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Butterfly-PSO Based Energy Efficient Data Analysis of Wireless IoT Devices

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***Abstract*: Paper collecting data from various sources for research observation, security, etc. are depend on IOT networks. As IOT device are remotely which transform information from nearby area and lifespan of this network rely on energy uses for communication. So this paper proposed a neural network and genetic algorithm combination for increasing the life span of the network. Error Back Propagation neural network was trained to identify best set of nodes for the cluster center selection. This machine learning based data selection increase the cluster selection accuracy of the BFPSO (Butterfly Particle Swarm Optimization). As combination get reduce by neural network data analysis so less number of population need to be developed for BFPSO algorithm which ultimately increase the accuracy of device selection. Various set of region size and number of nodes were developed to evaluate proposed model. Comparison of proposed model NN-BFPSO-CHS (Neural Network Butterfly Particle Swarm Optimization based Cluster Head Selection) was done with previous existing methods on different evaluation parameters and it was obtained that proposed model has improved all set of parameters.**

***Index Terms*— Clustering, IOT, Genetic Algorithm, Machine Learning, Soft Computing.**

I. INTRODUCTION

Collection of information from earth for environmental study depends on sensor and networks. So devices which are termed as information of things have sensor to collect information and transfer to nearby base station. So each device is known as node in a fix study region which collects environmental data with initial processing capacity and able to send data packet through transmitter. Although this data packet may use its own bandwidth channel or some internet kind of communication medium. So each node moving or placed in a study region totally depends on its battery energy to sense, process, transfer, etc. [1].

As processing units, memories are less expensive in case of energy consumption, so more or less researcher has to focus on network establishment with data transfer for minimizing the energy requirement. As large amount of data processing is not possible in odes so low complex data analysis was done.

So energy management or utilization is key point to increase the IOT virtual network life span.

Asset management is required to reduce the energy consumption during live network [2]. This was usually done by improving routing algorithm [3], arranging nodes in hierarchical manner, cluster structure [4] but node load remain same in all set of works.This load distribution or analysis part is highly required in the energy management. As clustered structure was a highly favorable technique to improve energy [3, 4, 5]. So each of node is assign under one cluster center where each cluster center transfer received data from the sensors to sink or base station. All non-cluster center nodes sense data and send to its respected cluster center, so selection of this cluster center is done by most of researcher. This work focus on this cluster center selection with continuous analysis of energy resource to reduce the transferring rate of sensed data. This reduction of data increases the overall time-span of the network. Hence paper introduce artificial model to gather information and predict nodes to reduce the data packet transferring rate.

Paper was design in few sections where second section has related work portion for understanding the different clustering methods. Next section explains proposed work named as NN-BFPSO-CHS (Neural Network Butterfly Particle Swarm Optimization based Cluster Head Selection). Now next section gives an experimental result comparison with other existing methods. Finally, whole paper is concluding in last section. Formatted paper, volume no/ issue no will be in the right top corner of the paper. In the case of failure, the papers will be declined from the database of journal and publishing house. It is noted that: 1.

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II. RELATED WORK

In [5] researcher proposed algorithm that base station can be situated at focal point of the algorithm and system is working in two dimensions. System group development is finished in the1stand in second dimension the determination of circulated bunch heads is performed. For the choice of CH parameters utilized are node situating and the energy of remaining.

In [6], researcher proposed another IDS system utilizing cross breed inconsistency recognition, by utilizing an information mining algorithm, the algorithm utilized is K-implies Clustering. For location the interruption, the K-implies algorithm of the Clustering assembles the examples of interruptions consequently over prepared information. Coordinating the exercises of the system against these examples of recognition the interruptions are identified. The researcher assessed the methodology over a remote sensor arrange dataset that was made by OpNet modeler, that contained different characteristics, for example, traffic got traffic sent a start to finish delay, the point of the introduced EAFCA is to give a skillful decision procedure of the CH concerning all the imperative favorable circumstances that helped alongside a straightforward hand-off model between group. From the outcome that was taken from HNA and FND methodologies demonstrated that the sensor organizes life span and consequently guaranteed the heap all through dissemination the system working.

