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Enhanced Distributed Energy Efficient Clustering (E-DEEC) based on Genetic Algorithm

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Abstract –**Heterogeneous wireless sensor network (WSN) consists of sensor nodes with different ability, such as different computing power and sensing range. Compared with homogeneous WSN, deployment and topology control are more complex in heterogeneous WSN. Many routing protocols have been proposed in this regard achieving energy efficiency in heterogeneous scenarios. However, every protocol is not suitable for heterogeneous WSNs. In this paper, we test Distributed Energy-Efficient Clustering (DEEC), Developed DEEC (DDEEC) and Enhanced DEEC (EDEEC) with Genetic Algorithm (GA) under several different scenarios containing high level heterogeneity to low level heterogeneity. In order to conclude the behaviour of this heterogeneous protocols.**

Keywords –**EDEEC, DEEC, DDEEC, GA, WSN.**

I. Introduction

The key challenge in setting up and proper operation of WSN is increase the lifetime of the network by minimizing the energy consumption. Since from last few year variety of changes have been made to limit the energy requirement inWSN, as mainly energy dissipation is more for wireless transmission and reception [1]. Main approaches till proposed were focusing at making the changes at MAC layer and network layer to minimize the energy dissipation. Two more major challenges are how to place the cluster heads over the grid and how many clusters would be there in a system. If the cluster heads are correctly positioned over the grid and sufficient clusters are molded, it will assistance to diminish the dissipation of energy and would help to increase the lifetime of the network to tackle with all the above mentioned challenges clustering have been found the efficient technique [2] [3]. Clustering is always been referred as an effective method to enhance the lifetime of WSN.

II. Problem Domain and Research Work

All the nodes have to send their data towards BS often called as sink. Usually nodes in WSN are power constrained due to limited battery, it is also not possible to recharge or replace batteryof already deployed nodes and nodes might be placed wherethey cannot be accessed. Nodes may be present far awayfrom BS so direct communication is not feasible due to limited battery as direct communication requires high energy. Clustering is the key technique for decreasing battery consumptionin which members of the cluster select a Cluster Head (CH). Many clustering protocols are designed in this regard [4] [5]. All the nodes belonging to cluster send their data to CH, where, CH aggregates data and sends the aggregated data to BS [6] [7] [8]. Under aggregation, fewer messages are sent to BS and onlyfew nodes have to transmit over large distance, so high energy is saved and over all lifetime of the network is prolonged. Energy consumption for aggregation of data is much less as compared to energy used in data transmission. A series of clustering techniques are subjected to literature of this survey that motivates the development of proposed architecture.

DDEEC

Elbhiri et al. [9] proposed a developed distributed energy efficient clustering scheme for heterogeneous wireless sensor networks. This technique is based on changing dynamically and with more efficiency the cluster head election probability.

DDEEC is based on DEEC scheme, where all nodes use the initial and residual energy level to define the cluster heads. To evade that each node needs to have the global knowledge of the networks, DDEEC like DEEC estimate the ideal value of network lifetime, which is used to compute the reference energy that each node should expend during each round.

In the scheme, the network is organized into a clustering hierarchy, and the cluster heads collect measurements information from cluster nodes and transmit the aggregated data to the base station

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directly. Moreover, the authors have supposed that the network topology is fixed and no-varying on time. The difference between DDEEC and DEEC is localized in the expression which define the probability to be a cluster head for normal and advanced nodes. Simulation results show that the protocol performs better than the SEP and DEEC in terms of network lifetime and first node dies.

SDEEC

An improvement of DEEC is proposed as stochastic DEEC by Elbhiri et al. [10]. SDEEC is a self-organized network with dynamic clustering concept. This protocol introduces a dynamic method where the cluster head selection probability is more efficient. In this protocol, the cluster head selection in overall network is based on nodes' residual energy.

