Gorilla Optimization Based Clustering and Fittest Node Routing Technique for Improving the Lifetime of Wireless Sensor Network

R.K.Krishna, B.Seetha Ramanjaneyulu

Abstract— In this paper Clustering is implemented using the Gorilla Optimization Technique, a technique inspired by the social behavior of the Gorillas. As is known Gorillas are generally found in groups of 5 to 12 with silverback gorilla being the dominant and leader. The adolescent males generally split from parent group to form their own clusters. This behavior is used for formation of Clusters. The nodes with highest energy are chosen as Cluster heads and nodes with third highest energies breakaway to form their own Clusters attracting all unattached nodes. The process continues till all nodes join the cluster. Routing is implemented using the fittest node technique. Communication between two nodes takes place through the cluster heads of the source and destination clusters and a relay node in between. For selecting the relay nodes maximum residual energy and minimum distance between node and destination is considered.

Keywords— Gorilla Optimization Technique, Silverback Gorilla, Adolescent males, Cluster heads.

I. INTRODUCTION

Many optimization techniques based on animal behavior are being proposed which are providing excellent results in comparison with the existing traditional techniques. As is known the two important techniques that are being prominently used for increasing the lifetime of Wireless Sensor Networks are Clustering and Routing techniques and modifications in these techniques. These techniques not only reduce the energy consumption of nodes but also increase substantially the life of wireless sensor networks. .Also nowadays because of the use of mobile sinks, path between two sensors also change rapidly and because these paths change frequently, it is being seen that there is a decrease in the lifetime as nodes die earlier because of the heavier load and more duties they have to perform resulting in rapid exhaustion of energy. Hence it is also a big challenge to maintain the paths between the nodes and the sink and also use minimum resources to maintain these paths.

Many of the optimization techniques which mimic the animal behavior include Particle Swarm optimization (PSO), Ant colony optimization (ACO), BEES optimization Algorithm (BOA), Particle Swarm optimization, Cuckoo search method, Firefly technique and Frog leaping hybrid optimization algorithm etc

One of the earliest techniques that were used to find the path that is the shortest among all the available paths was the ant colony optimization [1] where the foraging behavior of the ants is considered for finding the optimum solution. In this technique the ants deposit pheromone on the path for all other ants to follow. This method consists of three phases. In the initialization phase every sensor node is analyzed for fitness and the fittest one is selected. The iteration technique is used for the computation of the shortest path to the destination node. The data is then transmitted along this path whereas the other paths remain idle. Because the technique utilizes real time computation techniques, the technique gives good results. But the drawback of this technique is its overdependence on outputs of previous stages resulting in reduction of its performance. Also data processing time required in this technique is also more. Theoretical analysis is tough task due to sequence of random decision and change of probability distribution by iteration. In this technique it is known that convergence will occur there is certain uncertainty time when convergence will occur.

Bees' optimization technique is also a new Meta heuristic method that is being popularly used for finding the shortest path .The foraging behavior of the honey bees is the inspiration behind this method [3]. But there are also some disadvantages of this technique too. The convergence rate of this technique is very low and it has higher overhead resulting in decrease in throughput and latency.

The artificial Bee Colony optimizer as in [5] has nodes that have different energy levels. Generally the node that has highest ratio of residual energy to average energy of the network is chosen as the cluster head. This results in uniform energy distribution throughout the network. But the drawback in this technique is that

Clusters are formed randomly and cluster heads belonging to larger groups get exhausted quickly as compared to clusters that consist of sparse nodes.

Another prominent metaheuristic technique that is generally used to generate solutions to optimization and searching problems is the Genetic algorithm. As is known performance of GA is based on four operators that consist of crossover, mutation selection and fitness as discussed in [4].But there are certain limitations in this method also. One is that residual energy is only fitness factor considered. There are other parameters that are also required to be

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R.K.Krishna, Department of Electronics and Communication Engineering, Vignan foundation for Science,Technology and Research (VFSTR), Vadlamudi,Guntur,India. (rkrishna40@rediffmail.com)

Dr.B.Seetha Ramanjaneyulu, Department of Electronics and Communication Engineering Vignan foundation for Science,Technology and Research (VFSTR), Vadlamudi,Guntur,India . (ramanbs@gmail.com)

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considered. Again only rotation of cluster heads take place. Clusters are not changed throughout the lifetime of the network.

