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An Approach to Energy Optimization in WSN Using Hybrid Leach and Bird Swarm Algorithm

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ABSTRACT : WSN's have gained their importance slowly and steadily over the years since it's origin in 1950's . Though having lots of features it's compact size and ability to reach and work at the places where human's can not makes it an area worth to be studied and paid more and more attention .to. Energy consumption is the key concept behind the designing of WSN's as a great success as the lifespan of this network depends upon the energy usage and hence optimizing the energy efficiency is an extremely important point. So the work done in the file is a step further in optimizing the energy efficiency and hence we put forward a meta heuristic novel hybrid algorithm under the name An approach to energy optimization in WSN using hybrid BSA + LEACH. Ahead the paper is divided in introduction part then we study the related work in part two then going ahead we described the proposed methodology in part three and finally part four and five shows the simulated result and conclusion and future work respectively.

KEYWORDS: WSN, Cluster ,BSA , Optimization ,Meta-heuristic, Heuristic ,LEACH

I. INTRODUCTION

In simplest terms we can say that a WSN is a network (in a specific area) where wireless sensors are used to gather information and submit it to the base station which is placed at a specific location There are hundreds or thousands of sensor deployed in an area to gather information which acts as a transmitters and base station as receiver
In a network where sensor before submitting a data to the base station submits it to the cluster head (head of a cluster) by making clusters within a network ,is called as a" cluster WSN" and the concept is known as "clustering" WSN's gained it's popularity slowly and steadily and today have various applications in almost each and every area of human existence .
WSN also had various issues like networking standards , expensive sensors , deployment issues , power consumption (energy) and many more
Optimization can be defined as branch of mathematics & computational science that studies methods and techniques specially designed for finding the best of a given problem .or simply we can say that the action of making the best or most efficient use of a situation or resource .There are various optimization problems in WSN'S related to coverage, topology control, scheduling, routing, mobility and many more and in this paper to optimize WSN'S energy efficiency we are using a hybridization of well known clustering protocol LEACH and a novel algorithm BSA
Detailing of these two will be given ahead in the paper in next section we first go through the related work on these two areas

II. RELATED WORK

1. **Dervis Karaboga etal** In this paper, a novel hierarchical clustering approach for wireless sensor networks to maintain energy depletion of the network in minimum using Artificial Bee Colony Algorithm. which is a new swarm based heuristic algorithm is proposed by the above mentioned. They presented a protocol using Artificial Bee Colony Algorithm, which tries to provide optimum cluster organization in order to minimize energy consumption. In cluster based networks, the selection of cluster heads and its members is an essential

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process which affects energy consumption and simulation results demonstrate that the proposed approach provides promising solutions for the wireless sensor networks

2. **Dian Palupi Rini etal** proposed Particle Swarm Optimization (PSO) which is a biologically inspired computational search and optimization method developed in 1995 by Eberhart and Kennedy based on the social behaviors of birds flocking or fish schooling. They studied and gave in their paper a sneak peak into what PSO is all about , PSO's challenges , it's advantages and disadvantages .A number of basic variations have been developed due to improve speed of convergence and quality of solution found by the PSO. On the other hand, basic PSO is more appropriate to process static, simple optimization problem. Modification PSO is developed for solving the basic PSO problem. The observation focusing on function of PSO, advantages and disadvantages of PSO, the basic variant of PSO, Modification of PSO and applications that have implemented using PSO. The application can show which one the modified or variant PSO that haven't been made and which one the modified or variant PSO that will be developed.
3. **Meena Malik etal** this paper presents a detailed review and analysis of LEACH protocol and Comparison of various network parameters is done in the form of tables and graphs. Wireless Sensor Network is a network of sensor nodes without having any central controller. Its growth is expeditiously increasing and that's why there is an immense field for research in this area. Sensors depend entirely on the trust of their battery for power, which cannot be revitalized or substituted. So the design of energy aware protocol is essential in respect to enhance the network lifetime. LEACH is energy-efficient hierarchical based protocol that balances the energy expense, saves the node energy and hence prolongs the lifetime of the network.
4. **Xiang-Bing Meng etal** A new bio-inspired algorithm, namely Bird Swarm Algorithm (BSA), is proposed for solving optimization applications. BSA is based on the swarm intelligence extracted from the social behavior and social interactions in bird swarms. Birds mainly have three kind of behavior: foraging behavior, vigilance behavior and flight behavior. Birds may forage for food and escape from the predators by the social interactions to obtain a high chance of survival. By modeling these social behavior, social interactions and the related swarm intelligence, four search strategies associated with five simple rules are formulated in BSA. Simulations and comparisons based on eighteen benchmark problems demonstrate the effectiveness, superiority and stability of BSA