According to the protocol, all non-cluster head nodes send data to respective cluster heads in their allocated transmission time. The cluster head node must keep its receiver on, in order to receive all the data from the nodes in the cluster. Some signal processing is performed by cluster head to compress the data into a single signal when all the data is received. After this phase, each cluster head sends the aggregated data to its primecluster head. Each non-cluster head can turn off to the sleep mode to conserve the energy. The drawback in the protocol is that if non-cluster head nodes turn off to the sleep mode when cluster head is performing aggregation, how they will come to know about the next round of cluster head selection. Simulation results show that SDEEC performs better than SEP and DEEC in terms of network lifetime.

EDEEC

Heinzelman, et al. [11] proposed LEACHcentralized (LEACH-C), a protocol that uses a centralized clustering algorithm and the same steady state protocol as LEACH. SEP (Stable Election Protocol) [12] is proposed in which every sensor node in a heterogeneous two-level hierarchical network independently elects itself as a cluster head based on its initial energy relative to that of other nodes. Li Qing et al. proposed DEEC [13] (Distributed energy efficient Clustering) algorithm in which cluster head is selected on the basis of probability of ratio of residual energy and average energy of the network. Simulations show that its performance is better than other protocols. B. Elbhiri et al. proposed SBDEEC (Stochastic and Balanced Developed Distributed Energy-Efficient Clustering (SBDEEC) [14] SBDEEC introduces a balanced and dynamic method where the cluster head election probability is more efficient. Moreover, it uses a stochastic scheme detection to extend the network lifetime. Simulation results show that this protocol performs better than the Stable Election Protocol (SEP) and the Distributed Energy- Efficient Clustering (DEEC) in terms of network lifetime.

III. Proposed Architecture

DEEC

Let $p_i = 1/n_i$, which can be also regarded as the average probability to be a cluster-head during n_i rounds. When nodes have the same amount of energy at each epoch, choosing the average probability p_i to be p_{opt} can ensure that there are $p_{opt}N$ cluster-heads every round and all nodes die approximately at the same time. If the nodes have different amounts of energy, pi of the nodes with more energy should be larger than p_{opt}. Let $\bar{E}(r)$ denote the average energy at round r of the network, which can be obtained by

$$\bar{E}(r) = \frac{1}{N}\sum_{i=1}^{N} E_i(r) \quad (1)$$

The probability of the nodes of nodes will be given by:

$$\sum_{i=1}^{N} P_i = \sum_{i=1}^{N} P_{opt}\frac{E_i(r)}{\bar{E}(r)} = \sum_{i=1}^{N}\frac{E_i(r)}{\bar{E}(r)} = Np_{opt} \quad (2)$$

It is the optimal cluster-head number. The probability threshold that each node s_i use to determine whether itself to become a cluster-head in each round, as follow:

$$T(S_i) = \begin{cases} \frac{p_i}{1-p_i(r \bmod \frac{1}{p_i})} & if\ s \in G \\ 0 & otherwise \end{cases} \quad (3)$$

Where, G is the set of nodes that are eligible to be cluster head sat round r. If node s_i has not been a cluster-head during the most recent n_i rounds, we have s_i 2 G. In each round r, when node s_i finds it is eligible to be a cluster-head, it will choose a random number between 0 and 1. If the number is less than threshold T (s_i), the node s_i becomes a cluster-head during the current round.

DDEEC

DDEEC uses same method for estimation of average energy in the network and CH selection algorithm based on residual energy as implemented in DEEC. Difference between DDEEC and DEEC

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is centered in expression that defines probability for normal and advanced nodes to be a CH [9].