Another popularly used method used is the particle swarm optimization technique .In this technique the movement of the particles is the basis of obtaining an optimum solution [2]. The particles move based on their known position in search space as well as the complete swarm's position which guides the entire swarm's position for using the same path for data transmission. This procedure is repeated until a satisfactory solution is found. This method is being used not only for node deployment but also for clustering and data aggregating. But one of the drawbacks of PSO is that the convergence of swarm may occur before achieving optimal solution. Global best may be achieved by converging to a single point that is on the line between global best and personal best values but this point of convergence is not a guarantee to provide a local optimum. One of the reasons for this problem is that data flow between particles is very rapid which results in formation of particles that have high repetition. This results in chances of considering the optima as the solution.

In this paper a novel clustering method is proposed which is inspired from the typical social behavior of gorillas and routing technique based on the fittest node has been proposed. As is known Gorillas are herbivorous apes that are found in the forests of Central Africa. They are classified into two species eastern and western gorillas. The DNA of gorillas is similar to humans. Gorillas generally live in groups. These groups are called troops. These troops consist of one adult male called the silverback and many adult females and their children. The leader of the group is the silverback gorilla. A silverback gorilla is more than 12 years old and is called so because of the silver patch of hair on its back which comes due to maturity. Mature Gorillas generally tend to leave their groups to form new groups by attracting emigrating females. However male mountain gorillas stay back in the group and takes over the leadership once the silver back gorillas die. Sometimes the female and off springs after the death of silverback gorillas join other groups or stay back until a new silverback gorilla takes over this group. This behavior of young gorillas to form the groups of their own on maturity is the basis of the clustering technique proposed. Routing is proposed by selecting best route and this route is selected based on combination of two factors. One is the residual energy in the nodes and the other minimum distance between the nodes. That is nodes that have higher energy left and at a minimum distance to destination is considered and chosen as the relay node.

In this paper it is proposed to use this gorilla group behavior as an optimization technique for clustering process. The fittest node technique is proposed for the routing technique. This fitness function of the node is computed by considering the node with the highest energy and minimum distance to the destination node. The proposed method has been compared with the existing PSO technique and it is found that the proposed technique yields a higher lifetime as compared to PSO.

II. RELATED WORK

One of the earliest techniques that were used for finding a suitable route was the Ant Colony Optimization technique. As is known this technique operates in three phases. The first one is the initialization phase the second being the updating of pheromone and then finally construction of solution. In [1] Xinyu Wang at al. have proposed a novel algorithm and named it as AMR. In this unique technique the authors have proposed that the ants shall communicate with each other indirectly. This will be done by varying the thickness of the pheromone. As is known each ant is capable to search its own paths .The novelty of this technique is that in this technique a new state called halting state has been proposed. In case on coming back to the depot the ants do not settle in the halting state they have to go again in search of a new path. Also the authors a set up a time limit for termination of this algorithm. The uniqueness of this algorithm is that the authors have suggested two types of ants and are called ordinary ants and special ants. Ordinary ants move in the conventional manner depositing pheromone for the communication with other ants. The special ants travel in a TSP manner without considering the available capacity constraints. The advantage of this technique is that the special ants provide help in exploiting the local optima.

