A Balanced BBBC Based Leach Algorithm for Energy Effiency in WSN

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Abstract— Wireless sensor network (WSN) contain large number of tiny sensors that can be used as an effective tool for gathering data in diverse kind of environment.. The competing objective of WSN for optimizing the scare battery utilization with sending large amount of data to base station. To achieve this objective a BBBC based metaheuristic algorithm is proposedfor the selection of cluster head in such a way so that its energy is used uniformly with delayed disintegration of network.To evaluate the performance of our proposed BBBC based LEACH protocol we have compared it with random LEACH,max energy LEACH and k-means LEACH.

Key words: LEACH, Cluster head, base station, balanced BBBC

I. INTRODUCTION

Sensor network have become valuable tool for monitoring a variety of scenario. A number of technologies currently exist to provide users with wireless connectivity[1][2].WSN detect the relevant quantities, monitor and collect the data, asses and evaluate information, formulate meaning full user display and perform decision making and alarm function.

In WSN there are two objectives in the design of WSNs.The first objective is the capability to exchange large amount of data between node and base station .The second constraining objective is minimizing the energy consumption therefore many routing algorithm have been proposed due to the challenge in designing an energy efficient network. There are three type of network structure(1)Flat routing(2)Location based routing(3)Hierarchal routing. In flat routing protocol node play the same role and have similar functionality in transmitting and receiving the data while location based protocol utilize the position information to relay the data to the desired region rather than the whole network. Hierarchal routing protocol also known as cluster based routing is mainly considered as two-layer architecture where one layer is engaged in cluster head selection and other layer is responsible for routing the main goal of hierarchal routing protocol appropriately create cluster and choose cluster head in order to reserve energy in network. LEACH (Low energy adaptive clustering hierarchy)is one of the most known algorithms in this category [18].

The random election strategy of cluster head in LEACH may misdistribution cluster head leading to unbalance energy distribution and early network disintegration. In this method cluster head consume more energy for receiving, processing and directly sending this data to the BS.Various improvements LEACH-F, LEACH-C, H-LEACH, E-LEACH have been proposed in LEACH for network life elongation. In all this algorithms various new strategies of cluster scheme were employed to increase the WSNlife.This paper proposed a BBBC based clustering scheme to elongate WSN lifetime.

II. LITERATURE REVIEW

The main aim of clustering protocol is to generate the minimum number of cluster while maintain the network connectivity. In case of WSN the main objective of clustering protocol is to minimize energy consumption by network in order to extend the network lifetime. The WSN can be categorized into two categorized-Probabilistic and deterministic. The EEHC, EECS and HEED fall in probabilistic class and PEGASIS, TASC are categorized in deterministic class.

HU Junping, Jin Yuhui, Doubling et al [21] proposed a time based cluster head selection algorithm LEACH. We call this new protocol TB-LEACH. This provides comparison between our protocol and new protocol.Xu Long-long et al[25] introduced the wireless sensor network and analysis the problem existed in LEACH routingput forward the improvised algorithm basic on LEACH cluster head multihop algorithm. It could balance energy consumption and prolong the sensor network through the use of algorithm. Jinsu back al[2] introduced a new cluster head selection mechanism together with new cluster formation scheme.With this scheme each sensor node with in a cluster evaluate its relative energy consumption compared to other node in same cluster. According toXufei Mao et al[37] opportunistic routing has been shown to improve the network throughput by allowing nodesthat overhears the transmission and closer to the destination to participate in forwarding packet. We focus on selecting and prioritizing forwarded list to minimize energy consumption by all nodes.Hinzelmanet al proposed a modified version of LEACH protocol with fixed cluster and rotating cluster head. Here cluster are formed once and fixed and cluster head position rotates among the nodes within the cluster. Xiangning and yulin[36] improved the clusterhesdselection procedure in LEACH. It makes residual energy of node as the main matric which decide wheather the node turn into CH or not after the first round.

Camilo[47] in 2006 developed an energy efficient ant based routing algorithm for efferent routing algorithm. In every node a data structure store ant informationwhere as routing table stores the previous node.Xiaoming Wang[46] in 2008proposed an ant colonyoptimisationbased location aware routing as new communication protocol for WSN called ant colony optimisation based location awarerouting.

III. METHODOLOGY

In this algorithm each particle will consistcluster centres.In two dimensional space for our simulation problem, centre can be represented byabscissa and coordinate so for 10 centre each particle will have a dimension of 20.We will be using BBBC algorithm as a clustering technique for our simulation. A brief idea of BBBC is given below.