We find that nodes with more residual energy at round r aremore probable to become CH, so, in this way nodes having higher energy values or advanced nodes will become CH moreoften as compared to the nodes with lower energy or normal nodes. A point comes in a network where advanced nodes having same residual energy like normal nodes. Although, after this point DEEC continues to punish the advanced nodes so this is not optimal way for energy distribution because by doing so, advanced nodes are continuously a CH and they die more quickly than normal nodes. To avoid this unbalanced case, DDEEC makes some changes to save advanced nodes from being punished over and again. DEEC introduces threshold residual energy as in [9] and given below:

$$TH_{REV} = E_0\left(1 + \frac{aE_{disNN}}{E_{disNN} - E_{disAN}}\right) \quad (4)$$

When energy level of advanced and normal nodes falls downto the limit of threshold residual energy then both type ofnodes use same probability to become cluster head. Therefore, CH selection is balanced and more efficient. Threshold residual energy T h is given as in [9] and given below:

$$TH_{REV} \simeq \left(\frac{7}{10}\right) E_0 \quad (5)$$

Average probability pi for CH selection used in DDEEC is as follows as in [9]:

$$p_i = \begin{cases} \frac{p_{opt} E_i(r)}{(1+am)\bar{E}(r)} \\ \frac{p_{opt} E_i(r)(1+a)}{(1+am)\bar{E}(r)} \\ C\,\frac{p_{opt} E_i(r)(1+a)}{(1+am)^{\sim}\bar{E}(r)} \end{cases} \quad (6)$$

EDEEC

EDEEC uses concept of three level heterogeneous networkas described above. It contains three types of nodes normal, advanced and super nodes based on initial energy. $p_i$isprobability used for CH selection and p_{opt} is reference forp_i. EDEEC uses different p_{opt} values for normal, advanced and super nodes, so, value of pi in EDEEC is as follows

$$p_i = \begin{cases} \frac{p_{opt} E_i(r)}{(1+m(a+m_0 b))\bar{E}(r)} \\ \frac{p_{opt}(1+a) E_i(r)}{(1+m(a+m_0 b))\bar{E}(r)} \\ \frac{p_{opt}(1+b) E_i(r)}{(1+m(a+m_0 b))\bar{E}(r)} \end{cases} \quad (7)$$

Threshold for CH selection for all three types of node is as follows

$$T(s_i) = \begin{cases} \frac{p_i}{1-p_i\left(r \bmod \frac{1}{p_i}\right)} & if\ p_i \in G' \\ \frac{p_i}{1-p_i\left(r \bmod \frac{1}{p_i}\right)} & if\ p_i \in G'' \\ \frac{p_i}{1-p_i\left(r \bmod \frac{1}{p_i}\right)} & if\ p_i \in G''' \\ 0 & otherwise \end{cases} \quad (8)$$

Genetic Algorithm

This probabilistic search algorithm computationally mimics natural evolution process by alterating a population of candidate solutions to generate best optimal output.

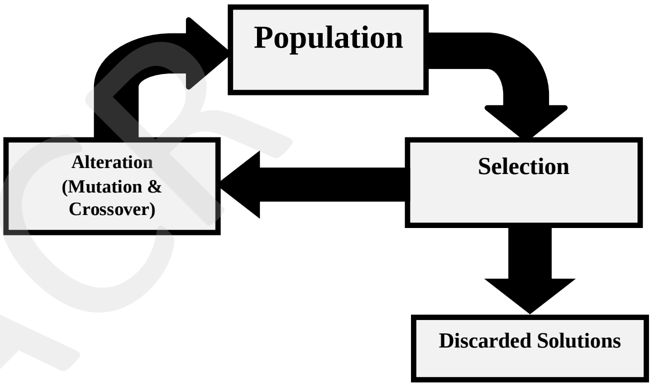

Figure 1: Genetic Algorithm Evolutionary Cycle

The chromosome (series of smallest unit 'gene') is the first possible solution of problem. Application dependent is coding technique of transforming unique solution to bit string. The approach of genetic algorithm is scaled in three steps depicted in terms of Selection, Crossover and Mutation.

Selection

Selection of fittest candidate to generate a succeeding possible solution is a mimic of nature's reproduction algorithm and candidates claim their fitness based on proportion to fitness proportional selection.