In [2] Yuan Zhou et al. have improved the conventional PSO algorithm. As is known this highly popular particle swarm optimization (PSO) algorithm was proposed and developed by Dr. Eberhart and Dr. Kennedy in 1995. The basic principle of this technique is inspired by the social behaviors of bird flocking. The process of this methods starts with system being first initialized with a population of random solutions and optima search is carried out. This is done by updating of generations. In this technique the potential solutions which are called particles fly through the problem space. While doing so they follow the current optimum particles. Since the concept of this PSO technique is very simple, this method has become one of the widely used an optimization technique .This technique is being applied to many real life problems. This method has been found to be a very efficient method and is being used to solve clustering problems yielding better and efficient results. In this paper authors have proposed to make the conventional PSO better by adjustment of inertial weight. This is done to avoid particles getting trapped in local optima. The aim of these improvements is increasing of the fitness function to the highest level which aids us in choosing the best cluster head and better relay nodes. This results in a robust and efficient network.

It is known the ABC has achieved substantially good results in multifunction optimization. But the disadvantage of this system is that it shows premature atmosphere in optimum process and easily gets caught in local convergence. In [3] Huadong Wang et al. propose to overcome this problem this paper introduces quantum computation in the ABC algorithm enhancing the global search capability with favorable convergence. This results in improvement in network efficiency and makes the system more reliable. The basic difference between the

conventional Leach and this technique is the new way of selecting the Cluster head. In this technique a cluster head is first chosen on the basis of various factors that include residual energy, distance between nodes, network architecture and distance between nodes and cluster head. Then QABC algorithm is applied, which gives the best solution for selecting the cluster head. After data transmission, once the cluster head loses its energy the process is repeated for selection of new cluster head

[4] Proposes a clustered optimization method which is based on genetic algorithm .This method is used to improve the efficiency of constrained networks. In this method proposed by J.A.Martins et al. the sensors first collect the data and then transmit it to the gateway router along with information regarding residual energy. Using this information, the gateway searches for optimal network topology for which this method uses genetic algorithm. In this method the optimization is initialized with a population of about thirty 30 chromosomes which are analogous to network configurations and fifty genes that are assumed as nodes. Fitness function is found out by considering the data from the previous rounds and the fittest chromosomes are the ones selected for both crossover as well as mutation. This step is repeated for every succeeding generation.

In [5] Hanning Chen et al. have proposed a new optimization technique. Here authors have implemented this technique for which they have hybridized artificial bee colony optimizer with the mechanism of bee life cycle. In the proposed HABC the authors have tried to develop a scheme in which the states of birth, foraging and death and reproduction can be dynamically shifted anytime during the life cycle of artificial bee colony. This new innovation proposed by the authors in avoiding redundant search and maintains diversity of population in environments that are complex.

In [6] Al-Aboody et al. propose a novel routing protocol based on the Grey wolf optimization (GWO).In this method which is inspired by the social behavior of grey wolves, clustering is done at three levels. Wolves live in a group of 8 to 12 wolves and are divided into four groups. The first group makes the hunting decisions, when to get up when to sleep etc. The second level of wolves is consultants and they take the decisions in the absence of the first set of wolves. The third set of wolves is the last to eat and play the role of devotees. The last set of wolves is responsible for the protection of boundaries and alerting at time of emergency. The hunting behavior consists of three stages a) searching b) surrounding the prey c) attacking the prey. The base station plays a prominent role in selection of cluster heads. In the second level the data transmission is proposed on the GWO method for selection of path. In the third level a distributed clustering takes place which is based on the cost function.

In [7], Nafaa Jabeur propose Firefly algorithm which is used for efficient clustering. This approach is classified into Phase I and Phase II. Phase I is called the micro clustering phase. In this phase the sensors self-organize into clusters. Phase II is called the macro clustering phase. This is the phase in which integration of small clusters is done. The characteristic of a firefly is its glowing bioluminescence. Generally cluster heads are on the basis of various factors such as residual energy or distance from base station. Node with higher fitness value is selected as the Cluster head. Naturally fitness fades with distance because distance not only affects communication costs but also makes it difficult to control large clusters. Therefore the authors propose a new technique called FICA wherein clusters with small numbers of nodes are formed to overcome the fading problem. These smaller clusters balance processing load and prevents rapid depletion of CH energies.

