International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Genetic Algorithms for Localization in WSN

Gondhi Navabharat Reddy, Sruthi Setlam, D Kiran Kumar, A Navya, Natasha Saude

Abstract—In wireless sensor networks, localization is a way to track the exact location of sensor nodes. Occasionally node localization may not be accurate due to the absence or limitation of anchor nodes. To reduce the mean localization error, soft computing techniques such as BAT and bacterial foraging driven bat algorithm (BDBA) are utilized in literature. For better localization with reduced error, in this paper, firefly driven bat algorithm (FDBA) is proposed, which combines the heuristic of firefly and BAT algorithms. Our proposed FDBA algorithm provides better localization in terms of error of 60% and 40 % less error as compared to BAT and BDBA algorithm, respectively.

Keywords: Localization, BAT algorithm, BDBA driven bat algorithm, firefly driven bat algorithm, mean localization error, wireless sensor network.

I. INTRODUCTION

Sensor nodes gives information of particular event the way of deployment of sensor nodes is random and mostly they are installed in flooded and disaster relief regions[1].position of sensor node is mandatory in order to get event informati where exactly it can be done [1]. Sensor node provides routing information and group of quires [3]. The node location estimation can be done localization. Localization means finding the location of sensor nodes [2]. Localization can be done by various algorithms they are taken from nature inspired algorithms [4]. Initially, localization can be done by BAT algorithm this algorithm inspired from the nature [5]. Localization means finding the location of sensor nodes localization can be done where Global positioning System (GPS) [11] fails as it may not work in indoor environments. Localization can be done in indoor as well as outdoor envorinments. Bat algorithm can be done in different ways [6] here we are proposing a new algorithm firefly driven bat algorithm[8] it gives better results compared to bat algorithm and bacterial foraging driven bat algorithm (BDBA). From literature of optimization algorithms for localization, bat algorithm is best localization algorithm compared to PSO and cuckoo search and firefly algorithm.

Revised Manuscript Received on March 30, 2020.

* Correspondence Author

Gondhi Navabharat Reddy, Assistant Professor, Department of ECE, Vignan Institute of Science and Technology, Bhuvanagiri, Telangana, India. E-mail: navabharath34@gmail.com

A Navya, Assistant Professor, Department of ECE, Vignan Institute of Science and Technology, Bhuvanagiri, Telangana, India. E-mail: navyaanthula95@gmail.com

D Kiran Kumar, Assistant Professor, Department of ECE, Vignan Institute of Science and Technology, Bhuvanagiri, Telangana, India. E-mail: kiranworld1991@gmail.com

Sruthi Setlam, Assistant Professor, Department of ECE, Vignan Institute of Science and Technology, Bhuvanagiri, Telangana, India. E-mail: sruthi.stlm@gmail.com

Natasha Saude, Assistant Professor, Department of ECE, Vignan Institute of Science and Technology, Bhuvanagiri, Telangana, India. E-mail: natasha.saude@gmail.com

Alternatively, BDBA is better as compared bat algorithm as it combines the characteristics of bat and bacteria foraging algorithm. Particle Swarm Optimization (PSO) algorithm is also one of the candidate algorithms in order to find out the position of sensor nodes but firefly driven bat algorithm is 80% better than PSO algorithm.

Distance vector hop algorithm one of the finest algorithm to find out the position of sensor nodes but firefly driven bat algorithm is 99% better than distance vector hop algorithm (DV-HOP).

As localization of WSN pose high challenge in the presence of noisy environment and the number of anchor nodes, in this paper we have combined the metaheuristic of firefly and bat to reduce the localization error for varying number of anchor nodes.

The reminder of the paper is organized as follows. In Section II the system model with anchor node, target node and localization node is presented. The WSN localization is given in Section III. Section IV describes the existing localization techniques and the proposed method is described in Section V. In section VI the simulation parameter and results are presented. Finally, section VII concludes the major findings.

