IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 7, Issue 04, November 2018)

Firefly Algorithm based Optimization of Cluster Head Election

Nikhil Garewal
M. Tech. Scholar
Department of Electronics and Communication
LNCT, Indore

Deepak Pancholi
Assistant Professor
Department of Electronics and Communication
LNCT, Indore

Abstract –**Sensor nodes in WSN are powered with a battery. Sensor nodes consume the battery power mainly in the tasks like data transmission, data reception and sensing. Sometimes it is impractical to replace a battery in WSN because humans can't reach. Therefore once energy or computational resources are consumed, immediate recovery of these resources is a complex task so it is necessary to make use of battery power efficiently to increase the lifetime of the sensor nodes that will also increase the lifetime of the whole network. This paper is based on indoor wireless sensor networks, in conjunction with an appropriate management methodology that allows us to analyze and verify the behaviour of these wireless networks in an internal way. To make WSN energy efficient and to increase the lifetime of the network, this paper presents an energy efficient clustering algorithm optimized by Firefly Algorithm (FF). Performance of this approach is evaluated using certain evaluation parameters; Throughput and Network Lifetime.**

Keywords –**FF, LEACH, WSN.**

I. INTRODUCTION

Now-a-days the whole life of any person becomes mobile. It also proves a remarkable power of mobility in global development. In past only money was the important thing in life of every person without which nobody left the home. But at present, most of us don't take wallet to us while sleeping and even don't check it after few minutes. Apart from this, the popularity of laptops, GPS devices and intelligent computing devices is increasing day-by-day [1]. Hence wireless network become a crucial part in our daily life. Recent advances in semiconductor networking and material science technologies are driving the ubiquitous deployment of large-scale wireless sensor networks (WSNs) [2]. These technologies all together form a new version of wireless network named as Wireless Sensor Networks (WSNs) which were developed about 5 to 10 years ago. It helps us to manage our lives with lower preparation and maintenance cost, contributing modern root ages of easily accessible information [3].

Wireless sensor network composed of numerous of sensor nodes which communicate with each other through wireless network. Each sensor node is required to be capable of sensing, processing and communicating the processed data to the neighbouring nodes to form a network. The data packets travel through these sensors nodes from source node to destination node via several intermediate nodes [4]. The data packets can uses long as well as short route to reach to the destination node. The long route may results in network delay and can take larger time while simulating it. On the other hand short route results in better network performance by consuming lesser energy and lowest network delay. Finally, the routing targets are oriented by the application, therefore different routing protocols have been offered for easily accessibility of those applications [5].

Deploying a wireless network that allows us to maximize the coverage of the different sensors for indoor environment, that is, it is an internal model in which we need to find the minimum number of active sites, so that the connection to at least a percentage P of the users is allowed [6]. This percentage should be the maximum possible to guarantee an adequate service and be able to consider that the algorithm works in an adequate manner. In the model presented, we cannot place the access points arbitrarily, they must place feasible points, which will then be optimized to obtain a better coverage with a smaller number of them [7]. This model is the basis for other models that seek to optimize the access points, because it does not present problems with coverage and also allows taking into account parameters such as

IJDACR International Journal Of Digital Application & Contemporary Research
International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 7, Issue 04, November 2018)

coverage and capacity. But it should be emphasized that the allocation of channels has been neglected, assuming the use of different channels, although this parameter could be implemented without any problem in this algorithm [8].
For this we have used a clustering algorithm that allows us to optimize the feasible points in an appropriate manner. With this algorithm, different parameters or restrictions are played depending on the internal area where you want to implement it; In addition, the different equipment that will be used must be taken into account [9].
If we suppose that we have an indoor zone in which we will locate several points that will allow us to connect to different sensors, then first we must establish different feasible points considering the location of the sensors, in order to later find the points of access, which are considered as those that allow connectivity to the sensors but using a coverage radius; in addition to the capacity of them, which is limited by the number of sensors that can be reached simultaneously [10].
If we consider that we have N number of sensors located inside a house, and in the same way, M possible locations, that is, feasible points [11]. The feasible points are all those places where our access points can be located, but they will not necessarily be located in those points. In addition, those sensors that are within a distance R of at least one access point will be considered as covered sensors and possible active sites, while the access points have a C capacity that allows them to attend a certain number of sensors simultaneously. All these possible variables must be taken into account when using this algorithm to obtain an adequate optimization [12].
This paper proposes an investigational comparison among LEACH and Firefly algorithm based cluster head election approach for indoor wireless sensor networks, so as to find a method which increases the lifetime and reduces the energy consumption of the network.

