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AN ADAPTIVE WSN CLUSTERING SCHEME USING LION OPTIMIZATION ALGORITHM TO MAINTAIN COVERAGE AREA IN WIRELESS SENSOR NETWORK

[1]K. Thenmozhi, [2]S. Udhaya, [3]N. Vinothini, [4]V. Nagaraju

Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, Chennai– 600 124.

ABSTRACT

Wireless sensor networks (WSNs) are composed of hundreds or thousands of sensor nodes in order to detect and transmit information from its surrounding environment. The sensor nodes have limited computation capability, limited power and small memory size. In these networks, sensor nodes are dependent on low power batteries to provide their energy. As energy is a challenging issue in these networks, clustering models are used to overcome this problem. Hence, many metaheuristic algorithms have been developed over the last years. Many of these algorithms are inspired by various phenomena of nature. In this paper, a new population based algorithm, the Lion Optimization Algorithm (LOA), is introduced. Special lifestyle of lions and their cooperation characteristics has been the basic motivation for development of this optimization algorithm. Some benchmark problems are selected from the literature, and the solution of the proposed algorithm has been compared with those of some well-known and newest meta-heuristics for these problems. The obtained results confirm the high performance of the proposed algorithm in comparison to the other algorithms used in this paper.

Keywords: *Wireless Sensor Network, Lion Optimization Algorithm (LOA), Metaheuristic.*

INTRODUCTION

Wireless Sensor Network is a challenging technology in real world applications. In recent years clustering techniques were implemented based on LEACH protocol. Instead of transmitting sensed information to the destination, a Specific node takes the responsibility for message transmission. The major constraints in wireless networks are energy, Routing, clustering, coverage deployment. Extracting genetic algorithm in WSN is to improve the energy dissipation among the sensor nodes and reduces the overall energy performance. At times nodes, which are located in a long distance could not able to communicate with the cluster lead due to larger transmission range. To overcome this problem multi hop routing techniques was developed. Another serious issue in wireless sensor networks is about coverage deployment. Achieving maximum coverage improves the quality of service as well efficient transmission rate. Coverage in wireless sensor networks characterized as area coverage, target coverage and point coverage. We mainly concentrated on area coverage. Coverage in the sense determined by placement of nodes efficiently. The placed nodes should cover maximum area in a sensing region.

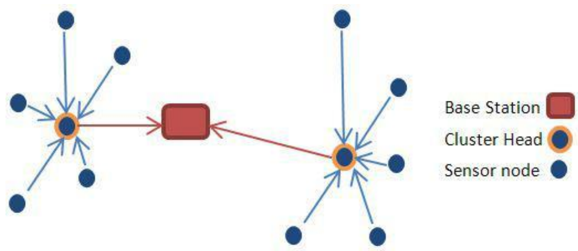

Fig. 1 Clustering in WSN

EXISTING MODEL

The Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm is a self-organizing protocol which distributes the CHs randomly in each round to minimize the dissipated energy in WSN. LEACH is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy. Nodes that have been cluster heads cannot become cluster heads again for *P* rounds, where *P* is the desired percentage of cluster heads. Thereafter, each node has a 1/*P* probability of becoming a cluster head again. At the end of each round, each node that is not a cluster head selects the closest cluster head and joins that cluster. The cluster head then creates a schedule for each node in its cluster to transmit its data. All nodes that are not cluster heads only communicate with the cluster head in a TDMA fashion, according to the schedule created by the cluster head. They do so using the minimum energy needed to reach the cluster head, and only need to keep their radios on during their time slot.

DRAWBACK OF EXISTING MODEL

- Remaining energy among the nodes isn't considered when selecting Cluster Heads.
- Random and variable size cluster formations.
- Random and uneven distribution of cluster heads
- Single hop communication in situations where energy use is less efficient from cluster head to base station.

LION OPTIMIZATION ALGORITHM

In this section, the inspiration of the proposed meta-heuristic is first discussed. Then, Lion Optimization Algorithm (LOA) is presented.