In [7] (Hbrid bunching energy mindful steering convention) H-CERP has been proposed to shape the effectiveness of the groups with lesser head check of the group than the ideal estimations and utilizing the correspondence of multichip with passages nodes for correspondence alongside the base station. This cutting edge procedure gives the frameworks more preferences that the inclusion of the sensors and system lifetime are much essential at no extra expenses.

In [8], scientist give an energy proficient Clustering strategy, in view of fake honey bee settlement algorithm and factional math. MFABC try to augment the system energy and life time of nodes by half breed ideally choosing group head. This algorithm created to control the union rate of Artificial Bee Colony with the recently structured wellness work which considered three targets like, energy utilization, remove ventured out and deferrals to limit the general goal. The execution for bunch head determination of MFABC is contrasted and three conventions; LEACH, PSO and ABC-based steering as indicated by energy and life time. The reenactment results appeared, FABC is amplifies the energy and life time of nodes as contrasted and existing conventions.

III. PROPOSED METHODOLOGY

Here explanation of proposed work NN-BFPSO-CHS (Neural Network and Genetic Algorithm Based Cluster Head Selection) is done by two modules first find the cluster center from available nodes in the region. While second involve node selection for participating the cluster head selection. This section gives complete explanation of selection of cluster head identification by using genetic algorithm and

Neural network. Node energy plays an important role for selection of cluster head. Some of IOT device are selected for packet transfer where selection was depending on training of neural network. While neural network remove less energy nodes from the completion of cluster heal selection and increase life span of wireless network.

- **Develop Virtual Region and Place Node position**

This work start with placement of N number of nodes and in an MxM region. In order to assume the initial stage of the network some energy need to be set for each node in the network. While calculation of energy losses for transmitting and receiving a bit from distance d is depend on eq. 1 and 2.

ETx(L,d) = Eelec x L+ a x Lx db----------Eq. 1

ERx(L,d) = Eelec x L----------Eq. 2

In above equation L represents the data size in bits, Eelecis the energy consumption per bit, while d is the distance unit between source and destination. As per the d value constant a and b are assume this can be understand as if d is less than a d0 reference distance than a and b will be afs and 2. Otherwise, they will be aamp and 4. Now value of afs and aamp are the amplifier cost of the nodes. So to send packet longer than reference distance higher energy need to spend.

Estimate K Cluster

As per [10] optimal size of cluster in a wireless network where N nodes are moving with an area of MxM is depends on eq. 3.

$$K_{opt} = \sqrt{\frac{N \times \varepsilon_{fs} \times M^2}{2\pi(2E_{elec} + E_A)}}$$

Where ε_fsis amplifier power consumption of the free-space, EAis energy requirement for packaging of data for length of K bits.

Data Analysis: Here input data contain two information first is nodes position while second is available energy in each

Node. Here on the basis of both parameter selection of cluster center and cluster size is done by using Butterfly-PSO genetic algorithm. In this model Butterfly-PSO was used for clustering the wireless nodes. In this work genetic algorithm BUTTERFLY-PSO is use because this takes two phase learning. Main motive of this model is to reduce the dataset size and increase the clustering accuracy.

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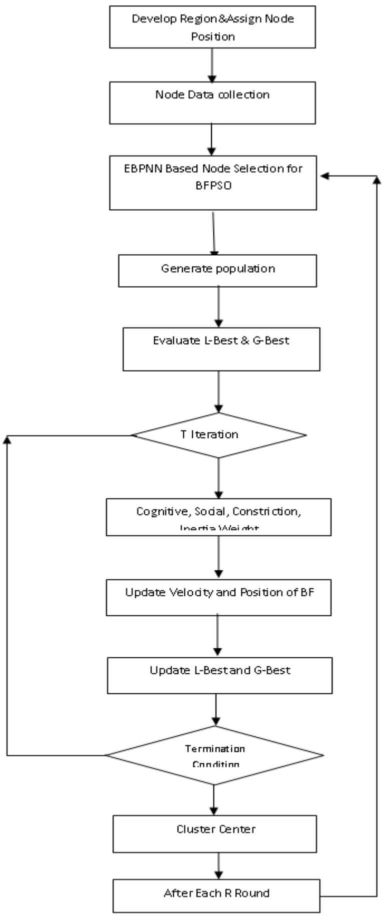