II. Proposed Methodology

A. *Method of Cluster Head Election*

The threshold formula given by Qian Liao et al. [13] is:

$$T(n) = \frac{p}{1-p^*\left(r \bmod \frac{1}{p}\right)} * \frac{E_{cur}}{E_0} \tag{1}$$

Where, E_0 and E_{cur} represent initial energy and current energy of the node respectively. The improvement in proposed protocol takes place using the increment in probability of high energy nodes, by which the nodes turn into the cluster-head. Although, this process causes an issue. The threshold $T(n)$ turn out to be small if the residual energy becomes very low resulting a reduction in nodes of the network. It will results the early death of nodes and finally the network lifetime will be less. Also, the threshold formula in equation (1) does not contains any impact of the distance between base station and nodes for cluster-head election.
Then the improvement in threshold is given as:

$$T(n) = \begin{cases} f(E_{cur}) * \left[\dfrac{(1-\alpha)p}{1-p^*\left(r \bmod \frac{1}{p}\right)}\right] & n\epsilon G \\ 0 & n \notin G \end{cases} \tag{2}$$

Where, $f(E_{cur})$ is the function related to the current residual energy of the node. It shows the impact of node energy on the election probability. It is given by:

$$f(E_{cur}) = \frac{E_{cur}}{E_{ave}} \tag{3}$$

E_{ave} is the average residual energy of entire nodes in the current round.
In generalized protocol, the optimal cluster-head are selected by normal nodes and the communication takes place between base station and nodes. While the proposed protocol calculates the distance between base station and normal node. If it is found to be minimum then there is no selection takes place for cluster head which causes a direction transmission of controlling packages to the base station and data transmission occurs.

B. *Optimized Cluster Head Election using Firefly Algorithm*

Let n_{alive} represents the number of alive nodes with residual energy greater then the threshold energy and p be the clusterhead election probability, then the optimum number of CH elected for a given round will be:

$$P_{opt} = n_{alive} * p \tag{4}$$

Here P_{opt} is optimized using Firefly Algorithm which is described as:

1) Firefly Algorithm

Firefly is an insect that mostly produces short and rhythmic flashes that produced by a process of bioluminescence. The function of the flashing light is to attract partners (communication) or attract potential prey and as a protective warning toward the predator. Thus, this the intensity of light is the factor of the other fireflies to move toward the other firefly.
The light intensity is varied at the distance from the eyes of the beholder. It is safe to say that the light intensity is decreased as the distance increase. The light intensity also the influence of the air absorb by the surroundings, thus the intensity becomes less

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 7, Issue 04, November 2018)

appealing as the distance increase [14]. Firefly algorithm was followed three idealize rules:

1. Fireflies are attracted toward each other regardless of gender.
2. The attractiveness of the fireflies is correlative with the brightness of the fireflies, thus the less attractive firefly will move forward to the more attractive firefly.
3. The brightness of fireflies is depend on the objective function [15].

2) Structure of Firefly Algorithm

In firefly algorithm, there are two important variables, which is the light intensity and attractiveness. Firefly is attracted toward the other firefly that has brighter flash than itself. The attractiveness is depended with the light intensity.

