.
- LEACH protocol is achieved base on many assumptions, such as assuming that all nodes in the network have the same structure and start with the same energy, and nodes can be aware of their residual energy, and so on.

In this method, the cluster head consumes more energy for receiving, processing and directly sending this data to the BS node. So for increasing the life time of the network it is necessary to replace role of cluster head between network nodes.

The proposed work is about to use some cluster algorithm such as K-Means or some metaheuristic technique for finding an optimal clustering scheme instead of using some random method, thus using less energy and more rounds of transmission to BS. For this, it will combine few parameters such as Distance as basis parameter for clustering. The proposed system is supposed to increase the overall network life time of WSN.

II. RELATED WORK

Recently there has been increased interest in studying energy-efficient clustering algorithms in the context of both ad hoc and sensor networks. The main aim of clustering protocols in ad hoc networks is to generate the minimum number of clusters while maintaining network connectivity. In these algorithms the election of CHs is based mainly on the identity of nodes, the degree of connectivity or the connected dominating set. These techniques are discussed in depth in. In the case of WSNs, the main objective of clustering protocols is to minimize energy consumption by the network in order to extend the network lifetime. The surveys dealing with WSN clustering protocols can be found in [3]. The WSN clustering protocols can be classified into two categories: probabilistic and deterministic. In probabilistic clustering protocols a node becomes a CH with a certain probability, which requires an exchange of overhead messages for the CH's election. The EEHC [5], EECS [6], and HEED [7] fall in the probabilistic class and PEGASIS [8], and TASC [9] are categorized in the deterministic class. Xu in Ji in [10] also proposed a PSO based strategy for clustering in LEACH.

At present routing in routing in WSNs is a hot research topic, with a limited but rapidly growing set of efforts being published. In this thesis we have conducted a

All rights reserved by *www.ijsrd.com*

survey of the various latest routing protocols in WSNs assuming underlying base of these protocol as LEACH and PEGASIS. We considered a comparison of the routing protocols discussed in the thesis in terms of clustering manner, intra-cluster topology, cluster head selection. Although the performances of these protocols are encouraging for improving scalability of large-scale WSNs, some issues remain to be considered. For clustering in data mining several meta heuristic techniques are being used such as GA, PSO and BBBC actively. These can be effectively used in clustering of nodes in WSN environment where equi-distribution of space and energy are the real concerns for enhancing the lifetime of network. Embedding these algorithms in the routing design is desirable.

III. PROPOSED METHODOLOGY

To simulate LEACH, we have used random 100-node networks for our simulations with similar parameters used in [2]. We placed the BS at a far distance from all other nodes. For a 50m x 50m plot, our BS is located at (25, 150) so that the BS is at least 100m from the closest sensor node.We use the same energy model as discussed in [1] which is the first order radio model. In our simulations, we used a control packet length *k* of 200 bits to send information from non-CH node to CH node. Size of packet length *K* of 6400 bits is fixed to send information from CH node to BS With these radio parameters, when d^2 is 500, the energy spent in the amplifier part equals the energy spent in the electronics part, and therefore, the cost to transmit a packet will be twice the cost to receive. It is assumed that the radio channel is symmetric so that the energy required to transmit a message from node *i* to node *j* is the same as energy required to transmit a message from node *j* to node *i* for a given signal to noise ratio (SNR).

A. Random LEACH in WSN:

In Random LEACH, each node has equal opportunity to be selected as cluster head (CH) with a probability *p.* the probability function is normal distribution function spread over every 10 rounds. It doesn't care about the energy a node is having. To become cluster head a node must be live and should have sufficient energy to send data to BS. After selection of cluster heads every node selects its cluster head on the basis of distance. It selects its cluster head which is closest to its position. The following algorithm shows it.

- Step 1: Find the nodes that are alive
- Nodes that are not of type dead nodes are alive.
- Step 2: In alive nodes randomly find whether a node is selected as a CH. Probability of selecting a node as CH is pre decided.
- Step3: Attach nodes to nearest CH to form cluster by finding distance matrix to form cluster

B. LEACH-C Algorithm

In contrast to Random LEACH, LEACH-C selects cluster head (CH) to those nodes which as the maximum energy. In this algorithm first all nodes are sorted as per their energy status in each round and then first k nodes are selected as CH. After selection of cluster heads every node selects its cluster head on the basis of distance. It selects its cluster head which is closest to its position. The following algorithms specifies the concept of maximum LEACH.