- **Butterfly-Pso**

The first part is the normalized energy consumption. The energy consumption for non-CHs is defined as

Enon-CH= ∑i=1∑j=1 (ETx(L, d(CHi, Nj)) x Xij -----eq. 4

In above eq. 4 CHi is cluster head and Nj is Jth non cluster node from N set of node for which cluster need to identify. D is again a distance between CHi and Nj node. Here Xij is a constant value which may be 0 to 1. The energy consumption for CHs is defined by eq. 5 as

ECH= ∑i=1(Lx|Cij|x(EDA+ERx)+ETx(L, d(CHi, BS))-----Eq. 5

where jCij is the number of members belonging to the ith CH, and EDA is the energy consumption for data collection.

D = ECH + Enon-CH-----Eq. 6

So output of above eq. 6 contain distance value from all set of cluster nodes from the non-cluster node. Finally, on-cluster node is assign to cluster which have minimum distance.

Generate Population: Here expect some probable solutions which are set of nodes act as cluster center. Randomization of this population was done by Gaussian function shown in eq. 7. This can be understand as let the number of cluster be K and number of initial population is IP, then one of the possible solution is Cc ={N1, N5, N7…..Nm} this can be assume as the solution set. While P = [Cc1, Cc2,……Ccn] is an population obtain randomly by eq. 7 while only those node participant who have energy greater than TE (Threshold of Energy), where m is number of cluster center and n is number of chromosomes.

P ← Rand(m, n)----Eq. 7

Evaluate L-Best and G-Best

This step find best chromosome form the population and fitness value of this best solution act as Local best and Global best value. Here it was obtained by evaluating the fitness value of each probable solution in the population. After this iteration of the algorithm starts where L-Best and G-Best update regularly.

Iteration Steps This involve calculation of Sensitivity of Butterfly by eq. 8 [12] than cognitive values with constriction factor and inertia weight were evaluate by eq. 9, 10 [12]. Here velocity and position of the butterfly also get update which are parameters of PSO. So as per position matrix crossover is done to update population.

Sensitivity of Butterfly

S=e^(-(M_r-C_r)/M_r)----Eq. 8

Where S is sensitivity of rth iteration where Mr is maximum number of iteration takes place and Cr is current iteration of this NN-BFPSO-CHS algorithm.

Cognitive and Social parameters

C_1=y*(C_r/M_r +x)

C_2=x*(C_r/M_r)

Where x, y are constants

Constriction Factor Ceq

α=C_1+C_2

C_eq=1-α -√ (α ^2-4α)----Eq. 9

Inertia Weight W

W=y+((M_r-C_r))/M_r -----Eq. 10

Update velocity V and position X of each probable solution

V_(i+1)=C_eq*(W*V_i+S_ *(1-P)*R*C_1*(L_best-C_r)+P*R'*C_2*(G_best-C_r)

X = R*P*V_(i+1)-----Eq. 12

In above equation V is velocity, X is position while R and R' are random number whose values range is between 0-1. p is probability of nectar for the butterfly selection. So as per X and V values crossover operation were performed.

Crossover

In this work population P is updated as per X column wise and V values update P row wise. Change in column help to assign new position for the cluster center in same probable solution. While changes in row value as per L best solution increase the chance of generation of better fitness probable. Solution.

Update G-Best

After each iteration values of G-Best get optimize if new solution probable solution fitness function values are better than previous G-Best values. Hence if two iteration shows same values than iteration will break.

Cluster Center

In this part best set of cluster center were obtained after T time iterations. So as per best cluster center solution all other nodes were distribute in respected clusters by using distance formula.

- **Neural Network Training**

In this step Error Back Propagation neural network was consider for the training of node selection for cluster head selection, here training vector of the neuron consist of three elements first is distance of node from base station, second was available energy of node, third was total packet transfer of the node in that energy [13]. Desired output is binary means 1 for the selected node while 0 for the non-selected node. During training both input vector pass in the neural network for proper learning of neurons.

