Advances in Computer Science and Information Technology (ACSIT)
p-ISSN: 2393-9907; e-ISSN: 2393-9915; Volume 5, Issue 2; April-June, 2018, pp. 54-56

http://www.krishisanskriti.org/Publication.html

Node Localization in Wireless Sensor Network using Firefly Algorithm

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Abstract—*The wireless sensor network is the decentralized kind of networks which monitor the environmental conditions and send data to base station. Due to self configuring nature of the network, various issues may raised in the network which are energy consumption, node localization etc. Accurate location of sensed nodes has a great impact on the performance of a Wireless Sensor Network. A node localization concept which is based on Firefly Algorithm is used and to improve the accuracy and computing time.*

Keywords*: Wireless Sensor Network (WSN), Node Localization, Firefly algorithm (FA)*

1. INTRODUCTION

WSN contains sensor nodes and base station (BS). It contains of large number of small, less power, cheaper sensor nodes with small memory and resources in order to check the real world conditions. It also involves autonomous sensors and base stations which co-operatively transfer their data from the network to a main node [1].

The BS act as interface between the sensor nodes and the outer atmosphere. The BS also has very large storage and data processing capabilities. The function of BS is to pass the data it receives from the sensor nodes to the server from where end user can access them. The sensor nodes have less life because it runs on batteries and once the energy of batteries is consumed by nodes then they cannot be able to operate properly [2].

Today's WSN's are operates in both directions and track the data which is being transmitted from nodes to central node. WSNs have specific features like small duty cycle, energy level and less battery. There is large number of WSN applications for example military, health, robot control [3].

2. NODE LOCALIZATION

Location estimation is one of the valuable, crucial and complicated problems in WSN. WSN plays important role in atmospheric conditions to evaluate many functions such as disaster recovery, atmospheric conditions, locating missions. It is a big problem in WSN. It is the way of finding the co-ordinates of nodes whose position is not known [4]. The distance estimation among unidentified node and anchor node is not the actual value. So optimization can be used to locate unknown nodes which reduce the localization error and increase the accuracy [5]. The localization error between anchor node and nearby unknown node can be defined as the fitness function of localization problem is calculated from following formula:

$$f_k(a^- b^-) = d_{k-\sqrt{(a_k-a^-)^2+(b_k-b^-)^2}} \qquad (1)$$

Where a_k, b_k (k= 1,2,…,M) is the actual co-ordinate of i^{th} anchor node and a, b is the evaluated co-ordinate of unknown node.

The separation among the k^{th} unknown node and anchor node is described below:

$$\sqrt{(a_k - a^-)^2 + (b_k - b^-)^2} \qquad (2)$$

The relation between gaussian error and real distance can be written as:

$$\boldsymbol{D_k = d_{kj}(1 + rand \times n)} \qquad (3)$$

The measured distance is defined as:

$$d_{kj} = \sqrt{(a_k - a^-)^2 + (b_k - b^-)^2}\ , n \qquad (4)$$

2.1 Significance of node localization

Position of sensor nodes is most important in many applications such as monitoring forests in field in which large number of unknown nodes are placed. The efficient optimization method can be used to locate the accurate position coordinates of devices or nodes. Furthermore location based routing protocol can also be used to save significant amount of energy [6].

2.2 Parameters for localization

There are number of parameters which are described below:

Accuracy: It is significant to find the location of nodes in WSN. The level of accuracy should be higher for military applications.

Cost: One of the critical problem in WSN is cost. The algorithms whose cost is less, gives less accuracy.

Power: Power is essential for computation. Power is supplied to sensor nodes through battery therefore they have limited life.

Static nodes: These nodes have identical nature and similar sensing ability, computational ability and the ability to communicate.

Mobile nodes: These nodes are also homogeneous in nature. Static nodes have less power than mobile nodes [7].

3. FIREFLY ALGORITHM (FA)

FA algorithm motivated from nature that copies the social nature of fireflies originate in the hot areas. Flashing patterns produced by fireflies helps them to find their food, mating partners and to be contact in each other. Three rules are used in FA:

i. Assumed that all fireflies have same sex and get attracted towards other fireflies irrespective of their sex.
ii. Attractiveness and brightness of each firefly are directly proportional to each other.
iii. Objective function is used to calculate the brightness of firefly [8].