III. PROPOSED ALGORITHM

LEACH

One well-known cluster-based data aggregation algorithm for WSN is Low Energy Adaptive Clustering Hierarchy Aggregation (LEACH) algorithm by LEACH has recorded good results in increasing the network life time by saving the total energy of sensors.

Low-Energy Adaptive Clustering Hierarchy (LEACH) is completely distributed ,clustering and the most popular hierarchical routing protocol for wireless sensor networks, requiring no control information from the base station.

LEACH works in two phases : setup phase and steady phase where setup phase deals with making cluster head and deciding TDMA schedule the steady phase deals with data transmission to CH and to base station .The cluster head is selected for each round with the help of the following formula:

$$T(n) = \begin{cases} \dfrac{P}{1 - P \times \left[r \bmod (1/P) \right]}, & n \in G \\ 0, & otherwise \end{cases}$$

BIRD SWARM ALGORITHM

Xiang-Bing Meng etal 2016 [24] proposed a new bio inspired algorithm for optimizing a network named bird swarm algorithm . Before we discuss what the algorithm is all about let us discuss the concept first and why was this concept chosen for optimization .As the name hints the algorithm follows the bird's behavior to optimize a network.

There have been various researches right from the origin of WSN's to improve and make these extremely wonderful networks more reliable and in quest to do that many protocols , algorithms and optimization techniques have been

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introduced and still continues .All these used mathematical formulae's relations , logics and what not some researchers looked around and saw that nature has given us so much to cherish and to learn from like how ants or bee's or birds survive or find their food and made them think to use these techniques in order to deal with these problems .
Well here we discuss .the behavior of birds and their survival. Birds always flies in flocks i.e in group and are always flying so needs continuous dosage of food to maintain their energy levels.
Now the key point here is how do they search for food or how they come to know that where their food is even flying at heights. Well birds have various x- factors with the help of which they easily detect where the food is which are sharp vision, frequent hearing, part of routine ,vigilance at other birds ,use of other senses
Typically birds exhibit three behaviors: Foraging, vigilance, flight . Out of all the birds the best fit bird will go forage the food and the other will choose between vigilance and flight . The best fit bird will be decided if a uniform random number in (0, 1) is smaller than P($P \in (0,1)$)a constant value, the bird would forage for food. Otherwise, the bird would continue vigilance.[24]
There are certain rules aiding which the algorithm works :

1> Each bird in the swarm fluctuate between vigilance and foraging behavior and either bird invigilate or forage it's a random decision which is taken after choosing a random variable between 0 and 1 if its value is greater then P (probability) then it is chosen as best fit function and hence forages .
2> During searching process birds evaluates it's position with respect to other birds and se if the position (present) is better than the previous one if not then birds update their position and further share the information in the flock.
3> Rule third says that during vigilating because of the threat of predators each bird would try to move to the centre in order to be safe hence faces competition or interference in between so the birds with more energy will make it to the centre and will forage and the others will keep vigilating which leads to rule 4
4> Rule 4 says that birds with highest reserves or more energy or strong birds will be the producers and the weak birds or the birds with low reserves will be the scroungers
5> Weak birds will follow the strong birds in order to have food .