- A layer neural network is assuming which have three layers.
- Input layer neuron were identified by I, while hidden layer neuron was identified by j. Output layer neuron is identified by k.

- Weights between neuron are represent by wij, where i and j are neuron layers.
- Eq. 13 shows output of neuron as per weight and biasing value bj:

$$X_j = \sum x_i \, . \, w_{ij} b_j \text{------Eq. 13}$$

where, 1£ i £ n; n is the number of inputs to node j, and bj is the biasing for node j. Hence network will learn the weights between layers. This error need to be correct by adjusting the weight values of each layer. So estimation of error was done by eq. 8 [13].

$$\frac{\partial E_i}{\partial O_i} = \frac{\partial(-1 * ((y_i * \log(O_i) + (1 - y_i) * \log(1 - O_i)}{\partial O_i}$$

$$\frac{\partial E_i}{\partial O_i} = (-1 * ((y_i * \log(O_i) + (1 - y_i) * \log(1 - O_i) \quad \text{Eq. 14}$$

In similar fashion other values can be calculate to find other set of derivatives using above equation.

For each input to neuron calculate the derivative with respect to each weight using equation. Now let us look at the final derivative by eq. 15, [13].

$$\sum_{i=1:n} \frac{\partial H_i}{\partial W_{i\,(j,k)}} = \frac{\partial (h_{i\,(ouput)} * W_{i\,(j,k)})}{\partial W_{i\,(j,k)}} - Eq.15$$

Now by using chain rule final derivates were calculated for the below equation. Here multiplication of each derivative was done in eq. 16.

$$\frac{\partial E_i}{\partial W_i} = \frac{\partial E_i}{\partial O_i} * \frac{\partial O_i}{\partial H_i} * \frac{\partial H_i}{\partial W_i} - - - Eq.16$$

So overall ∂W_i can be obtained by getting value of weight from above equation, here all set of weight which need to be update are change by eq. 17 values.

$$\partial W_i = \begin{bmatrix} \frac{\partial E_1}{\partial W_{1,1}} & \frac{\partial E_2}{\partial W_{1,2}} & \frac{\partial E_3}{\partial W_{1,3}} \\ \frac{\partial E_1}{\partial W_{2,1}} & \frac{\partial E_2}{\partial W_{2,2}} & \frac{\partial E_3}{\partial W_{2,3}} \\ \frac{\partial E_1}{\partial W_{3,1}} & \frac{\partial E_2}{\partial W_{3,2}} & \frac{\partial E_3}{\partial W_{3,3}} \end{bmatrix} - - - - Eq.17$$

The SNN weight updates was done by above matrix of ∂W_i.
W_ij=W_ij+∂W_ij----Eq. 18
So end of above iteration steps over when error obtained from the output layer get nearer to zero or some constant such as 0.0001.

- **Testing of Neural Network**

After each fix number of round of packet transfer node Position, energy, and total packet transfer data were collect and pass in the trained neural network for finding the set of nodes which are fit for the cluster head selection through BFPSO. While nodes which are not fit for the cluster head selection were consider as weak nodes and their packet transfer rate get reduce by fifty percent. This reduction of packet transfer increases the life span of wireless network. Here area cover by the node is still sensible by the live nodes. Hence neural network for node selection improve cluster head selection technique as well as lifespan of network.

IV. EXPERIMENT AND RESULT

So as to lead test and measure assessment results MATLAB 2012a platform was used. This area of paper show experimental arrangement and results. The tests were performed on a machine having configuration of Intel Core i3 machine, outfitted with 4 GB of RAM, and running under Windows 7 Professional. Four sets of environment were utilized to assess the working of the proposed work. The main benchmark is 100 sensor nodes in a region of 100m x100m, the subsequent environment have 150 nodes in 100 x 100m area. While third setup has 100 nodes having 200x200m region, finally fourth have same region with 150 nodes.

- **Evaluation Parameters**

Number of Rounds: One cycle of sending packet from non-cluster center node to Base station is considered as Round. Here numbers of round are count for each comparing methods.