FA focuses on 2 parameters such as in what manner brightness has to be altered and in which way attractiveness is found. For simplicity, brightness factor of each firefly is used to calculate the attractiveness. Let I be the brightness of a firefly in a region and I(x) α f(x) for maximization case. β is defined as attractiveness of each firefly which can be seen by other firefly in the same region. Therefore attractiveness should varied by changing the distance between them. As the separation from the source increases, brightness and attractiveness decreases as defined by laws of physics.

Light intensity (I) can be defined by following formula:

$$I = I_0 \exp(-\gamma r^2) \quad (5)$$

I stand for light intensity, I0 is the initial light intensity, γ is coefficient of light absorption, r stands for the distance between source and destination.

Attractiveness (β) is defined as follows:

$$\beta = \beta_0 \exp(-\gamma r^2) \quad (6)$$

β_0 is the attractiveness of firefly when the distance 'r' is zero.

The motion of a less bright firefly *i*th towards the more intensity firefly *j*th is determined by Euclidean norm:

$$x_i = x_i + \beta_o^{-\gamma r_{ij}^2}(x_j - x_i) + \alpha(rand - \tfrac{1}{2}) \quad (7)$$

Let r_{ij} is the distance between any two fireflies. 2nd term indicates attractiveness and 3rd term denotes randomization.

Pseudo Code of Firefy Algorithm (FA):

1: Objective function f(x), $x=(x_1, x_2, \ldots\ldots x_d)$

2: Generate population of n fireflies, x_i, i=1, 2,…...,n

3: Light intensity I_i at X_i is determined by f (x_i)

4: Define the light absorption coefficient γ

5: while (t < Max generation)

6: for *i= l: n,* all n fireflies

7: for *j=l: n,* all n fireflies (inner loop)

8: if ($I_i < I_j$)

9: Move firefly *i* towards j using eq. (7)

10: end if

11: vary attractiveness with distance *i* via exp [$-\gamma r^2$]

12: end for *j*

13: end for *i*

14: Rank the fireflies and find the global best solution

15: End while

16: Post process the results

4. RESULTS AND DISCUSSION

The simulations of the proposed node localization scheme are performed on MATLAB 2014. Area in which target nodes and anchor nodes are deployed is taken as 100 m×100 m.

Table 1: Parameters of FA for node localization

Target nodes	No. of localized nodes	Locali-zation error	Computing time
10	31	0.155	0.801
20	76	0.380	0.812
30	126	0.630	0.816
40	148	0.560	0.832
50	167	0.835	0.836
60	179	0.895	0.864
70	188	0.940	0.891
80	192	0.98	0.910
90	198	1.00	0.962
100	200	1.04	0.880

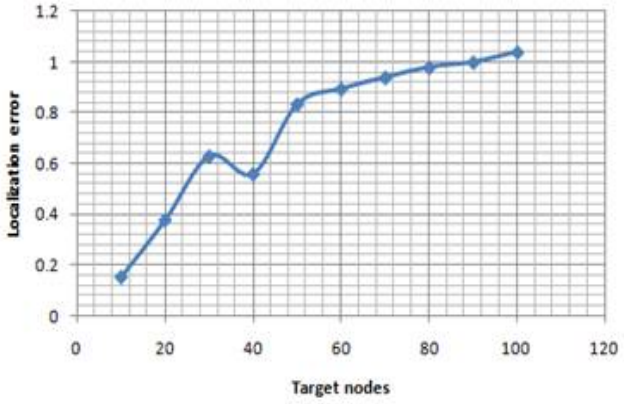

Figure 1: target nodes v/s localization error

Figure 1 depicts if we increase the target nodes the error is also increases. In order to decrease the error different iterations should be performed.

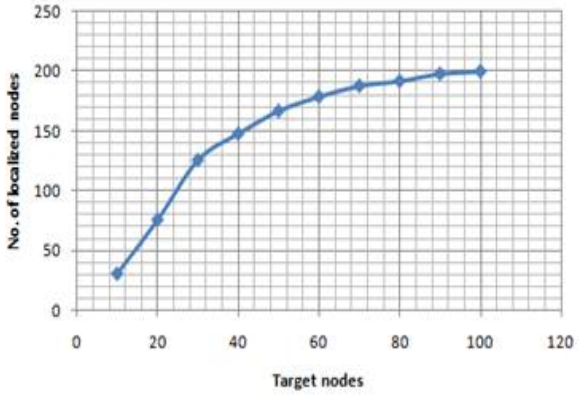

Figure 2 Target nodes v/s no. of localized nodes

Figure 2 defines with the increase in value of target nodes or area, number of node localized also increases.

