A Review on Energy efficient Optimization of clustering process in WSN designs using PSO & BFO

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ABSTRACT- ***The use of Wireless Sensor Networks (WSNs) is expected to bring enormous changes in data gathering, processing and distribution for different environments and applications. However, a WSN is a powerful controlled system, since nodes run on limited power batteries. Prolong the lifetime of sensor networks depends on efficient management of sensing node of energy. Hierarchical routing protocols are best known in regard to energy efficient. By using a clustering technique hierarchical routing protocol greatly minimize the energy consumed in collecting and distributing the data. The proposed protocol focuses on reducing the energy consumption and increasing the energy efficiency and also increasing the number of alive nodes of wireless sensor networks better than moving protocol. In this paper the contrast of particle swarm (PSO) and bacterial frozen (BFO) on wireless sensor network is proposed.***

Key Words: EDECC,PSO,BFO.

1. INTRODUCTION

By improvement in processors and wireless communication technologies, wireless sensor networks (WSNs) in the upcoming days will be used everywhere. WSNs consist of many sensors which usually diffuse in an unavailable area and after collecting data and doing some primary process in that region they will send them to the base station. Sensor networks are used in different fields, like: military areas, medical access, environmental activities and household quest. But, in all these fields, energy has a determining role in the staging of WSNs. Consequently, data routing methods and the way of transferring them to the base station are very important. This is because sensor nodes usually use battery power; therefore sensor's energy is limited. To sum up, a new routing method with Optimum consumption of energy and selecting the shortest path for data transfer in WSNs is desired [1]

As the battery life is restricted which is used for computing, storage and data processing of a sensor, however to reduce the energy consumption while prolonging the network lifetime stays the key problem.

Clustering is widely adopted in WSNs, wherever the whole network is split into multiple clusters. Clusters have cluster heads (CHs) be answerable for information aggregation. It has the ease of use of low energy , routing is easy and sensitive quantifiability, and it cut back the energy hole downside to some extent [2]. ancient lump routing protocols for WSN square measure supported uniform networks wherever all device nodes square measure identical in terms of battery energy and hardware configuration

Cluster head is a node which is responsible for maintain cluster, collect data from nodes in the cluster and communicating with sink. By using clustering methodology it has been observed that there is large amount of energy that has been saved. In static clustering method some rules were followed to elect a cluster head, once a cluster is made and cluster head is chosen, the cluster was inactively operated until the head node dead.

Because cluster head node have more responsibility so rapid decrease in energy in the Cluster head node. The end time was head node was too soon in static clustering technique..

Artificial Intelligence is one of the technique that can mostly used for optimization process, many researchers are working on optimization process of any system by using Fuzzy, Neural network, genetic based algorithms independently or in combination (hybrid) manner, also particle swarm optimization (PSO) is giving optimized solution in some systems based problem.

A number of protocols play an important role to reduce energy utilization. Direct communication and multi-hop data transmission used at the beginning. But due to determined power of sensor nodes these techniques don't work effectively. Energy is very critical issue in WSN, because of limited energy in sensor nodes, so to preserve energy clustering technique was introduced; in which out of thousands of nodes few nodes become cluster head and they manage the entire network.

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Bacterial Foraging Optimization (BFO) is a recently developed nature-inspired optimization algorithm, which is depend on the foraging behavior of E. coli bacteria[3].

In 2001, Bacterial Foraging Optimization (BFO)algorithm has been developed to model the bacterial foraging behavior for solving optimization problems. Recently, the BFO algorithm has been applied successfully to some engineering problems [4].

In this proposed research work comparison of optimization results for clustering process in wireless sensor network using PSO & BFO with the consideration of Energy efficiency will be carried out.

2. SCOPE OF PROBLEMS

Energy efficient clustering is one of important process in wireless sensor network design, also life span of network is energy dependent if cluster head drains completely while transmitting the data then complete network may get fail. So, routing recital /life period of WSN can be increase by using proper clustering algorithm with the consideration of energy optimization.