Crossover

At a point of crossover, chromosomes from two different solutions are artificially mated and swapped the slice part to generate a new solution. The genes of fittest candidates mate with genes of similar cateogy (with distinct properties) generates better solution known as new chromosome.

Mutation

Crossever limits its functionality to generate new chromosomes based on parents' properties. Mutation is random adjustment of these to avail

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new composition of properties that was not possible only with crossover step.

The steps in the typical GA for finding a solution to a problem are listed below:

1. Generate an initial solution population of a certain size randomly.
2. Calculate each solution in the current generation and assign it a fitness value.
3. Select "good" solutions based on fitness value and discard the rest.
4. If satisfactory solution(s) found in the current generation or maximum number of generations is exceeded then stop.
5. Change the solution population using crossover and mutation to create a new generation of solutions.
6. Go to step 2.

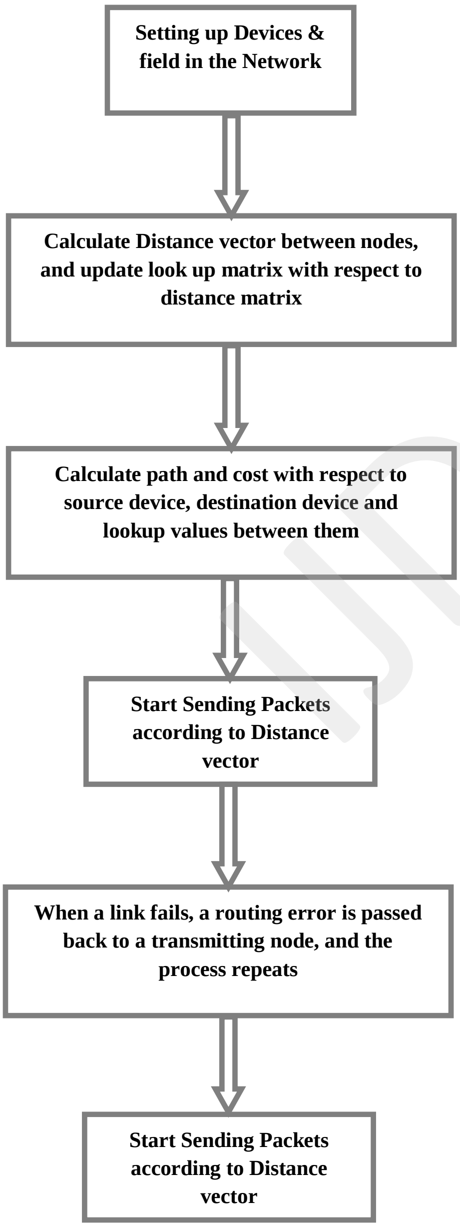

Figure 2: Flow Chart of Proposed Work

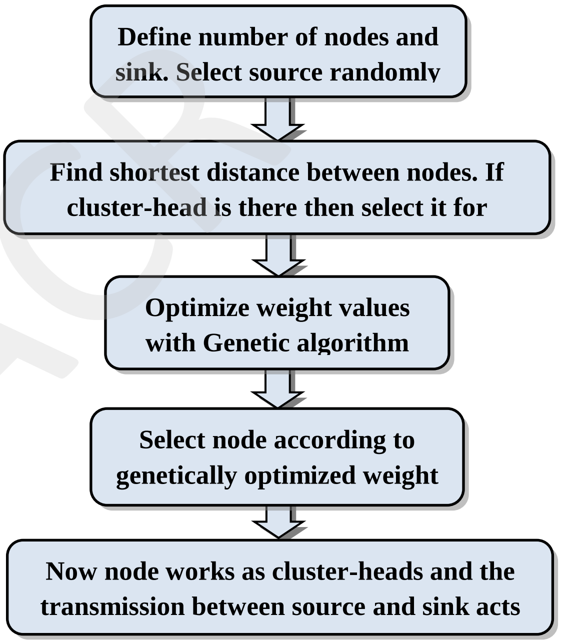

Figure 3: Flow Diagram of Genetically Optimized Cluster Heads

IV. Results

Simulation Parameters

Table 1: Parameters table

Field Area	100x100 meter squares
Number of nodes in the field	100
Optimal Election Probability	P=0.1
Initial Energy of nodes	0.5 J
Energy consumption of transmit and receive	500 nano Joules per round