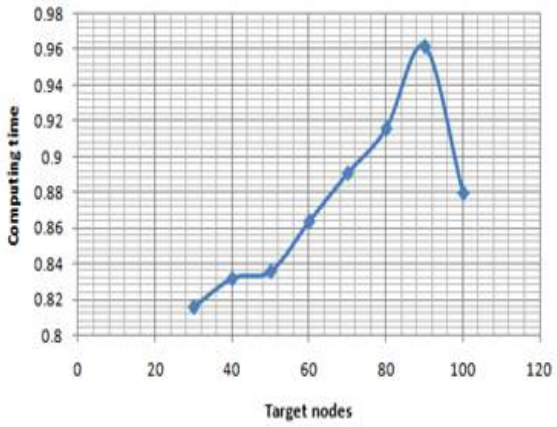

Figure 3 Target nodes v/s computation time

Figure 3 shows the plot between target nodes and computation time. The increase in number of nodes localized, time also increases.

5. CONCLUSION

The estimation of accuracy of location and localization nodes increases with the raise of anchor node or coverage area. If anchor nodes are not placed in sufficient manner then position of nodes are difficult to locate. So nature inspired algorithms are used to improve the accuracy and computing time. Further angle and distance based techniques are used to decrease the localization error.

REFERENCES

[1] S. Sharma, R. K. Bansal and S. Bansal, "Issues and Challenges in Wireless Sensor Networks," *IEEE Mach. Intell. Research Adv.*, vol. 4, pp. 58-62, Dec. 2013.

[2] H. Ahmadi, F. Viani, A. Polo and R. Bouallegue, "An Improved Anchor Selection Strategy for Wireless Localization of WSN Nodes," *Symp. Comput. Commun.*, vol. 44, pp. 345-350, 2016.

[3] R. Aggarwal, A. Mittal, R. Kaur, " Various Optimization techniques used in Wireless Sensor Networks", *Int. Research J. Eng. Technol.*, vol. 03, no. 06, pp.2085-2090, June 2016.

[4] C. S. Shieh, V. O. Sai, Y. C. Lin, T. F. Lee, T. T. Nguyen and Q. D. Lee, "Improved Node Localization for WSN using Heuristic Optimization Approaches,"*IEEE International Conference on Networking and Network Applications*, 2016, vol. 3, pp. 95-98.

[5] M. Joo, S. Zhang, B. Zhang, C. J. Chien, and F. Wang, " A novel localization approach towards anchor to node in wireless sensor networks," *International Automatic Control Conference*, Nov. 2016, vol. 4, pp. 143-148.

[6] S. Arora and S. Singh, "Node Localization in WSN Using Butterfly Optimization Algorithm," *Arab. J. Sci. Eng.*, vol. 42, pp. 3325–3335, 2017.

[7] P. K. Singh, B. Tripathi and N. P. Singh, "Node localization in Wireless Sensor Networks", *Int. J. Comput. Sci. Infor. Technol.*, vol. 2, pp. 2568-2572, 2011.

[8] B. Pei, H. Zhang and T. Pei, H. Wang, "Firefly Algorithm Optimization based WSN localization algorithm," *Int. J. Infor. Commun. Technol.*, vol. 54, 2015.

[9] M. F. Othmana and K. Shazalib, "Wireless Sensor Network Applications: A Study in Environment Monitoring System", *Int. Symp. Robot. Intell. Sensors*, vol. 41, pp. 1204-1210, 2012.

[10] L. Cheng, C. Wu, Y. Zhang, H. Wu, M. Li and C. Maple, "A Survey of Localization in Wireless Sensor Network," *Int. J. Distributed Sensor Netw.*, pp. 1-12, Dec. 2012.

[11] N. A. Alrajeh, M. Bashir and B. Shams, "Localization Techniques in Wireless Sensor Networks", *Int. J. Distributed Sensor Netw.*, pp 1-9, June 2013.

[12] L. Z. kun and L. Zhong, "Node Self-localization Algorithm for Wireless Sensor Networks Based on Modified Particle Swarm Optimization", *27th Chinese Control and Decision Conference (CCDC)*, May 2015, pp. 5968-5970.