- Step 1: Find the nodes that are alive
- Nodes that are not of type dead nodes are alive.
- Step 2: In alive nodes find p*livenodes number of node which have maximum energy in nodes architecture is selected as a CH. Probability p of selecting a node as CH is pre decided.
- Step3: Attach nodes to nearest CH to form cluster by finding distance matrix to form cluster.

C. K-means LEACH Algorithm

In this algorithm idea is to select cluster in such a way that their intra distance is minimum which ensures that less communication energy is consumed and WSN can run more rounds.

K-means is a simple algorithm that has been adapted to many problem domains. As we are going to see, it is a good candidate for extension to work with fuzzy feature vectors. The algorithm for this is given below:

- Step 1: Find the nodes that are alive
- Nodes that are not of type dead nodes are alive.
- Step 2: In alive nodes using some standard clustering algorithm such as k- means or k-medoid for spatial distribution of nodes in clusters.
- Step 3: In the next step, from each cluster CH is chosen on the basis of surplus energy, its position in cluster and its distance from Base Station, a node is having. So this scheme involves both things spatial distribution as well as energy distribution in the network architecture which may ultimately improve the network life and its quality.

D. The Wind Driven Optimization (WDO) algorithm

The Wind Driven Optimization (WDO) algorithm is a new type of nature-inspired global optimization methodology based on atmospheric motion used by Bayraktar in antenna design optimization [10]. The Wind Driven Optimization (WDO) technique is a population based iterative heuristic global optimization algorithm for multi-dimensional and multi-modal problems with the ability to implement constraints on the search domain. At its core, a population of infinitesimally small air parcels navigates over an N-dimensional search space following Newton's second law of motion, which is also used to describe the motion of air parcels within the earth's atmosphere.

The collective force applied on a wind particle is given by

$$F= (F_P)+(- F_F)+(- F_G)+(- F_C) \text{ ----------(1)}$$

Where Pressure gradient force- F_P, Friction force- F_F , Gravitational force- F_G, Coriolis force- F_C. In these pressure gradient force help to move wind particles in forward direction, friction force oppose its movement and gravitational force is a vertical force in three-dimensional atmosphere. The Coriolis force (FC) as caused by the rotation of earth, deflects wind from one dimension to another. The velocity parameter for a single i^{th} particle in d^{th} dimension is given by the following equation:-

vel(i,d) = (1- alp) * vel(i,d) - g*Particles(i,d) + abs(1-1/i) * (global_best_position-Particles(i,d).* RT + c*vel(i,d)/i-- (9)

Particles(i,d) =Particles(i,d) +vel(i,d)------ -----(10)

So updated velocity for the next iteration, depends on the current iteration velocity, current location of air parcel in search space, distance from the highest pressure point that has been found , maximum pressure, pressure at

All rights reserved by www.ijsrd.com

the current location, temperature, gravitational acceleration (), and constants R and c.

Compared to similar particle based algorithms, WDO employs additional terms in the velocity update equation (e.g. gravitation and Coriolis forces), providing robustness and extra degrees of freedom to fine tune the optimization. WDO is further applied to electromagnetics optimization problems. These examples suggest that WDO can, in some cases, out-perform other well-known techniques such as Particle Swarm Optimization (PSO) and that WDO is well-suited for problems with both discrete and continuous-valued parameters. The base idea of the wind moving from high pressure points to low pressure points nicely mapped to the optimization where search moves from low performing combinations to high performing combinations within a search space.

- Step 1: Find the nodes that are alive
- Nodes that are not of type dead nodes are alive.
- Step 2: In alive nodes using some standard clustering algorithm such as WDO ALGORITHM for spatial distribution of nodes in clusters.
- Step 3: In the next step, from each cluster CH is chosen on the basis of remaining energy of nodes only.

So this scheme involves both things spatial distribution as well as energy distribution in the network architecture which may ultimately improve the network life and its quality.