BIRD SWARM ALGORITHM'S PSEUDOCODE [24]

Input: N: the number of individuals (birds) contained by the population
M: the maximum number of iteration
FQ: the frequency of birds' flight behavior
P: the probability of foraging for food
C, S, a1, a2, FL: five constant parameters
t=0; Initialize the population and define the related parameters
Evaluate the N individuals' fitness value, and find the best solution
While (t <M)
If (t % FQ!=0)
For i=1: N
If rand(0,1) <P
Birds forage for food (Equation 1)
Else
Birds keep vigilance (Equation 2)
End if End for
Else
Divide the swarm into two parts: producers and scroungers.
For i=1: N
If i is a producer
Producing (Equation 5)
Else
Scrounging (Equation 6)
End if End for

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End if Evaluate new solutions
If the new solutions are better than their previous ones, update them
Find the current best solution
t =t+1; End while
Output: the individual with the best objective function value in the population

Foraging behavior Each bird searches for food according to its experience and the swarms' experience. Rule 2 can be written mathematically as follows:

$$x_{i,j}^{t+1} = x_{i,j}^{t} + \left(p_{i,j} - x_{i,j}^{t}\right) \times C \times \text{rand}(0, 1) + \left(g_j - x_{i,j}^{t}\right) \times S \times \text{rand}(0, 1)$$

where j∈ [1 ...D], rand (0, 1) denotes independent uniformly distributed numbers in (0, 1). C and S are two positive numbers, which can be respectively called as cognitive and social accelerated coefficients, pi,j is the best previous position of the i^{th} bird and g_j the best previous position shared by the swarm.

Vigilance behavior: Given the Rule 3, birds would try to move to the centre of the swarm, and they would inevitably compete with each other. Thus, each bird would not directly move towards the centre of the swarm.

Flight behavior The behaviors' of the producers and scroungers can be described mathematically as follows, respectively

$$x_{i,j}^{t+1} = x_{i,j}^{t} + \text{rand}n(0, 1) \times x_{i,j}^{t},$$

$$x_{i,j}^{t+1} = x_{i,j}^{t} + \left(x_{k,j}^{t} - x_{i,j}^{t}\right) \times FL \times \text{rand}(0, 1)$$

:

where rand(0,1) denotes Gaussian distributed random number with mean 0 and standard deviation 1, k ∈ [1;2;3; ...N] k != I, FL(FL ∈ [0,2]) means that the scrounger would follow the producer to search for food.

IV. RESULT SIMULATION

In this section we evaluate the performance of WSN using hybrid LEACH and BSA via simulations and compare it with existing ABC .
For simulations we used MATLAB. We deployed 400 nodes randomly in grid range of 200mx200$m^{2.}$ Various energy parameters that has been used are shown in the following table:

E_0	E_{rx}	E_{tx}	E_{amp}	K	f
¼ j	5.0000e^{-08}j	5.0000e^{-08}j	1.0000e^{-10}pJ/bit/m^2	2000bit	2000bit/s

Where E_0 is the initial energy , E_{rx} is the receiving energy, E_{tx} is the transmitted energy, E_{amp} is the amplifier's energy ,k is size of data packet in bits and f is the frequency

Fig 4.1 shows plot distribution for nodes , it is plotted with respect to target it shows the sensor nodes deployed within grid range of 200x200 m^2 . Line is drawn with the nodes coordinates and sink points x= 50 m , y= 200 m. Let us suppose that node 1 has coordinates (X1 and X2) and let us suppose that Xm and Ym are the coordinates of the sink and we calculate the Euclidean/ any distance between two points and these points are joined by a line ..

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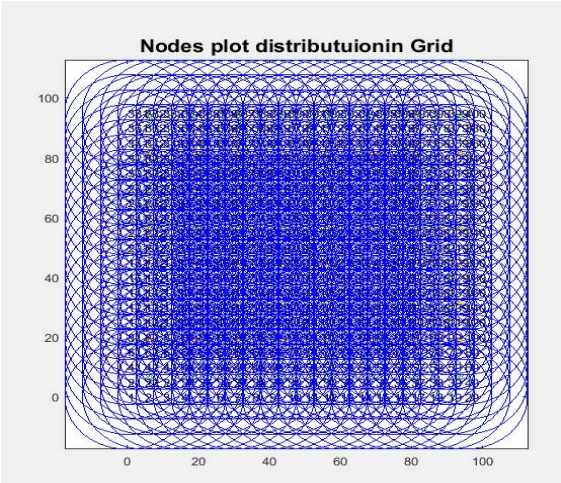

Fig 4.1 : Plot distribution grid

Fig 4.2 demonstrates the sensing coverage ratio of all the experimented methodologies in comparison to the proposed that is BSA+LEACH , where we can clearly see that for leach sensing coverage ratio started decreasing at less than 1000 nodes , for PEGASIS it started decreasing near around 1200 nodes, then for existing around 3500 node it started decreasing and collapsed at 4000 round and finally for proposed it collapsed at 5000 node that means highest area was sensed by the proposed algorithm