II. SYSTEM MODEL

In this section we are representing sample network scenario for wireless sensor network in localization how unknown node can be found out using anchor nodes as illustrated in Figure 1. The system model shows deployment of anchor and sensor nodes in random way the localized node can be found with the help of anchor node. Here the sensor node position can be found out using various algorithms like particle swarm optimization bat algorithm BDBA, FDBA and Dv-hop.

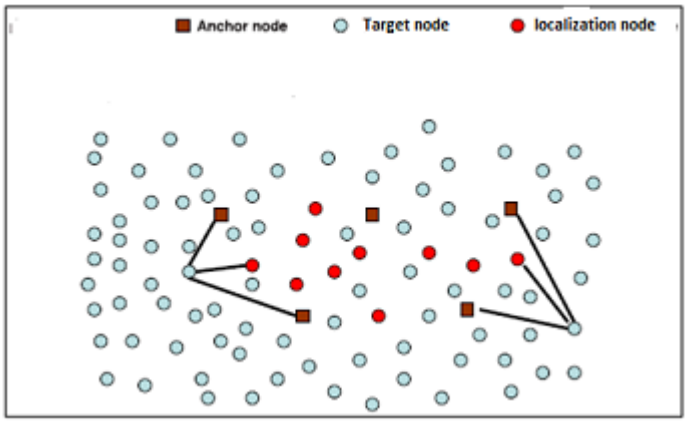

Fig1. Sample WSN scenario for localization

Target nodes are the nodes which we want to find out the location of sensor nodes anchor nodes know their position because it inbuilt GPS technology [11]. Localized sensor nodes are the nodes which we get the information of location of sensor nodes.

If more no of anchor nodes then system complexity will increase because anchor nodes are built upon GPS technology. Hence, if we deploy more anchor node means we have to deploy GPS technology for more nodes it will leads too much cost GPS technology normally not works in indoor environments. So in order to over come all problems we use meta heuristic algorithms like BAT and BOFA driven BAT algorithm and firefly driven BAT algorithm. Meta heuristic algorithms reduce the complexity of the system and works in effective manner.

III. WSN LOCALIZATION

Sensor nodes are deployed in random way. Node localization can be done by various algorithms. Here we are using 3 localization algorithms [6] in order to find out node localization. Every sensor node is separated by certain distance called transmission range. The nodes are surrounded by certain number of anchor nodes. The sensor node position is random so in order to find out the location of sensor nodes we use anchor node position (anchor node deployed with GPS technology so anchor node know its position) .The node position can be calculated by using distance but that include noise

$$G_j = G_j + n_j \tag{1}$$

where n_j is noise added G_j is the estimated distance, Gj is actual distance between the localizable node and anchor node which is given by

$$G_j = \sqrt{(a-b_j)^2 + (c-e_j)^2} \tag{2}$$

In this way we have to find out the location of sensor node. We can express Error as follows

$$E = \frac{\sum_{j=1}^{N} G_i - G_j^{\wedge}}{N} \tag{3}$$

where N is no of sensor nodes

The mean localization error be given as

$$MLE = \frac{\sum_{j=1}^{N} G_j - G_j^{\wedge}}{N(R)} \tag{4}$$

where R is transmission range

This localization can be done in different algorithms they are bat algorithm bofa driven bat algorithm and firefly driven bat algorithm.

IV. LOCALIZATION ALGORITHMS

A. BAT algorithm

BAT algorithm is one of the finest algorithm to find out the localization process.BAT algorithm is taken from nature inspired algorithms in these we have to find out the best location of sensor nodes.

The pulse frequency found using Equation 5 as follows:

$$f_i = f_{\min} + (f_{\max} - f_{\min})\beta \tag{5}$$

The velocity function can be found using the following Equation:

$$v_i^t = v_i^{t-1} + (x_i^t - x^*) f_i \tag{6}$$

Where x^* is aexisting global best location (solution) which is positioned after comparing all the solutions among all the n bats at each iteration is given as:

$$x_i^t = x_i^{t-1} + v_i^t \tag{7}$$

where v_i^t is the velocity at time step *t*. The new solution can be updated using older solution adding with velocity function. In this way bat algorithm find its solutions