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AMPLIFIERS	
MAXIMUM NUMBER OF ROUNDS	5000
DISTANCE BETWEEN CLUSTER HEAD AND BASE STATION	38.25 M
DISTANCE BETWEEN CLUSTER MEMBERS AND CLUSTER HEAD	24.9649 M

Simulation Results

Simulation is carried out using MATLAB 2010a:

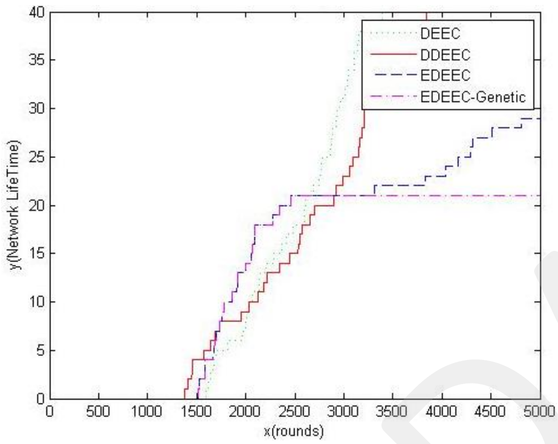

Figure 4: Network Lifetime for different clustering algorithms

The figure above shows the comparison of Lifetime for different clustering algorithm. It can be noticed that the EDEEC-Genetic gives better results as compared to others. At the end of round we are getting the minimum number of dead nodes in EDEEC-Genetic as compared to other algorithms.

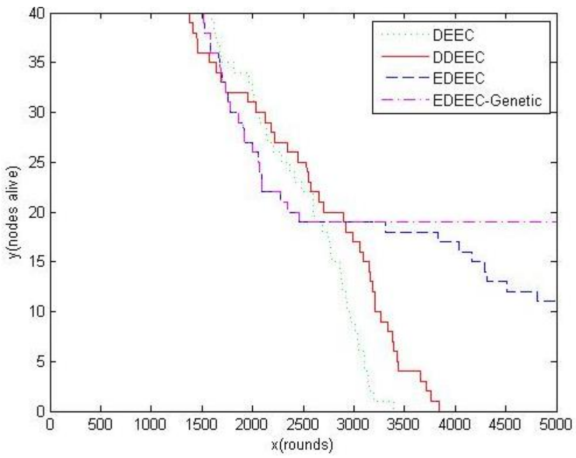

Figure 5: Nodes alive during rounds for different clustering algorithms

The figure above shows the comparison of alive nodes during the rounds for different clustering algorithm. It can be noticed that the EDEEC-Genetic gives better results as compared to others. At the end of round we are getting the maximum number of alive nodes in EDEEC-Genetic as compared to other algorithms.

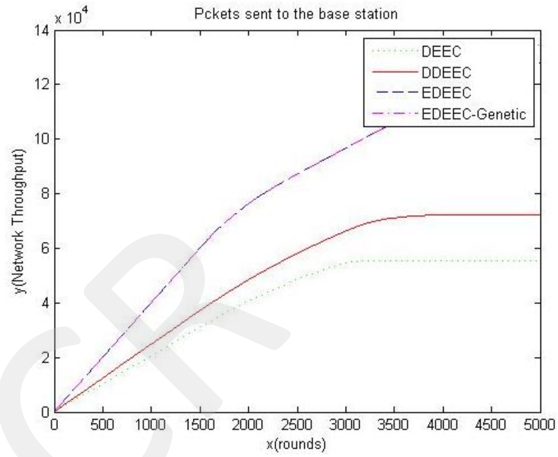

Figure 6: Network throughput for different clustering algorithms

The figure above shows the comparison of throughput for different clustering algorithm. It can be noticed that the EDEEC-Genetic gives better throughput as compared to other algorithms.