Execution Time: This is the execution time of the work where cluster center were elected dynamically from available set of nodes.

Packet Transfer: This is the number of packet transfer done in the WSN while all the node get discharge, so wireless arrangement having maximum number of packet transfer is good solution.

RESULTS

Here proposed methodology was compared with two existing methods first is LEACH [11] and second is [10]. Results of the proposed work NN-BFPSO-CHS Genetic Algorithm Based Cluster Head Selection is compare with the existing method in [10].

Table 1 Comparison of First Node Loss Different Area and Nodes.

Region size	Nodes	E-LEACH	UCATD	TLBO	NN-BFPSO-CHS

100	**100**	9298	11752	10126	12443
100	**150**	8381	5700	9481	11161
200	**100**	434	667	1496	1572
200	**150**	581	925	956	1451

Table 1 shows that NN-BFPSO-CHS has improved the number of rounds for first node loss in the network. Here it was obtained that proposed work efficiently select the cluster center so losses will be reduced and node survive for long duration.

Table 2 Total number of packet transfer count based comparison.

Region size	Nodes	E-LEACH	UCATD	TLBO	NN-BFPSO-CHS
100	**100**	845789	950202	1058222	1110803
100	**150**	1414535	1108058	1571764	1914447
200	**100**	79565	115159	213026	276245
200	**150**	161733	206456	243741	413405

Table 2 shows that NN-BFPSO-CHS has improved the number of packets in all set of situations of area and nodes. Here combination of Butterfly and PSO combined algorithm reduce number of iteration for the efficient cluster center selection.

Here huge experimental area increment separation between nodes which builds energy prerequisite for moving same packet size.

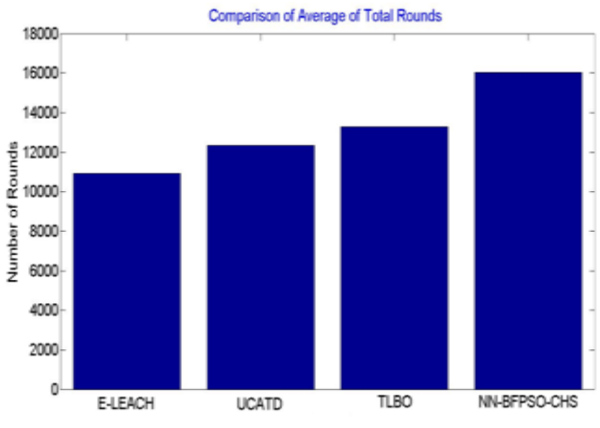

Fig. 2. Average total number of rounds comparison between different methods.

Table 3 Number of rounds count based comparison of proposed work.

Region size	Nodes	E-LEACH	UCATD	TLBO	NN-BFPSO-CHS
100	**100**	18877	20438	19580	23609
100	**150**	18813	19441	20897	23615
200	**100**	2768	4037	6842	8783
200	**150**	3243	5459	5796	8129

Table 3and fig. 2 shows that NN-BFPSO-CHS has improved the quantity of rounds in various set of experimental setup and number of nodes. As shown that in small region either number of nodes are less or more number of packets are high. Here huge experimental area increment separation between nodes which builds energy prerequisite for moving same packet size.

Table 4 Comparison of time taken to identify cluster center.

Region size	Nodes	E-LEACH	UCATD	TLBO	NN-BFPSO-CHS
100	**100**	3.6872	0.3144	0.2983	0.2175
100	**150**	5.4883	0.2184	0.2054	0.1844
200	**100**	3.7805	0.4379	0.3237	0.2707
200	**150**	5.7925	0.3538	0.3416	0.3938

Table 4 shows that NN-BFPSO-CHS has reduced the execution time for finding the cluster center. As genetic two phase population updating in Butterfly-PSO increases the clustering approach in less time.

Here it was also obtained that UCATD algorithm was less was effective due to merging and splitting of cluster nodes.