A. Big Bang Big Crunch Search Algorithm:

The big bang and big crunch theory is introduced by Erol and Eksin which is based upon the analogy of universe evolution where two phase of evolution is represented by expansion (big bang) &contraction(big crunch).This algorithm has a low computational time and high convergence speed. In fact the big bang phase dissipates energy and produces disorder and randomness. In the big crunch phase randomly distributed particle are arranged into an order by way of a convergence operator "centre of mass". Below in figure is given the algorithm for the BBbC algorithm in steps

(1) Create random population of solution.
(2) Evaluate solution.
(3) The fittest individual can be selected as the centre of mass

Calculate new candidates around the centre of mass by adding or subtracting a normal random number whose value decreases as the iteration elapse.

The algorithm continues until predefined stopping criteria has been met.

$$x_i^{\,d}(t+1) = C^d(t) + rand * 0.5 * \frac{F_u^{\,d} - F_l^{\,d}}{1 + \frac{t}{s}}$$

Where C^d is a central point in d dimension .

$x_i^{\,d}(t+1)$ position vector at t+1 iteration for I particle in d dimension.

Rand( ) is random number generator

$f_u^{\,d}$. upper limit of x variable in d dimension.

$f_l^{\,d}$ lower limit of x variable in d dimension.

S is smooth function to control explore.

In our simulation, we have used MATLAB programming MATLAB is a software package that make it easier for you to enter matrices and vector and manipulate them. We measure algorithms' efficiency by assessing total no. of rounds up to which network survives. A network is assumed to be live if more than 30% nodes are alive with total energy greater than zero. For showing the robustness of algorithm, we also measure the round at which first node of network is dead (FND) and half of the network is dead (HND). Other two parameters against which algorithms' efficiency is measured are total number of packet sent.We use the same energy model as discussed in [19] which is the first order radio model. In this model, a radio dissipates E_{elec} = 50 nJ/bit to run the transmitter or receiver circuitry and E_{amp} = 100 pJ/bit/m^2 for the transmitter amplifier. The radios have power control and can expend the minimum required energy to reach the intended recipients. The radios can be turned off to avoid receiving unintended transmissions. The equations used to calculate transmission costs and receiving costs for a *k*-bit message and a distance *d* are shown below:

Transmitting:

$E_{Tx}(k,d)=E_{elec}*k+E_{amp}*k*d2$ (1)

Receiving:

$E_{Rx}(k)=E_{elec}*k$ (2)

IV. ALGORITHM

The above BBBC algorithm considers only inter-cluster distance as objective function. This serves the concept of equi-space distribution but doesn't address the concept of load balancing among clusters. For better clustering and load balancing a multi-objectives fitness function is required. Another modification is made in third algorithm where nodes are clustered based on inter distance by using a heuristic algorithm such as BBBC. Fourth algorithm is an improvement over simple BBBC algorithm in which we allow only limited nodes to each cluster for load balancing in clusters.

The following steps show this concept:

Step 1: Find the nodes that are alive Nodes that are not of type dead nodes are alive.

Step 2: In alive nodes using BBBC clustering algorithm for spatial distribution and load balancing among nodes in clusters.

Step 3: In the next step, from each cluster CH is chosen on the basis of surplus energy only a node is having. So our proposed scheme involves both things spatial distribution as well as load distribution in the network architecture which may ultimately improve the network life and its quality.

V. RESULT 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.

The statistics in table clearly show that BBBC clustering based LEACH algorithms perform better as compared to other methods if we consider the no of rounds covered by the algorithms. The BBBC algorithm performs nearly 100% better than random LEACH and nearly 10% better than max energy LEACH if we consider number of rounds. If we consider a network dead if 50% nodes are dead then Max Energy LEACH and balanced BBBC LEACH both have performed better than random LEACH and simple BBBC LEACH algorithm. This shows that Random LEACH has performed worst in every situation. If we consider 80% node criterion for network life then the BBBC algorithm performs better.

WSN Routing Algorithm	Network Life (in rounds)	Rounds of FND	Rounds of HND	No of packets sent to BS	Remaining Energy
Random LEACH	234	195	115	5622	1.56

Max_Energy LEACH	408	401	378	3985	1.43
BBBC LEACH	426	419	305	3959	1.468
Balanced BBBC LEACH	446	443	430	4412	0.47

Table 1: Experimentation Results

Figures from 1 to 3 compare all four algorithms for individual parameters. Figure 1 shows the energy efficiency of algorithms by depicting residual energy of total network after each round. Residual after the 80% disintegration of network shows the level of equal distribution attained by algorithms. As shown in figure 1, in this parameter, balanced BBBC LEACH algorithms is better than random LEACH and Max_energy LEACH and BBBC LEACH algorithm. Very less residual energy is remaining at the end of network shows efficient energy distribution of balanced BBBC LEACH algorithm. Other algorithms are more or less same level of residual energy. Simple random LEACH has performed worst on this parameter. In case of balanced BBBC LEACH nearly 100% network life improvement is recorded for over simple LEACH. This improvement is 10% and 5% are attained over max Energy LEACH and simple BBBC LEACH.