B. BACTERIA FORAGING DRIVEN BAT ALGORITHM (BDBA)

In BDBA, in the exisitng bat algorithm, parameter $\triangle_i$ is multiplied with velocity function and changes is carried out to the solution particle. Every time solution gets updated until you get best particle. This mulitiplication factor $\triangle_i$ changes solutions because it multiplied with velocity. This BDBA is taken from the concept of bacterial foraging strategies. The new solutions are generated using the equations motivated by the concept of bacterial for a gingalgorithm (BFO).

$$x_i^t = x_i^{t-1} + v_i^t * \frac{\triangle_i}{\sqrt{\triangle_i^T * \triangle_i}} \tag{8}$$

$\triangle_i$ is the random number generated between[-1 1]

In this way we change the bat algorithm and we get better results than bat algorithm.

V. PROPOSED FIREFLY DRIVEN BAT ALGORITHM (FDBA)

Combining the concepts of bat algorithm and firefly algorithm gives FDBA algorithm gives improvement to existing BAT algorithm.

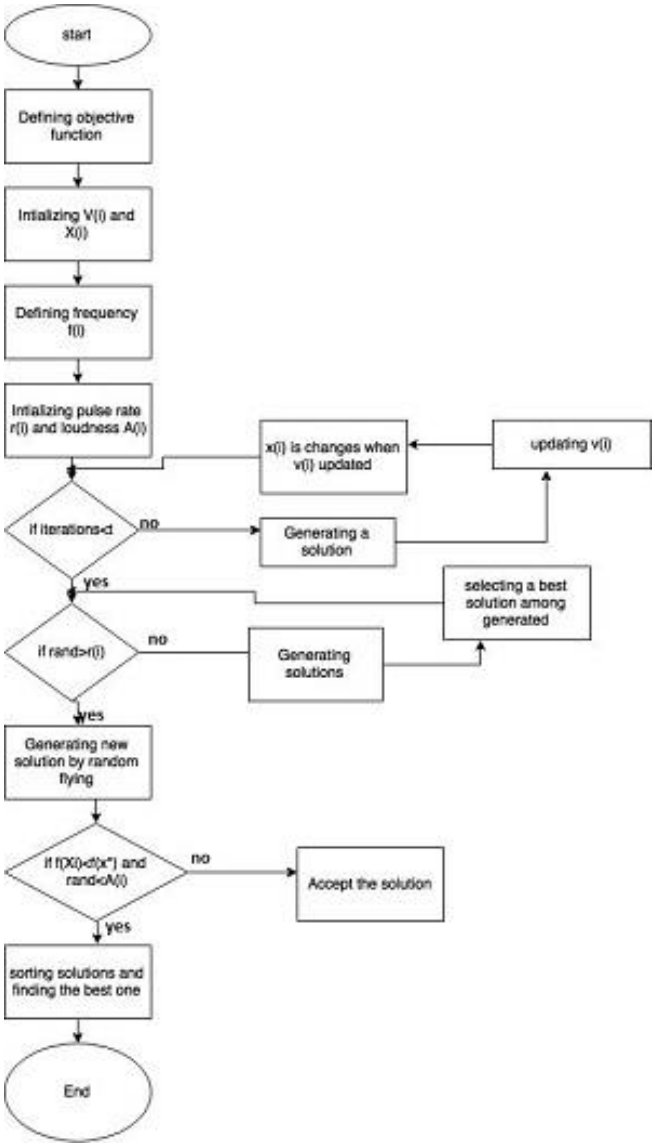

Fig. 2 Flow chart of the proposed FDBA

In FDBA, parameters like velocity function is updated as in Eq, (9) and it gives better result and better accuracy compare to bat and BOFA driven bat.

$$v_i^t = v_i^{t-1} + (x_i^t - x^*) f_i + C * \exp(-\beta * \beta) \qquad (9)$$

Where c is constant and β is random generation of [0 1]. The flow of the proposed algorithm is described in Fig. 2.