1. INSPIRATION

Lions are the most socially inclined of all wild cat species which display high levels of cooperation and antagonism. Lions are of particular interest because of their strong sexual dimorphism in both social behavior and appearance. The lion is a wild felid with two types of social organization: residents and nomads. Residents lives in groups, called pride. A pride of lions typically includes about five females, their cubs of both sexes, and one or more than one adult males. Young males are excluded from their birth pride when they become sexually mature. As mentioned before, the second organizational behavior is called nomads, who move about sporadically, either in pairs or singularly. Pairs are more seen among related males who have been excluded from their maternal pride. Notice that a lion may switch lifestyles; residents may become nomads and vice versa.

Unlike all other cats, Lions typically hunt together with other members of their pride. Several lionesses work together and encircle the prey from different points and catch the victim with a fast attack. Coordinated group hunting brings a greater probability of success in lion hunts. The male lions and some lionesses usually stay and rest while waiting for the hunter lionesses to return from the hunt. Lions do mate at any time of the year, and the females are polyestrous (when females not rearing their cubs are receptive). A lioness may mate with multiple partners when she is in heat. In nature, male and female lions mark their territory and elsewhere, which seems a good place with urine.

In this work, some characters of lions are mathematically modeled in order to design an optimization algorithm. In the proposed algorithm, Lion Optimization Algorithm (LOA), an initial population is formed by a set of randomly generated solutions called Lions. Some of the lions in the initial population (%*N*) are selected as nomad lions and rest population (resident lions) is randomly partitioned into *P* subsets called prides. *S* percent of the pride's members are considered as female and rest are considered as male,while this rate in nomad lions is vice versa.

For each lion, the best obtained solution in passed iterations is called best visited position, and during the optimization process is updated progressively. In LOA, a pride territory is an area that consists of each member best visited position. In each pride, some females which are selected randomly go hunting. Hunters move towards the prey to encircle and catch it. The rest of the females move toward different positions of territory. Male lions in pride, roam in territory. Females in prides mate with one or some resident males. In each pride, young males are excluded from their maternal pride and become nomad when they reach maturity and, their power is less than resident males.

Also, a nomad lion (both male and female) moves randomly in the search space to find a better place (solution). If the strong nomad male invade the resident male, the resident male is driven out of the pride by the nomad lion. The nomad male becomes the resident lion. In the evolution, some resident females immigrate from one pride to another or switch their lifestyles and become nomad and vice versa some nomad female lions join prides. Due to many factors such as lack of food and competition, weakest lion will die or be killed. Above process continues until the stopping condition is satisfied.

PROPOSED MODEL

1. INITIALIZATION

The LOA is a population-based meta-heuristic algorithm in which the first step is to randomly generate the population over the solution space. In this algorithm, every single solution is called ‘‘Lion”. In a

N dimensional optimization problem, a *var*

Lion is represented as follows:

Cost (fitness value) of each Lion is computed by evaluating the cost function, as: fitness value of lion ¼ f ð Lion Þ ¼ f x_1; x_2; x_3; …; x_{Nvar} ð2Þ

In first step, N_{pop} solutions are generated randomly in search space. %*N* of generated solutions are randomly in search space. %*N* of generated solutions are randomly chosen as nomad lions. The rest of the population will be randomly divided into *P* prides. Every solution in this algorithm has a specific gender and remained constant during the optimization process. To emulating this fact, in each pride %*S* (%75–%90) of entire population formed in the last step are known as females and the rest as males. For nomad lions, this ratio is vice versa % (1 *S*). Over the searching process every lion marks its best visited position. According to these marked positions, every pride's territory is formed. So, for each pride, marked positions (best visited positions) by its members form that pride's territory.

2. HUNTING

In each pride some female look for a prey in a group to provide food for their pride. These hunters have specific strategies to encircle the prey and catch it. In general, lions followed approximately the same patterns when hunting. Stander divided the lions into seven different stalking roles, grouping these roles into Left Wing, Centre and Right Wing positions. During hunting, each lioness corrects its position based on its own position and the positions of members of the group. Due to this fact that during hunting some of these hunters encircle prey and attack from opposite position.