If we consider no of packets sent to BS shown in figure 2 then random LEACH is clear winner in the first look. This may be due to large number of cluster formed during random LEACH. This shows mismanagement in cluster head selection. If we compare rest three algorithm then balanced BBBC LEACH algorithm performs better.

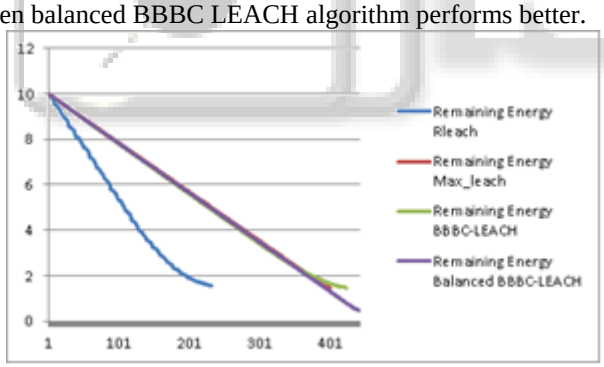

Fig. 1: Nodes Remaining Energy pattern in WSN

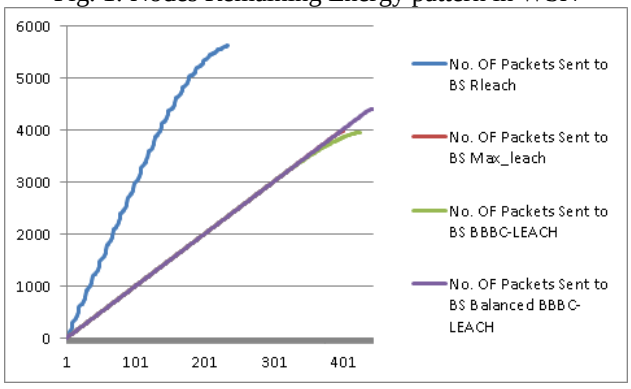

Fig. 2: No of Packets Sent to BS by CHs

Figure 3 compares the no of dead nodes. As per our simulation results Balanced BBBC LEACH and Max energy LEACH seems to perform better, but there nodes once start dying accelerates network decay very fast. Random LEACH algorithm performs very Bad on this parameter i.e. network disintegration in this front.

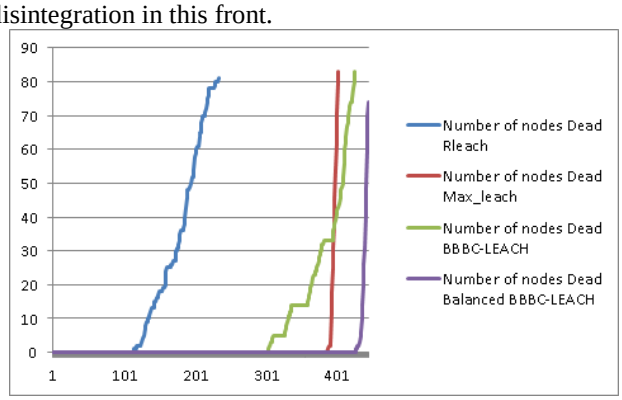

Fig. 3: No of dead nodes per round

We have measured the performance of four algorithms. Parameters for performance measurements are Residual Energy, Dead Nodes, Packets sent to BS. These parameters are shown in above figures and are plotted against number of rounds. If we consider residual energy and total number of rounds then balanced BBBC-LEACH and its variants perform better than Max Energy LEACH and random LEACH. This shows that balanced BBBC LEACH and Max Energy LEACH most uniformly distributed energy dissipation among nodes. For network integration or dead nodes criterion again BBBC based Leach and Max Energy LEACH performs better.

VI. Conclusion and Future Scope

The network life, number of dead nodes and number of packet sent to BS effect the performance of routing algorithm in WSN. The performance of cluster based routing protocol show some differences by varying life pattern among nodes and number of dead nodes. From our analysis we conclude BBBC based algorithm gives better performance. Balanced based BBBC LEACH algorithm which is made of both type of search capability local as well as global performance better than other clustering method and provide better distribution of usage of energy and equal distribution of cluster in space. LEACH has an advantage of distributed management which we miss in all other type of algorithm. We must explore such algorithm, which provide distributed management and also give better efficiency.

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