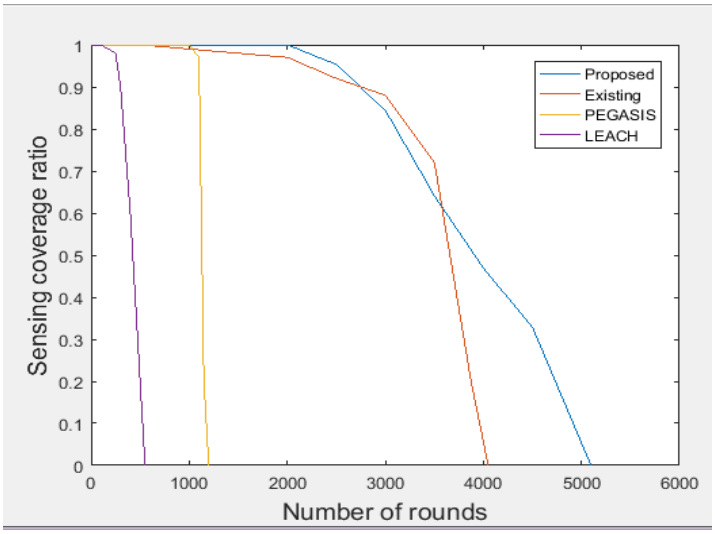

Fig 4.2 Demonstrates sensing coverage ratio with respect to no of rounds

Fig 4.3 Finally demonstrates the comparisons on the basis of percentage of nodes dying at various levels between the predecessor approaches for enhancing the energy efficiency along with the proposed approach . In the figure below we can see that 20 % of the nodes of LEACH , PEGASIS, existing and proposed methodologies dies at 400,1100,900,800 rounds respectively, similarly 100 % of the nodes for the same died at 600,1200 ,3900,4700 rounds respectively which again showed that the proposed algorithm is the long lasting algorithm and can survive for much more time span then the existing one .

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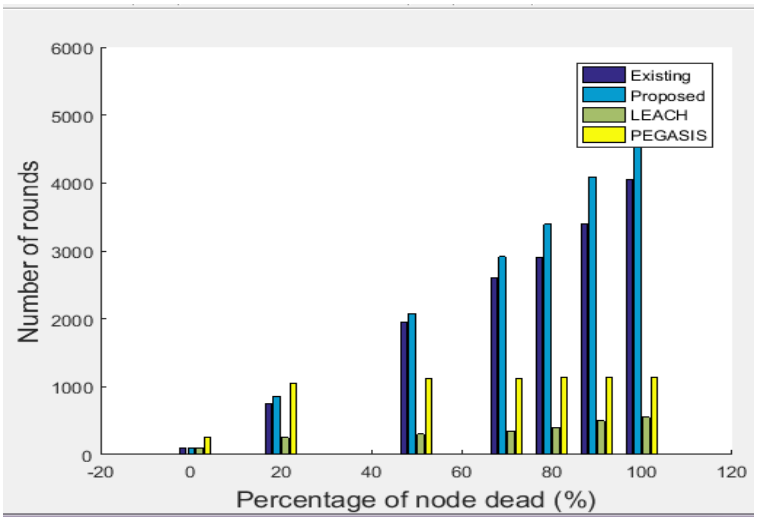

Fig 4.3: Showing % of nodes dead with respect to the number of rounds

V. CONCLUSION AND FUTURE SCOPE

WSN'S are designed for extreme conditions where human's themselves can not reach to gather information , so WSN's gathers more and more information with minimum consumption of energy as energy is the core working element of WSN's .Hence more and more researches takes place every day in order to make WSN more energy efficient . In this direction we also made an effort to put forward a novel optimization algorithm for increasing energy efficiency in WSN using hybrid LEACH and BSA . Results proved that the proposed algorithm surpasses and gives way better results than WSNCABC ,LEACH, PEGASIS and proved to be an energy efficient algorithm

In future more efforts can be made in order to further increase the lifetime of a WSN by implementing more meta heuristic algorithms and also efforts can be made to save the WSN from attackers during steady phase.

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