As compared to the existing algorithms bat algorithm is better and our metaheurstic approach bat algorithm is better than bat algorithm it will reduce the error further extent. Every time velocity gets updated and we get best solution out of it. when velocity function updated each particle updated and finds better location than previous one. Global best solution is effected by randomization factor. FDBA is better and it gives better result when we changes or introduce some parameters to bat algorithm

Here β function and constant C affects the velocity function and so that velocity of the particle gets updated so that solution changes and we get best particle out of it. When we increase the constant value the error will be less. And the error is always depends on how much best particle we are getting from solution that is depends on velocity function the velocity function changes according to the parameters so indirectly the parameters effects error.

VI. SIMULATION RESULTS

Here we represent the node localization of BAT algorithm the BAT algorithm is far better than remaining heuristic techniques it will reduce the error further extent based on the anchor node availability when no of anchor nodes increases so BAT algorithm is considered as one of the heuristic techniques. The Fig. 3, Fig. 4 and Fig. 5 refer to the distribution of various nodes in WSN for BAT, BDBA and FDBA, respectively.

Table1: Network simulation parameters

Parameter	Value
Area	200m*200m
Communication range	40m
Sensor nodes	150
Minimum frequency	0.1
Maximum frequency	200
No of anchor nodes	10 to 100
No of iterations	40 to 100

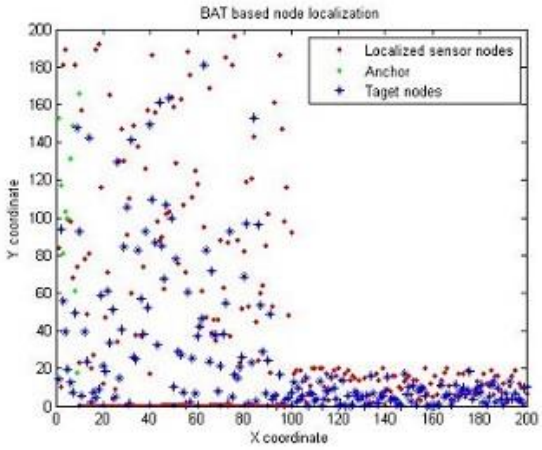

Fig. 3: Node localization using BAT algorithm

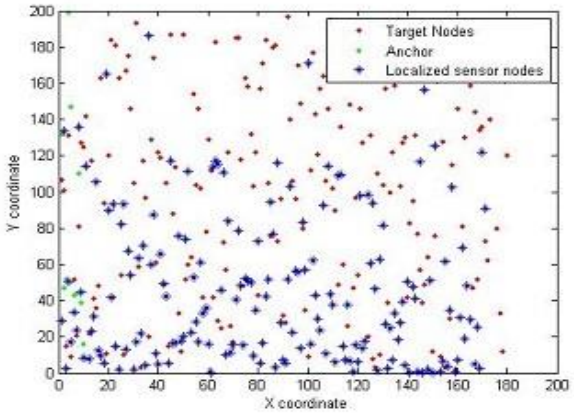

Fig. 4 Node localization using BDBA

Here the figure represents node localization BDBA (bacteria foraging driven bat algorithm) compared to BAT algorithm BDBA increase the optimization and reduce the error improves accuracy. The Fig. 5 represents the node localization of FDBA (firefly driven BAT algorithm) FDBA reduce the error further extent compared to BAT and BDBA algorithm. FDBA improves accuracy and it will give good optimization so our own proposed FDBA algorithm is far better than remaining two algorithms and so FDBA is considered as one of the best meta-heuristic approaches.