In [8] for clustering the Reza Azizi et al. have proposed a novel technique called Artificial Fish Swarm Algorithm (AFSA).This method improves the existing Fish swarm algorithm method This is implemented by increasing the balance between local and global searches. This method also improves the convergence speed of the clustering procedure. In this method it has been tried to obtain a balance between exploration and exploitation. For this purpose some modifications have been carried out and applied to the structure of visual and step parameters. First the Euclidean distance between artificial fish position and the best position is computed. By reducing the visual parameters of each fish and amount of step parameter a balance between local and global search is obtained. This results in improvement of efficiency of the algorithm. The difference between visual parameters of different fishes can also be reduced resulting in improvement in convergence speed. Another mechanism has also been proposed with the purpose of improving the convergence speed of clustering. Here fitness function has been used for each artificial fish which is the total intra cluster distance and is equal to the Euclidean distance between nodes and nearest cluster head. In a third technique one cluster head changes its position every iteration. In this method in order to avoid the death of nodes with lesser energy average energy of alive nodes are calculated and nodes with energy nearer to the average energy are selected. Small clusters are also formed based on 5%of the total nodes as cluster.

In [9] Boucetta et al. propose a hierarchical routing algorithm called Cuckoo search algorithm. In this method in the whole sensing area the nodes are spread out randomly. After the clustering process is over then the next step implemented is transmission of data to the sink. In this technique as usual the node that has highest energy is chosen as the cluster head. For data transmission the member nodes send the information regarding its geographical position and energy left to Cluster heads .These Cluster heads send the information to the base station. For this they use the neighborhood cluster heads using the cuckoo search method. The data is sent to the neighborhood cluster heads on the basis of fitness function. The optimum path is selected based on the fitness of the neighborhood Cluster heads. The next hop is further selected based on the quality of the next neighborhood cluster head.

Nowadays Bio inspired systems are being used to improve many parameters in wireless sensor networks. In [10] the Sandra Sendra et al. have studied the bio inspired systems that are being used in wsn applications. They have explained most of the well-known animal behaviors used in bio inspired algorithms. Those include algorithms based ant

colony optimization, honey bee colony optimization and also algorithms based on behavior of various birds, bats fireflies etc. The authors have also analyzed algorithms based on genetics, bacteria plant growth and immune systems. They have also studied works based on no animal behaviors that include GA, immune systems, bacteria and artificial plant optimization algorithms. Many open issues have been discussed and the authors propose that contributions in the areas such as robotics, environmental monitoring and underwater communications are required.

III. PROPOSED WORK

The silverback gorilla is the center of attraction of a group of gorillas .It is the leader of the group. It takes all the decisions, mediates in cases of conflicts, determines the movements of the groups and is responsible for the security and safety of the group. The communication is done based on grunts and barks .Screams and roars are signal alarms or warnings that are produced by silverbacks. The gorillas are generally found in groups. Each group consists of one to four males called silverbacks. The group also includes adult females and children. The strongest silverback is the one that dominates the group. Generally the first female that reproduces becomes its permanent family. The females that join the family early are given more importance or higher rank whereas the females that join the troops at a later stage are not given a higher rank. Therefore they prefer to join isolated silverback or newly established troops. Adolescent males generally split from the parent group and remain isolated till it forms its own group. The number of gorillas in a troop varies from 5 to 12.

If the number of silverbacks in a troop is more than one that means they are the children of the head silverbacks. Adult females are not bonded to one another and they generally are in contact with silverback .But mothers are close to their off springs Based on the above behavior certain rules are framed for the purpose of modeling. About 100 nodes are spread out randomly in the sensing area. Initially clusters are formed on a random basis. The nodes are ranked as per decreasing order of energy in the cluster. The nodes with maximum energy are called Cluster heads analogous to the silverback gorilla. The nodes with the third highest energy analogous to adolescent males move out of the group to form their own groups or clusters. They attract nearby unattached and form new clusters. This process is continued until all the nodes join their cluster heads. Clusters are formed with about 5 to 12 nodes in a group.