The light intensity thus attractiveness is inversely proportional with the particular distance r from the light source. Thus the light and attractiveness is decrease as the distance increase.

$$I(r) = I_0 e^{-\gamma r^2} \tag{5}$$

I = light intensity,
I_0 = light intensity at initial or original light intensity,
γ = the light absorption coefficient
r = distance between firefly i and j

Attractiveness is proportionally to the light intensity seen by the another fireflies, thus attractiveness is β

$$\beta = \beta_0 e^{-\gamma r^2} \tag{6}$$

β_0= Attractiveness at r is 0

The distance between two fireflies can define using Cartesian distance

$$r_{ij} = |x_i - x_j| = \sqrt{\sum_{k=1}^{d} (x_{i,k} - x_{j,k})^2} \tag{7}$$

Firefly i is attracted toward the more attractive firefly j, the movement is defined as:

$$\Delta x_i = \beta_0 e^{-\gamma r_{ij}^2}(x_j^t - x_i^t) + \alpha\varepsilon_i, x_i^{t+1} + \Delta x_i \tag{8}$$

In equation (8), the first term is for attraction, γ is the limitation when the value is tend to zero or too large. If γ approaching zero ($\gamma \to 0$), the attractiveness and brightness become constant, $\beta = \beta_0$. In another word, a firefly can be seen in any position, easy to complete global search. If the γ is nearing infinity or too large ($\gamma \to \infty$), the attractiveness and brightness become decrease. The firefly movements become random. The implementation of firefly algorithm can be done in these two asymptotic behaviours. While the second the term is for randomization, as α is the randomize parameter. The ε_i can be replace by ran -1/2 which is ran is random number generated from 0 to 1.

III. Simulation Results

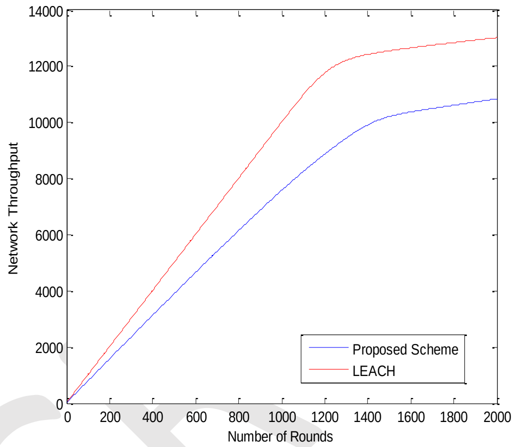

Figure 1: Network throughout comparison for proposed algorithm

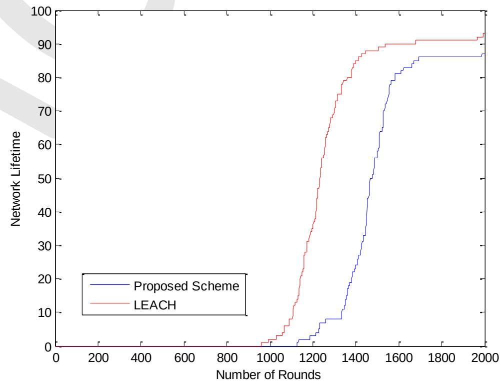

Figure 2: Network lifetime comparison for proposed algorithm

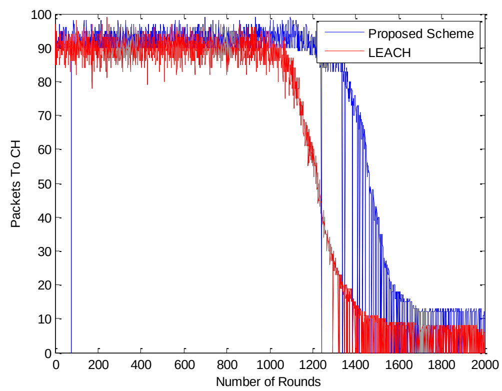

Figure 3: Comparison for number of packets transmitted with respect to rounds

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 7, Issue 04, November 2018)