Artificial Intelligence based optimization has been proved significant for many technical /scientific application ,so the main aim of this propose research work is to verify whether Particle Swarm Optimization (PSO) & Bacterial Foraging Optimization (BFO) can be use for optimized energy based clustering process in wireless sensor network design & up to what extend which one is superior with the consideration of energy constraints.

3. RELATED WORK

A Distributed Energy Efficient Clustering (DEEC) Protocol:

Let pi = 1/ni, which may be additionally considered as the average probability to be a cluster-head during ni rounds. Once nodes have an similar amount of energy at every era, selecting the average probability pi to be popt will make sure that there are popt N cluster-heads each round and every one nodes die some at an equivalent time. If the nodes have totally different amounts of energy, pi of the nodes with a set of energy ought to be larger than popt. Let E (r) denotes the average energy at round r of the network, which may be obtained by as follow:

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

The nodes of nodes probability will be given by:

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

It is the optimal cluster-head number. The prospect threshold that each node si use to determine whether itself to become a cluster-head in each round.

3.1 BFO

It depends upon the fitness criteria of the bacteria, which relies upon their food searching and percipient behaviour. The law of development supports those species who have better food searching ability and either eliminates or reshapes those with poor search ability. The harder genes of those species gets propagated in the evolution chain since they posses ability to reproduce even better species in next generations. So a clear comprehend and sculpt of foraging behaviour in any of the evolutionary species, show its application in many non-linear system optimization algorithm. The foraging strategy of E. coli bacteria present in human intestine can be explained by four processes specifically Chemotaxis, Swarming, Reproduction, Elimination and Dispersal.

Chemotaxis: The movement of bacteria in search of food can be distinct in two ways, i.e. swimming and tumbling collectively known as chemotaxis. A bacterium is alleged to be 'swimming' if it moves in a known direction, and 'tumbling' if moving in an wholly dissimilar direction. Mathematically, drop of any bacterium can be represented by a unit length of random direction _ (*j*) multiplied by step length of that bacterium *C(i)*. In case of Swimming this random length is predefined.

Swarming: For the bacteria to reach at the richest food location it is desired that the optimum bacterium till a point of time in the search period should try to attract other bacteria so that together they converge at the desired location more rapidly. We can resemble the best food location as the convergent solution point of the algorithm.

Reproduction: The original cluster of bacteria, after feat developed through various chemotactic stages reach there production stage. Here best set of bacteria get divided into two categories. The healthier half replaces the other half of bacteria, which gets removed, due to their lesser foraging abilities. This makes the population of bacteria stable in the evolution process.

Elimination and Dispersal: In the evolution process a sudden unforeseen event can occur, which may drastically alter the smooth process of evolution and cause the removal of the set of bacteria and/or disperse them to a new environment. Instead of disturbing the usual chemotactic growth of the set of bacteria, this indefinite event may place a advanced set of bacteria nearer to the food scene. From a broad perspective, elimination and dispersal are parts of the population-level long-distance motile performance. In its application to optimization it assist in reducing the behaviour of *stagnation*,(i.e. being trapped in a premature solution point or local optima) E. coli bacteria's Chemotaxis foraging behaviour has a common type of bacteria with a diameter of 1 µm and length of about 2 µm and which under appropriate circumstances reconstruct in 20 min. It is this capacity to budge which is from a set of up to six rigid 100–200 rps spinning flagella, each obsessed by a biological motor. When flagellas spin clockwise, they work as propellers and so an E.Coli can run or tumble. The Chemotaxis Actions are as follows:

(A1) In neutral medium, the alternate tumbles and runs ⇒ search.