Similarly for communication between two nodes the node with highest energy is selected as the cluster head in the first Cluster. Similarly in the second cluster also node with the highest energy is chosen. This will be the cluster head in the second cluster or any cluster in which it is required to communicate. Now the source node will transmit the data to the cluster head which in turn will transmit the information to the destination cluster head through a relay node .From the destination cluster head the data may be transmitted to the destination node.

The proposed method consists of the following steps.

1) Initially there are 100 nodes. Let the nodes form into 10 clusters with each cluster consisting of 5 to 15 nodes respectively. The node which has the highest energy is the cluster head (CH) & the next highest is the future CH. This is analogous to the silverback gorilla and another silverback Gorilla which may the future Cluster head.
2) After the network runs for some time, energy of CH will come down, and will be below the levels of those nodes which were there in 3rd, 4th, 5th etc. positions of energy. So nodes 3, 4, 5 etc. will leave the group. They are similar to late-joined females & energy-gained male offspring of the troop.
3) Now the 3rd node will be the Cluster head of the newly formed Cluster and the 4th node is the future cluster head of the new cluster. They are similar to the adolescent male and its troop members which have formed the new cluster.
4) By this time the old cluster will come under the control of the 2nd cluster head as the 1st cluster will have its energy exhausted with its energy lesser than even the 5th node and hence now it will act as a normal node.
5) Now all the nodes with good energies have come out as mentioned in step 3.The old cluster continues with the 2nd node as the cluster head and all the other low energy nodes. No nodes will leave the old cluster because now the energies of the nodes in the 1st cluster are lesser than the 2nd node.
6) This process is continued for all the clusters formed during the first phase. Therefore initially if 10 clusters are formed, then the second phase twenty clusters each consisting of 2 to 9 nodes are obtained.
7) Routing Phase: The data communication phase now starts. The data is collected by the Cluster head. This cluster head now sends the data to fittest node between the cluster head in the source cluster and the cluster head of the destination cluster. The fittest node also called the relay node is chosen. The factors that are considered for the selection of the relay node are that the residual energy of the nodes is maximum and should be at the minimum distance to the destination. This node then sends the data to the fittest node in the next cluster. This process continues till the data reaches the destination node. This scenario and methodology are simulated using NS2 simulator and the quantities of number of alive nodes and lifetime are recorded. The simulation parameters are as shown in Table1.

Table 1. Values of simulation Parameters

Sr.No	Simulation Parameters	Values
1	Channel Type	Wireless
2	Simulation Area	300m × 300m
3	Number of Nodes	100
4	Transmitting power	2mw
5	Receiving power	1 mw
6	Packet size	1000bits
7	Performance parameters	Number of Alive Nodes and lifetime.

IV. RESULTS

The simulation results of the proposed technique are compared with the existing PSO technique in terms of number of alive nodes and lifetime.

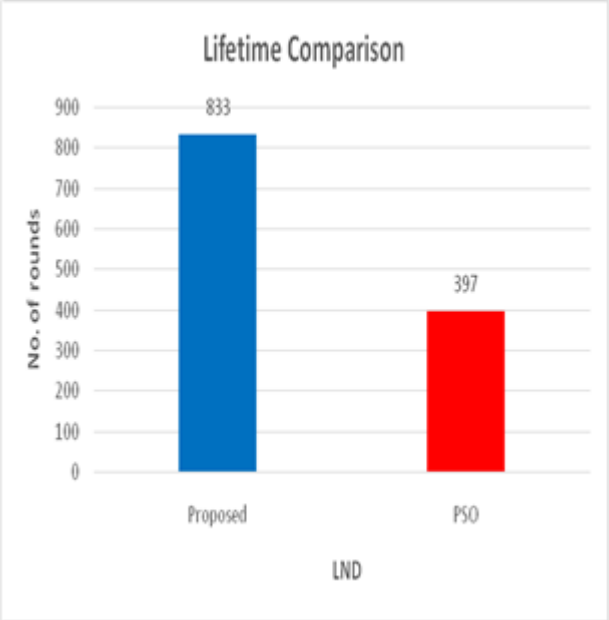

Fig.1. Lifetime comparison of proposed technique with the existing PSO technique (Last Node Death).