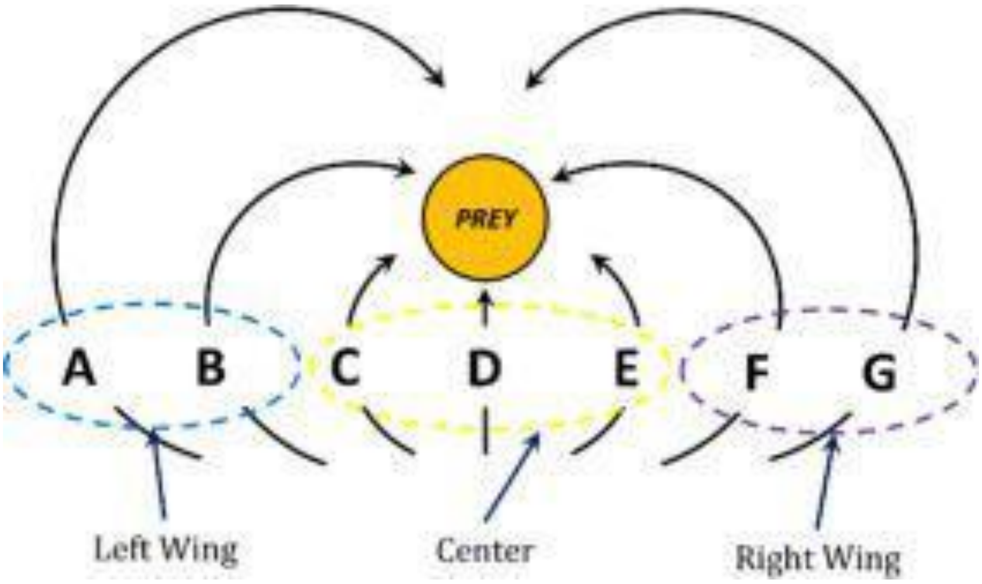

Fig. 2. A schematic of generalized lions hunting behavior

3. ROAMING

Each male lion in a pride roams in that pride's territory due to some reasons. To emulate this behavior of resident males, % *R* of pride territory are selected randomly and are visited by that lion. Along roaming, if resident male visits a new position which is better than its current best position, update his best visited solution. This roaming is a strong local search and assists Lion Optimization Algorithm (LOA) to search around of a solution to improve it.

4. DEFENSE

In a pride, male lions when mature, they become aggressive and fight other males in their pride. Beaten males abandon their pride and become a nomad. On the other hand, if a nomad male lion is strong enough to try to take over a pride by fighting its males, the beaten resident male lion is driven out of the pride and becoming a nomad. Defense operator in LOA divided into two main steps:

I. Defense against new mature resident males.

II. Defense against nomad males.

5. MIGRATION

Inspired by the lion switch life and migratory behavior in the nature when one lion travels from one pride to another or switch its lifestyle and resident female become nomad and vice versa, it enhances the diversity of the target pride by its position in the previous pride. On the other hand, the lion's migration and switch lifestyle builds the bridge for information exchange. In each pride, the maximum number of females is determined by *S* % of population of the pride. For migration operator, some female selected randomly and become nomads. Size of migrated female in each pride is equal to Surplus females in each pride plus %*I* of the maximum number of females in a pride. When selected females migrate from prides and become nomad, new nomad females and old nomad females are sorted according to their fitness. Then, the best females among them are selected randomly and distributed to prides to fill the empty place of migrated females. This procedure maintains the diversity of the whole population and share information among prides.