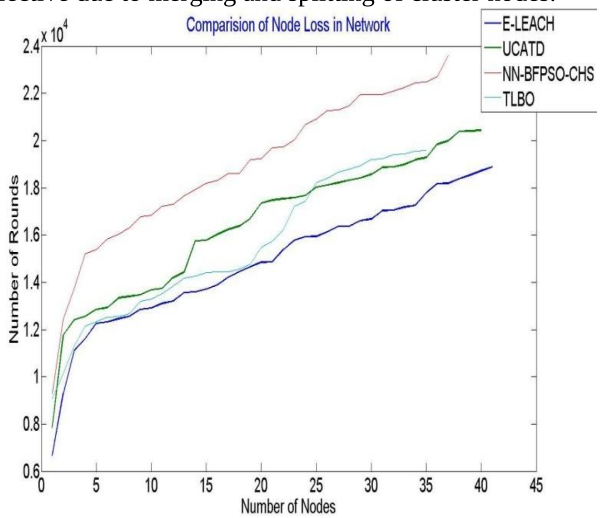

Fig. 4. Number of node loss in network having 150 nodes of 100x100m region.

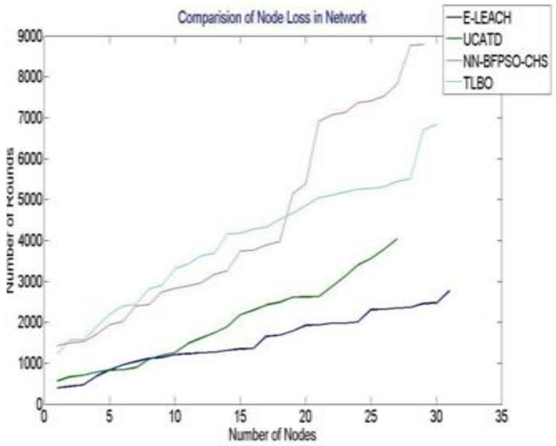

Fig. 5. Number of node loss in network having 100 nodes of 200x200m region.

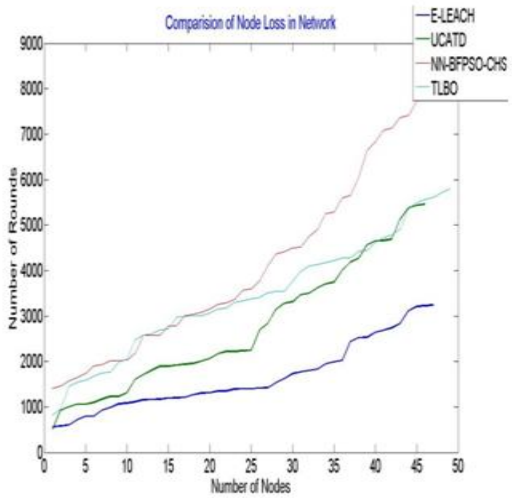

Fig. 6. Number of node loss in network having 150 nodes of 200x200m region.

Fig. 3, 4, 5 and 6 shows that proposed work number of rounds for NN-BFPSO-CHS first node was always high as compared to other existing algorithm. Combination of butterfly sensitivity, nectar searching and particle swarm optimization velocity as well as position improved cluster efficiency. Here different experimental area results show that proposed algorithm data analysis for cluster head identification improved the work performance.

V. CONCLUSION

To make an energy efficient design for routing protocol in WSN is the major challenge faced today. The main aim is to make the IOT devices to work for long time with less usage of energy. Consequently, many innovative security protocols and techniques have been developed to meet this challenge. It was obtained that use of dynamic algorithm which handle real time situation without any prior training is highly demanding. So this paper develops a genetic algorithm NN-BFPSO-CHS which increases the cluster head selection accuracy which directly increases the network life span. Here this combination improves the correct cluster head position selection with higher sensing of nearby region. Experiment is done on different dynamic condition where region size and number of nodes vary. Results are compared with various existing methods where packet transfer percentage was increase by 0.94 times. While it was also shown that life span of the WSN network was an increase by 23.5% as compared UCATD algorithm. Finally, research is continuous process of learning in future routing strategy need to be developed with heterogeneous energy distribution in nodes.

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