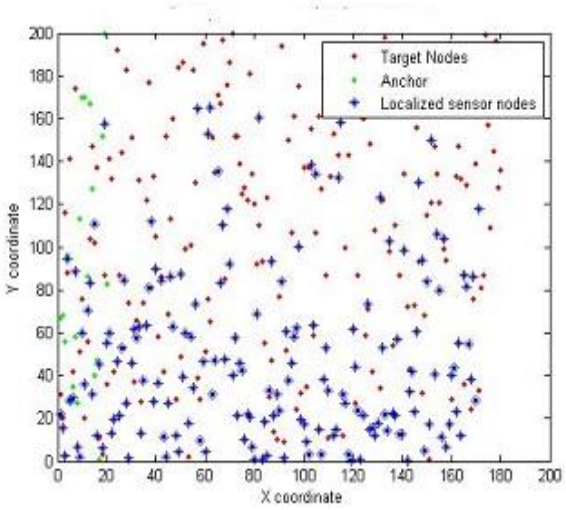

Fig. 5 Node localization using firefly driven BAT

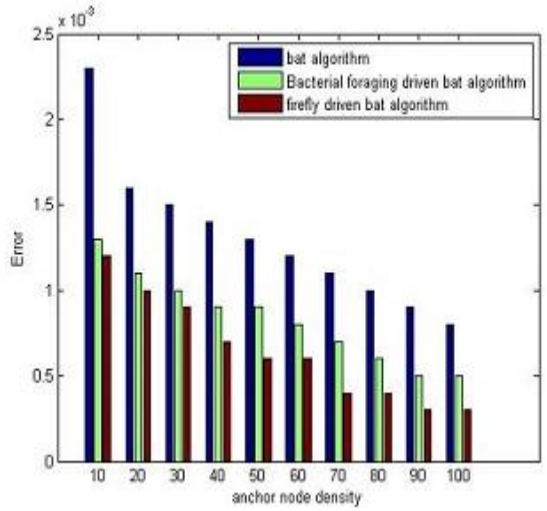

Fig. 6 MLE for BAT AND BOFA driven BAT and FDBA

In Fig. 6, we are represent the error for various algorithms BAT algorithm is showing high error compared to remaining two algorithms BDBA is less MLE compared to BAT algorithm and our own proposed FDBA is very less error compared to BAT and BDBA. Our FDBA algorithm gives better optimization so the error is very less so we can say our algorithm is best compared to remaining heuristic approaches.

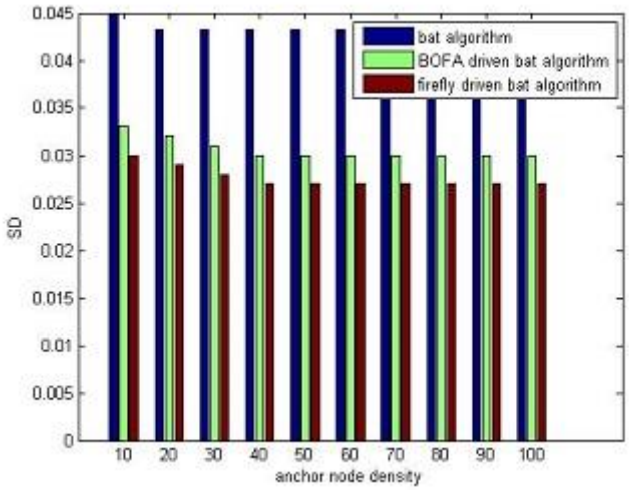

Fig 7. Standard deviation for three algorithms

Table 2. Mean localization Error for various algorithms

No of Anchor nodes	DV-HOP	PSO	BAT	BDBA	FDBA
10	0.64	0.006	0.0023	0.0013	0.0012
20	0.635	0.0058	0.0016	0.0011	0.0011
30	0.63	0.005	0.0015	0.0010	0.0009
40	0.628	0.004	0.0014	0.0009	0.0008
50	0.625	0.003	0.0013	0.0009	0.0007
60	0.62	0.002	0.0012	0.0008	0.0006
70	0.619	0.0018	0.0011	0.0007	0.0004
80	0.617	0.0017	0.0010	0.0006	0.0004
90	0.615	0.0015	0.0009	0.0005	0.0003
100	0.61	0.0015	0.0008	0.0005	0.0003

The standard deviation for various algorithms as shown in Fig. 7 and form the curves, the FDBA algorithm shows good standard deviation compared to remaining algorithms. In addition, the mean localization error between the classical methods, heuristic and meta-heuristic methods is compared in Table 1.