Fig.1. shows the comparison of the proposed technique with the existing technique PSO technique. It is found that the proposed technique runs for a lifetime of 833 rounds as compared to the PSO technique with 397 rounds which shows that the lifetime of the proposed technique is better as compared to the PSO technique.

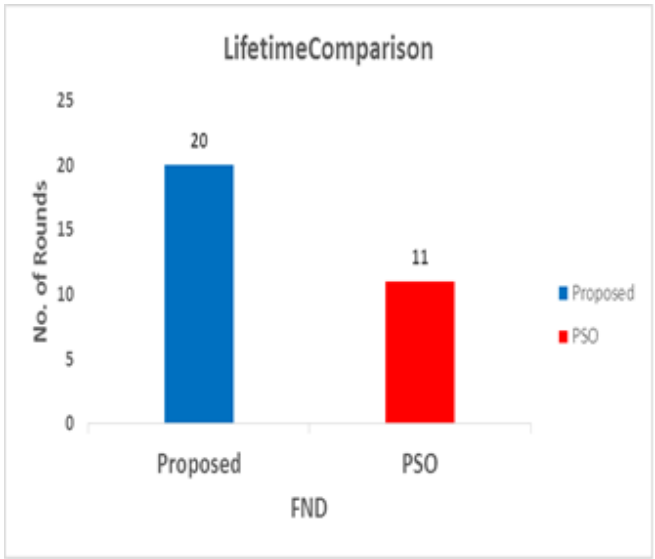

Fig.2. Lifetime comparison of proposed technique with the existing PSO technique (First Node Death).

Fig.2 shows the comparison of the proposed technique with the existing PSO technique in terms of first node death. It can be seen that the first node dies after 20 rounds in the proposed technique as compared to the PSO technique where the first node after 11 rounds.

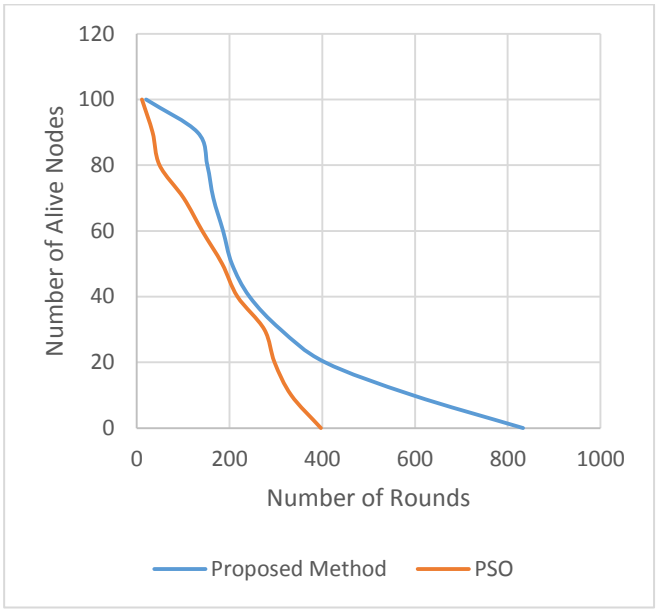

Fig.3. Comparison of alive nodes for the proposed Method with the existing PSO technique

Fig 3 shows a comparison of alive nodes for the proposed method with the PSO technique. It can be seen from the graph that nodes in the PSO technique die earlier as compared to the proposed technique for all the rounds.

V. CONCLUSIONS

In this paper we have proposed a technique in which clustering is inspired by the social behavior of Gorillas whereas the routing is done by selecting the path considering the nodes with highest energy and minimum distance to the sink. As can be seen from the results the proposed technique has the higher lifetime as compared to the existing PSO technique during all the rounds. Also the first node in the proposed technique dies later as compared to the PSO technique. Thus it can be concluded that the proposed technique provides not only higher lifetime but also provides for more energy savings as compared to the PSO technique.

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