Lion Optimization Algorithm pseudo code

1. Generate random sample of Lions N_{pop}(N_{pop} is number of initial population).
2. Initiate prides and nomad lions
   i. Randomly select %N (Percent of lions that are nomad) of initial population as nomad lion. Partition remained lions into P (P is number of prides) prides randomly, and formed each pride's territory.
   ii. In each pride %S (Sex rate) of entire population are known as females and the rest as males. This rate in nomad lions is inversed.
3. For each pride do
   i. Some randomly selected female lion go hunting.
   ii. Each of remained female lion in pride go toward one of the best selected position from territory.
   iii. In pride, for each resident male; %R (Roaming percent) of territory randomly are selected and checked.
   %Ma (Mating probability) of females in pride mate with one or several resident male. → *New cubs become mature.*
   iv. Weakest male drive out from pride and become nomad.
4. For Nomad do
   i. Nomad lion (both male and female) moving randomly in search space.
   %Ma (Mating probability) of nomad Female mate with one of the best nomad male. → *New cubs become mature.*
   ii. Prides randomly attacked by nomad male.
5. For each pride do
   i. Some female with I rate ((Immigrate rate)) immigrate from pride and become nomad.
6. Do
   i. First, based on their fitness value each gender of the nomad lions are sorted. After that, the best females among them are selected and distributed to prides filling empty places of migrated females.
   ii. With respect to the maximum permitted number of each gender, nomad lions with the least fitness value will be removed.

If termination criterion is not satisfied, then go to step 3

WORKING PROCEDURE

Step 1: Pride Generation

Step 1.1: Generate territorial male and female subject to solution constraints

Step 2: Mating

Step 2.1: Crossover

Step 2.2: Mutation

Step 2.3: Gender grouping

Step 2.4: Kill sick/ weak cubs

Step 2.5: Update Pride

Step 3: Territorial Defense

Step 3.1: Keep the record of cub's age

Step 3.2: Do

Step 3.2.1: Generate and Trespass Nomadic lion

Until stronger Nomadic lion trespasses Until Cubs get matured

Step 4: Territorial Takeover

Step 4.1: Selection of best lion and lionesses

Step 4.2: Go to Step 2 until termination criteria is met.

SOFTWARE REQUIREMENTS

1. NS2 Simulator
2. NAM animator
3. Xgraph plotter
4. Ubuntu
5. Vmware

RESULTS

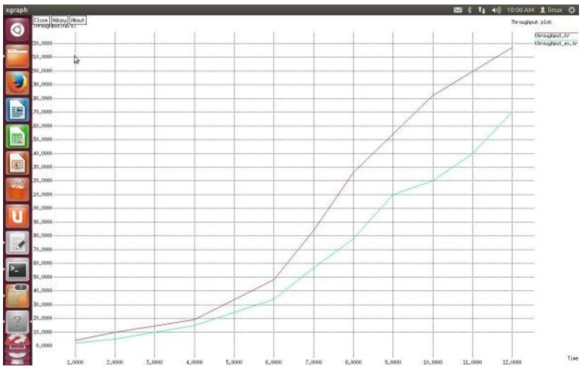

Fig: 3. Throughput

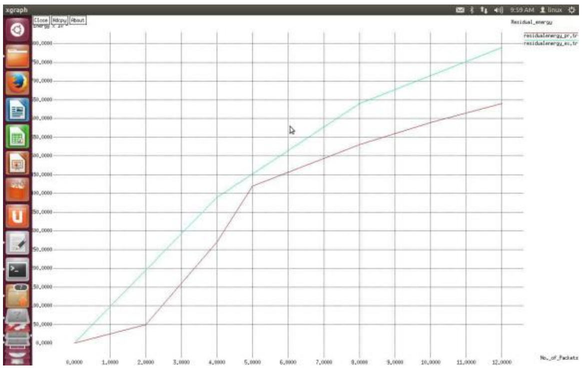

Fig:4. Residual energy

→ Green colour represents the existing model throughput and residual energy level.
→ Red colour represents proposed model throughput and residual energy level.

CONCLUSION

In this paper, a new search algorithm called lion's algorithm was proposed and experimentally compared with general evolutionary programming. The experiments were conducted under various solution space sizes at predefined algorithmic parameters. Under such an experimental environment, the algorithm was closely monitored for its
performance, when executing at every solution space. From the analysis, it can be said that the algorithm maintained a stable and reliable performance over convergence of problem to the optimal solution, when compared to the evolutionary programming. In other words, the algorithm minimized the cost function i.e. found out the solution that minimizes the cost function in a consistent manner despite the size of strengthening their generation, the convergence is very less time consuming and reliable. As encouraging results are obtained, the -time search problems and its performance will be studied.

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