V. CONCLUSION

In this paper we have examined the current state of proposed clustering protocols, specifically with respect to their power and reliability requirements. In wireless sensor networks, the energy limitations of nodes play a crucial role in designing any protocol for implementation. In addition, Quality of Service metrics such as delay, data loss tolerance, and network lifetime expose reliability issues when designing recovery mechanisms for clustering schemes. These important characteristics are often opposed, as one often has a negative impact on the other.

We have examined DEEC, E-DEEC with GA, and DDEEC for heterogeneous WSNs containing different level of heterogeneity. Simulations prove that DEEC and DDEEC perform well in the networks containing high energy difference between normal, advanced and super nodes. Whereas, we find out that EDEEC-GA perform well in all scenarios. EDEEC-GA has best performance in terms of stability periodand life time.

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REFERENCES

[1] Heinzelman W, Chandrakasan A, Balakrishnan H. "Energy-Efficient Communication Protocol for Wireless Micro sensor Networks" Proc. 33rd HICSS, 2000.

[2] N. Vlajic and D. Xia Wireless Sensor Networks: To Cluster or Not To Cluster? WoWMoM'06, 2006.

[3] VivekKatiyar, Narottam Chand, SurenderSoni, Clustering Algorithms for Heterogeneous Wireless Sensor Network: A Survey International Journal of Applied Engineering Research, DINDIGUL Volume 1, No 2, 2010.

[4] P. Krishna, N.H. Vaidya, M. Chatterjee, D. Pradhan, "A cluster-based approach for routing in dynamic networks, ACM SIGCOMM Computer Communication Review", 27 (2) (1997) 49-65.

[5] B. McDonald, T. Znati, "Design and performance of a distributed dynamic clustering algorithm for Ad-Hoc networks", in: Proceedings of the Annual Simulation Symposium, 2001.

[6] V. Mhatre, C. Rosenberg, D. Kofman, R. Mazumdar, N. Shroff, "Design of surveillance sensor grids with a lifetime constraint", in: 1st European Workshop on Wireless Sensor Networks (EWSN), Berlin, January 2004.

[7] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "Energy efficient communication protocol for wireless micro sensor networks", in: Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS-33), January 2000.

[8] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "An application specific protocol architecture for wireless micro sensor networks", IEEE Transactions on Wireless Communications 1 (4) (2002) 660-670.

[9] Elbhiri, B., Saadane, R., El Fkihi, S., Aboutajdine, D. "Developed Distributed Energy-Efficient Clustering (DDEEC) for heterogeneous wireless sensor networks", in: 5th International Symposium on I/V Communications and Mobile Network (ISVC), 2010.

[10] B. Elbhiri, R. Saadane and D. Aboutajdine, "Stochastic Distributed Energy-Efficient Clustering (SDEEC) for heterogeneous wireless sensor networks," ICGST-CNIR Journal, Volume 9, Issue 2, December 2009, pp.11-17

[11] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "An application specific protocol architecture for wireless micro sensor networks", IEEE Transactions on Wireless Communications 1 (4) (2002) 660-670.

[12] G. Smaragdakis, I. Matta, A. Bestavros, "SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks", in: Second International Workshop on Sensor and Actor Network Protocols and Applications, 2004

[13] L. Qing, Q. Zhu and M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks," Computer Communications, Vol. 29, 2006, pp. 2230–2237

[14] Elbhiri Brahim, Saadane Rachid, Alba-Pages Zamora, Driss Aboutajdine, "Stochastic Distributed Energy-Efficient Clustering (SDEEC) for heterogeneous wireless sensor networks", ICGST-CNIR Journal, Volume 9, Issue 2, December 2009