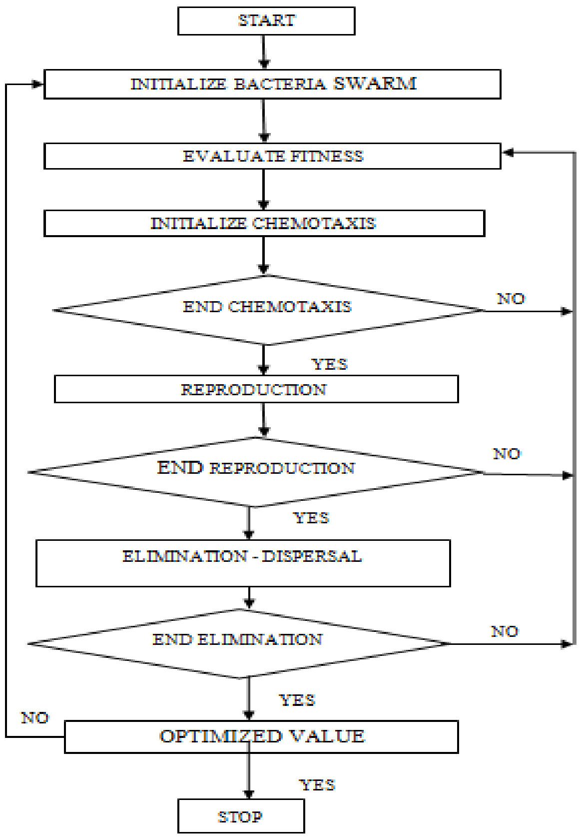

Fig:1 Flow chart Of Bacteria Swarm

The bacteria swarm S behaves as follows [5]:

1) Bacteria are arbitrarily allotted in nutrients map.

2) Bacteria go to high-nutrient in the map. Those located in noxious substances areas or low-nutrient regions no more alive and disperse, respectively. Bacteria in convenient region reproduce (split).

3) Bacteria are established in promising regions of nutrients atlas as they try to attract other bacteria by generating chemical attractants.

4) Bacteria are now situated in peak-nutrient region.

5) Bacteria now disseminate to look for new nutrient regions in map.

The parameters initialized for run are: number of chemo-tactic steps (Nc), number of reproduction steps (Nre), number of elimination and dispersal steps (Ned), dispersal probability (Ped), number of bacteria (N) & swim length (Ns). An Ecoli can move in different ways: a 'run' shows movement in a particular direction whereas a 'tumble' denotes change in direction. A tumble is represented by:

$$\theta^i(j+1,k,l) = \theta^i(j,k,l) + v(i)\phi(j)$$

where ,

$\theta^i(j+1,k,l)$ represents i^{th} bacterium in j^{th} chemo-tactic k^{th} reproductive l^{th} elimination step , v(i) gives the step length and $\phi(j)$ is a unit length random direction given by :

$$\phi(j) = \frac{\Delta(i)}{\sqrt{\Delta(i)^T * \Delta(i)}}$$

At the end of specified chemo-tactic steps, the bacterium is calculated and assorted in descending order of fitness. In the act of reproduction, the first half of bacteria is retained and duplicated while the other half is eliminated. Finally, bacteria are dispersed as per elimination and dispersal probability which helps hasten the process of optimization.

3.2 PSO

PSO is an evolutionary computation technique developed by Eberhart and Kennedy [24] in 1995, which was inspired by the Social behavior of Bird flocking and fish schooling. PSO has its start in artificial life and social psychology as well as in Engineering and Computer sciences. It is not mainly affected by the size and non-linearity of the problem and can converge to the optimal solution in many problems where most analytical methods fail to converge. Particle Swarm Optimization has more advantages over Genetic Algorithm as follows: PSO is easier to implement and has fewer parameters to adjust. Every particle in PSO remembers its own previous best value as well as the neighbourhood best. PSO utilizes a population of particles that fly through the problem space with given velocities. Each particle has a memory and it is capable of remembering the best position in the search space ever visited by it. The Positions matching to the Best fitness is called *Pbest (*also called local best) and the global best out of all the particles in the population is called *gbest.* At each loop, the velocities of the individual particles are updated according to the best position for the particle itself and the neighbourhood best position.

The velocity of each instrument can be modified by the following iterative equation:

$$V_i^{k+1} = W.V_i^k + C_1 R_1.(p_{besti} - S_i^k) + C_2 R_2 (g_{best} - S_i^k)$$

where,

viK = Velocity of agent i at iteration k.

W = Weighting Function

C1 and C2 = acceleration/weighting factor.

R1 & R2 = random number between 0 and 1.

SiK = Current position of agent i at kth iteration.