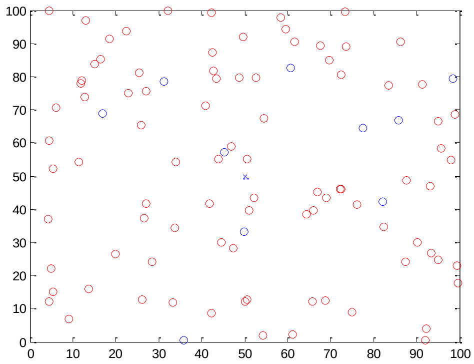

Figure 4: Sensor node deployment

IV. Conclusion

Firefly Algorithm has been a famous procedure used to take care of optimization issues in WSNs because of its straightforwardness, high calibre of result, quick joining and inconsequential computational complexity. In any case, iterative nature of Firefly Algorithm can deny its utilization for rapid ongoing applications, particularly if optimization needs to be done frequently. Firefly Algorithm obliges a lot of memory, which may limit its execution to asset rich base stations. Literature has inexhaustible fruitful WSN applications that endeavour preferences of Firefly Algorithm. We have examined LEACH and Firefly algorithm based cluster-head election for heterogeneous WSNs containing different level of heterogeneity. Simulations prove that Firefly algorithm based cluster-head election performs well in all scenarios. It has best performance in terms of Network Throughput and Lifetime. Since the routing methods in WSNs are application specific, there is always scope for improvements. Moreover, future work can be carried out to improve the throughput of this method using other optimization algorithms.

Reference

[1] Doherty, Lance, Jonathan Simon, and Thomas Watteyne. "Wireless sensor network challenges and solutions." *Microwave Journal* 55, no. 8 (2012): 22-34.

[2] Zhan Wei Siew, " Fuzzy Logic Based Energy Efficient Protocol In Wireless Sensor Networks," ICTACT Journal On Communication Technology, December 2012, Volume: 03, Issue: 04, 2012

[3] Er.Sadhna ,"Hybrid Protocol Based On HBO And ACO For Routing In Wireless Sensor Network", International Journal Of Electrical & Electronics Engineering Ijeee, Vol. 1, Issue 2, 2014.

[4] Imad S. AlShawi, "Lifetime Enhancement in Wireless Sensor Networks Using Fuzzy Approach and A-Star Algorithm", IEEE SENSORS JOURNAL, VOL. 12, NO. 10, OCTOBER 2012.

[5] S. Prasanna, Srinivasa Rao, "An Overview of Wireless Sensor Networks Applications and Security," International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-2, May 2012.

[6] Erol-Kantarci, Melike, and Hussein T. Mouftah. "Wireless sensor networks for cost-efficient residential energy management in the smart grid." IEEE Transactions on Smart Grid 2, no. 2 (2011): 314-325.

[7] Li, Mingfu, and Hung-Ju Lin. "Design and implementation of smart home control systems based on wireless sensor networks and power line communications." IEEE Transactions on Industrial Electronics 62, no. 7 (2015): 4430-4442.

[8] Das, Pronaya Prosun, Nirjhar Chakraborty, and Shaikh Muhammad Allayear. "Optimal coverage of wireless sensor network using termite colony optimization algorithm." In 2015 international conference on electrical engineering and information communication technology (ICEEICT), pp. 1-6. IEEE, 2015.

[9] Wang, Qihua, Ge Guo, and Lijie Cao. "Coverage strategy based on Voronoi geometric relationship for wireless sensor networks." In The 27th Chinese Control and Decision Conference (2015 CCDC), pp. 1465-1469. IEEE, 2015.

[10] Zhou, Jingxuan, Lingguo Cui, Senchun Chai, and Zixiao Guan. "A localization strategy based on a region division for wireless sensor networks." In 2016 35th Chinese Control Conference (CCC), pp. 8433-8437. IEEE, 2016.

[11] Fathany, Maulana Yusuf, and Trio Adiono. "Wireless protocol design for smart home on mesh wireless sensor network." In 2015 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), pp. 462-467. IEEE, 2015.

[12] Gnanavel, R., P. Anjana, K. S. Nappinnai, and N. Pavithra Sahari. "Smart home system using a wireless sensor network for elderly care." In 2016 Second International Conference on Science Technology Engineering and Management (ICONSTEM), pp. 51-55. IEEE, 2016.

[13] Qian Liao, Hao Zhu, "An Energy Balanced Clustering Algorithm Based on LEACH Protocol", IEEE, Proceedings of the 2nd International Conference On Systems Engineering and Modeling (ICSEM-13), Vol. 341, pp. 1138-1143, 2013.

[14] Yang, Xin-She. Nature-inspired metaheuristic algorithms. Luniver press, 2010.

[15] Yang, Xin-She. "Firefly algorithm, Levy flights and global optimization." In Research and development in intelligent systems XXVI, pp. 209-218. Springer, London, 2010.