IV. RESULTS ANALYSIS

Following table shows the results obtained from the experimentations done as per the setup explained in the previous section. Four algorithms have been implemented in this thesis. In first algorithm i.e. Random LEACH algorithm is implemented where CHs are selected randomly based on a probability function. We have taken this probability as 10%. It is further improved by using a fair distribution of energy by selecting maximum energy nodes to be CHs. In this method a fix number of CHs are selected based on the number of nodes that are living. Another modification is made in third algorithm where nodes are clustered based on inter distance by using a standard algorithm such as K-means. We measure algorithms' efficiency by assessing total number of rounds up to which network survives. A network is assumed to be live if more than 75% nodes are alive with total energy greater than zero.

WSN Routing Algorithm	**Network Life (in rounds)**	**Rounds in which first Node Dead**	**Rounds in which 50% Node Dead**	**No of packets sent in total rounds**	**Remaining Energy after 80% node is dead (Joules)**
Random LEACH	718	100	410	12165	2.383
LEACH-C	1249	1209	1242	12383	1.267
K-means LEACH	1756	72	814	9319	8.155
WDO	1848	545	1283	12220	1.328
LEACH					

Table 1: Experimentation Results

In the table it is clearly shown that WDO clustering based LEACH algorithms perform far better as compared to other methods if we consider the number of rounds covered by the algorithms. The WDO algorithm performs nearly three times better than random LEACH and nearly 50% better than LEACH-C.If we consider a network, dead if 50% nodes are dead then LEACH-C is performing better than K-means based LEACH and nearly equal to WDO variants LEACH. Random LEACH has performed worst in every situation. If we consider 80% node criterion for network life then the WDO algorithm performs better. We have shown these statistics in the following figures.

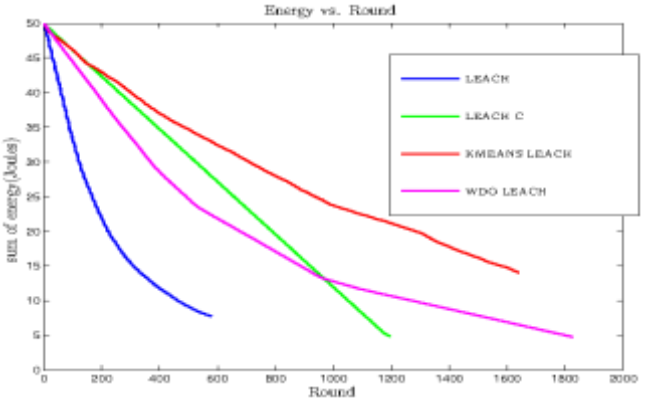

Fig. 1: Nodes Remaining Energy pattern in WSN

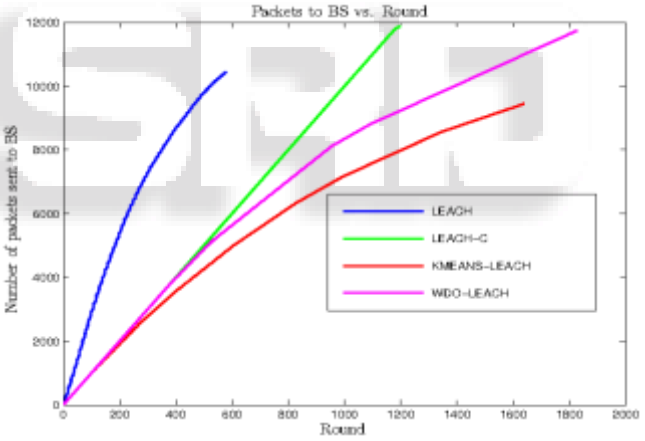

Fig. 2: Number of Packets Sent to BS by CHs

If we closely look the figures from 5.1 to 5.3 and table 5.1 then we can easily say that the WDO based algorithm is much better than random LEACH and K-means LEACH. Nearly 300% network life improvement is recorded for over simple LEACH and 50% over LEACH-C and K-means. If we compare the number of dead nodes as per our simulation results LEACH-C seems to perform better, but there nodes once start dying accelerates network decay very fast. On one front random LEACH and K-means-LEACH algorithms are lacking i.e. network disintegration in this front. In these algorithms, first node is dead very. Even WDO is not performing well if we consider this parameter. This is the grey area which needs to be addressed in future research.