Pbest i = Pbest of agent i.

gbest = gbest of the group.

The present position can be modified by the equation

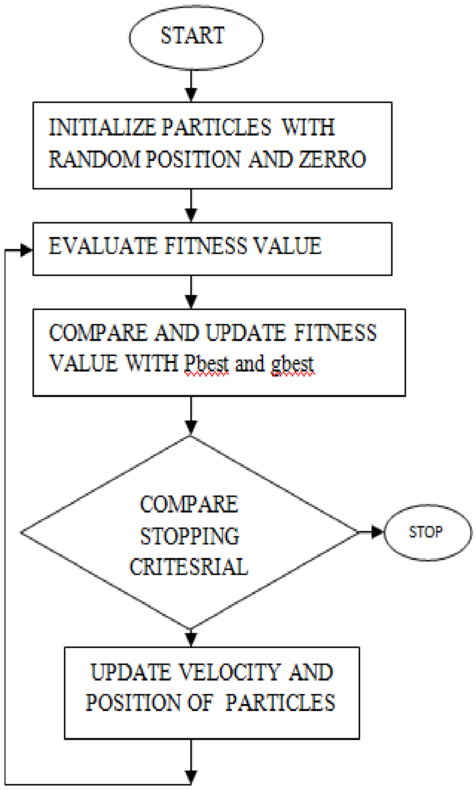

Fig:2 Flow chart of PSO

The PSO procedure has various phases consist of Initialization, Evaluation, Update Velocity and Update. The Algorithmic steps involved in Particle Swarm Optimization Algorithm are as follows:

Step 1:

Select the relevant parameters of PSO.

Step 2:

Start a Population of particles with random Positions and Velocities in the quandary space.

Step 3:

Measure the approximate Optimization fitness Function

for each particle.

Step 4:

For each Individual particle, compare the Particles fitness value with its Pbest. If the Current value is better than the Pbest value, then revise Pbest for agent i.

Step 5:

Identify the particle that has the best fitness value. The value of its fitness function is recognized a best.

Step 6:

compute the recent Velocities and Positions of the particles according to equations (5) & (6).

Step 7

Repeat steps 3-6 until the stopping condition of Maximum Generations is met.

Enhanced –DEEC (E-DEEC) Protocol:

EDEEC uses concept of three level heterogeneous networks. It comprise three types of nodes common, advanced and super nodes situated on initial energy. pi is probability used for CH selection and popt is reference for pi. EDEEC uses different popt values for normal, advanced and super nodes, so, value of pi in EDEEC is as follows:

Pi=

$$\begin{cases} \dfrac{p_{opt}E_i(r)}{(1+m(a+m_0b))\bar{E}(r)} & \text{if } s_i \text{ is the normal node} \\ \dfrac{p_{opt}(1+a)E_i(r)}{(1+m(a+m_0b))\bar{E}(r)} & \text{if } s_i \text{ is the advanced node} \\ \dfrac{p_{opt}(1+b)E_i(r)}{(1+m(a+m_0b))\bar{E}(r)} & \text{if } s_i \text{ is the super node} \end{cases}$$

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

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

Parameters	Value
Network Field	(100,100)
Number of nodes	100
Eo (Initial energy of normal nodes)	0.5 J
Message Size	4000 Bits
E_{elec}	50nJ/bit
E_{fs}	10nJ/bit/m^2
E_{amp}	0.0013pJ/bit/m^4
E_{DA}	5nJ/bit/signal
d_o(Threshold Distance)	70m
p_{opt}	0.1

Fig. 3 Simulation Parameters

The various parameters are consider which shows the performance of E-DEEC (Enhanced Distributed Energy

Efficient Clustering) and SEP(Stable Election Protocol). Simulation results in fig 4 shows that E-DEEC has better performance as compared to SEP in terms of parameters used. It the lifetime and stability of the network. [6]