VII. CONCLUSION

Here, we have presented a scheme for localization by BAT and BDBA algorithm and FDBA algorithms. BAT algorithm is better compared to pso and cukoos and dv-hop algorithm. The BDBA is better than bat algorithm as it combines the local search of BAT and global search of firefly heuristics. In addition, FDBA algorithm gives best results as compared to algorithms reported in literature. FDBA is 99% better localization process compared to DV-HOP and 80% better than PSO and 60% better compared BAT and 40% better compared to BDBA so our proposed FDBA is best compared to all algorithms. FDBA improves standard deviation also by 33% compared to BAT and 26% by BDBA algorithm so FDBA gives better process compared to remaining algorithm.

REFERENCES

1. Shailendra Singh ,Dr. Ashok Kumar," Novel Optimal Deployment of Sensor Nodes Using Bio Inspired Algorithm" 2014 IEEE International Conference on Advanced Communication Control and Computing Technologies.
2. Guangjie Han Jinfang Jiang, Chenyu Zhang, Trung Q. Duong, , Mohsen Guizani, George Karagiannidis, "A Survey on Mobile Anchor Node Assisted Localization in Wireless Sensor Networks" 2016.
3. I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci,"Wireless sensor networks: a survey," *Computer Networks, vol.*38, no. 4, pp. 393–422, 2014.
4. A. Hanif Halim, I. Ismail" Bio-Inspired Optimization Method: A Review" NNGT Int. J. of Artificial Intelligence , Vol. 1, July 2014
5. Sivakumar,R. Venkateshan Meta heuristic approaches for minmzing error in localization of wireless sensor networks Wireless Pers Commun (2016) 86:657–670 2015
6. M. X. Chen and Y. D. Wang, "An efficient location trackingstructure for wireless sensor networks," *Computer Communications* ,vol. 32, no. 13-14, pp. 1495–1504, 2014.
7. P. Bahl and V. N. Padmanabhan, "RADAR: an in-building Rf based user location and tracking system," in *Proceedings ofthe 19th Annual Joint Conference of the IEEE Computer andCommunications Societies (IEEE INFOCOM '00), pp. 775–784*,March 2010.
8. N. B. Priyantha, A. Chakraborty, and H. Balakrishnan,"Cricket location-support system," in *Proceedings of the 6th Annual nternational Conference on Mobile Computing andNetworking (MOBICOM '00), pp. 32–43, August 2000* [9] G. Mao, B. Fidan, and B. D. O. Anderson, "Wireless sensor network localization techniques," *Computer Networks, vol. 51*,no. 10, pp. 2529–2553, 2007
9. D. Niculescu and B. Nath, "Ad hoc positioning system (APS) using AOA," in *Proceedings of the 22nd Annual Joint Conference*
10. *on the IEEE Computer and Communications Societies, pp.*1734–1743, April 2013.
11. N. Bulusu, J. Heidemann, and D. Estrin, "GPS-less low-cost outdoor localization for very small devices," *IEEE Personal Communications, vol. 7, no. 5, pp. 28–34, 2000.*
12. L. Doherty, K. S. J. Pister, and L. El Ghaoui, "Convex position estimation in wireless sensor networks," in *Proceedings of the 20th Annual Joint Conference of the IEEE Computer andCommunications Societies, pp. 1655–1663, April 2001.*

AUTHOR PROFILE

NAVABHART REDDY: Navabharat Reddy currently working as a Assistant professor in Vignan Institute of Technology and science his completed postgrduation in communication engineering at VIT Vellore his current intrests in communication engineering and wireless networks .

Sruthi Setlam: Setlam sruthi currently working as a software professional she completed her postgrduation in communication engineering at VIT Vellore her current intrests in wireless networks.

Kiran Kumar: his working as a Assistant professor in Vignan Institute of Technology and science his completed postgrduation in communication engineering at VIT Chennai his current intrests in embedded systems he did several projects in Embedded systems.

Navya Ananthula: Currently she is working as Assistant professor in Vignan Institute of Technology and science she completed postgrduation in signal processing her current research intrest in communication and wireless.

Natasha Saude: Currently she is working as Assistant professor in Vignan Institute of Technology and science she completed postgrduation in signal processing her current research intrest in communication and wireless.