If we consider no of packets sent to BS then LEACH-C and WDO LEACH is clearly winner. Both have sent highest number of packets to BS but if we consider the ratio between packet sent and number of rounds performed by the algorithm then LEACH-C is clear winner in this.

All rights reserved by *www.ijsrd.com*

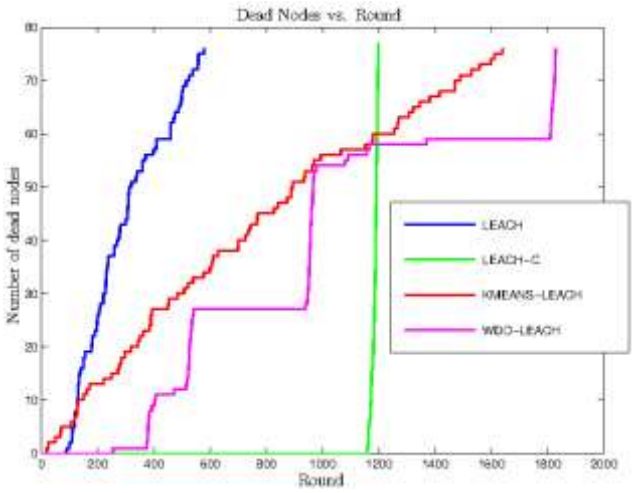

Fig. 3: Number of dead nodes per round

V. CONCLUSION

The network life, number of dead nodes and number of packet sent to BS affect performance of routing algorithm in WSN. The performance of cluster based routing protocol shows some differences by varying life pattern among nodes and number of dead nodes. From our experimental analysis we conclude that WDO based LEACH algorithm gives better performance in network life overall but could not restrict early network disintegration. LEACH-C perform better in network disintegration criterion but it give less network life as compared to WDO based LEACH. IN WDO which is made of both types of search capabilities performs better than other methods.

REFERENCES

[1] 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, vol.2, pp. 3005-3014, 2000.

[2] W. B. Heinzelman, A. P. Chandrakasan and H. Balakrishnan. An application-specific protocol architecture for wireless microsensor networks. IEEE Transactions on Wireless Communications, vol. 1, no. 4, pp. 660- 670, 2002.

[3] O. Younis, M.Krunz, and S.Ramasubramanian. Node clustering in wireless sensor networks: recent developments and deployment challenges. IEEE Network , vol.20, no.3, pp. 20- 25, 2006.

[4] Yuping Dong, Hwa Chang and ZhongjianZou, "Energy Aware Routing Algorithm for WSN Applications in Border Surveillance" Tufts University Medford, MA, p.p 530-535, 2010

[5] Bandyopadhyay, S. and Coyle, E.J., "An energy efficient hierarchical clustering algorithm for wireless sensor networks," INFOCOM 2003. Twenty-Second Annual Joint Conference of the IEEE Computer and Communications. IEEE Societies, vol. 3 pp 1713–1723, 2003.

[6] M. Ye, C. Li, G. Chen, and J. Wu, "EECS: An energy Efficient Clustering Scheme in wireless Seneor networks," National Laboratory of Novel Software Technology, Nanajing University, China, 2005.

[7] O. Younis, and S. Fahmy, "HEED: A hybrid, energy-efficient, distributed clustering approach for ad-hoc sensor networks," IEEE Transactions on Mobile Computing, vol. 3, no. 4, pp. 366–379, October-December 2004.

[8] Lindsey, S. and Raghavendra, C.S.,"PEGASIS: Power-efficient gathering in sensor information systems," IEEE Aerospace Conference Proceedings, vol. 3, pp. 3–1125, 2002

[9] Virrankoski, R. and Savvidees, A., "TASC: topology adaptive spatial clustering for sensor networks," IEEE International Conference on Mobile Adhoc and Sensor Systems Conference, pp. 614, 2005

[10] ZikriBayraktar, MugeKomurcu, Jeremy A. Bossard, and Douglas H. Werner, The Wind Driven Optimization Technique and its Application in Electromagnetics IEEE transactions on antennas and propagation, vol. 61, no. 5, May 2013 pp.2745-2757

All rights reserved by *www.ijsrd.com*