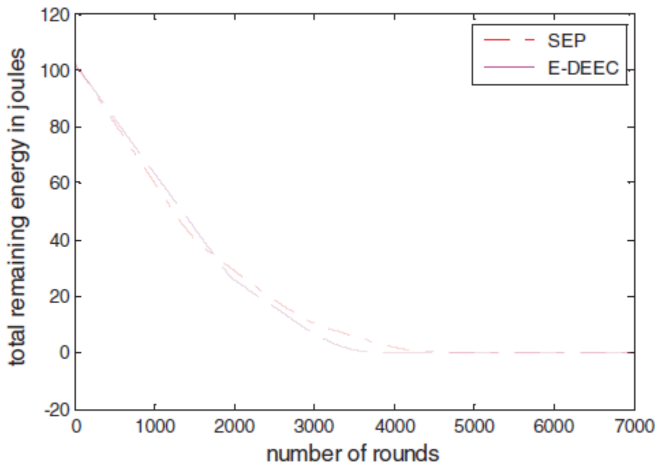

Fig:4 Total remaining energy over rounds under three-level heterogeneity of SEP and E-DEEC

Fig. 4 Data Packets over rounds under three-level heterogeneity of SEP and E-DEEC

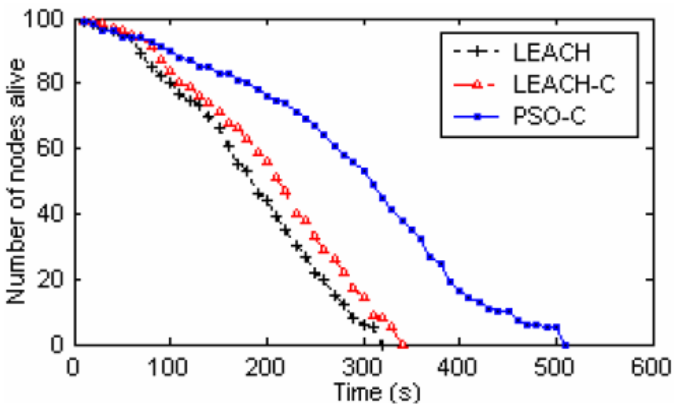

Fig. 5 Number of nodes alive over time

Fig. 5 shows the data message received at the base station over the time for LEACH,LEACH-C & PSO-C. Number of alive nodes are more for PSO-C over LEACH and LEACH-C.

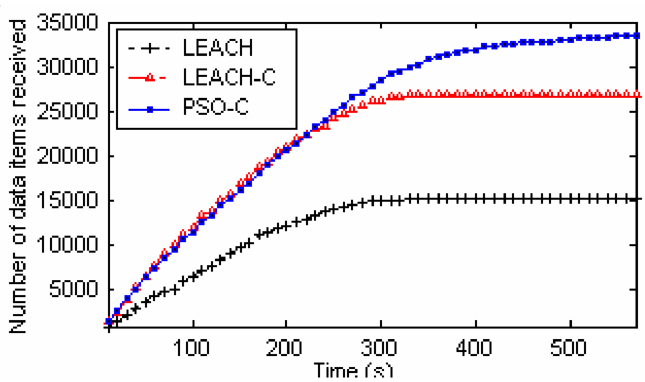

Fig. 6 Total data messages received at the BS

Fig 6 shows the data received over a period of time is more in PSO-C compared to the LEACH and LEACH-C [7].

EDEEC-PSO:

The Optimal probability distinct in Enhanced distributed energy-efficient clustering protocol (EDEEC) is not user defined in our work, we are optimizing it through particle swarm optimization (PSO), by simply selecting our protocol as a fitness function for PSO and calculate the optimal value for which our fitness function becomes zero.

4. RESEARCH METHODOLOGY TO BE EMPLOYED:

1. Study & Simulation of cluster formation algorithm EDEEC

2. Study & Simulation PSO based EDEEC

3. Study & Simulation BFO based EDEEC

4. Energy optimized Comparison of EDEEC-PSO with EDEEC-BFO

5. CONCLUSION:

Energy optimization based on different protocol has been studied. Optimizing it throughout particle swarm optimization (PSO).The PSO gives the better performance over LEEC. Also the network lifetime is more in case of PSO. In future work projected algorithm can be studied and compare it with EDEEC-PSO with EDEEC-BFO.

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