Hybrid Optimization Approach for Node Localization in Underwater Acoustic Networks

Manjeet Singh[1], Ms. Mandeep Sharma[2]
[1]*M.Tech Student,* [2]*HOD, ECE Department*
[12]*Electronics & Communication Engineering*
[12]*Guru Gobind Singh College of Modern Technology, Kharar*

Abstract- The underwater acoustic network is the type of network which is deployed under the deep sea to sense ocean conditions like pressure etc. Due to the presence of limited bandwidth, higher multi-path, higher fading, huge time-variations as well as Doppler shifts, it is difficult to perform high-speed communication within underwater acoustic channels. Within the sea waters, the propagation of electromagnetic waves is very poor. Originally for the terrestrial wired and wireless channels, the communication techniques were designed. Thus, in order to make them appropriate for underwater channels, there is a need to modify these techniques. In the previous research, the fry fly algorithm is applied for the node localization. In the fry fly algorithm the optimal value is calculated for the node localization. In this research work, distance based technique is applied for the node localization. The proposed and existing algorithms are implemented in MATLAB. The simulation results show that proposed algorithm performs well in terms of certain parameters.

Keywords- Node Localization, Firefly, Artificial Bee Colony, Localization Error

I. INTRODUCTION

A network that consists of various sensor nodes and base station for collecting data from surroundings is known as a wireless sensor network. The power, memory as well as computational capacity of sensor nodes in these networks is very less. There is a random distribution of the sensor nodes within these networks such that the surrounding conditions can be sensed and the important information can further be forwarded to be the base station of the network. To aggregate the data, the base station is deployed centrally within these wireless networks. The environmental conditions are monitored from the sensor nodes deployed in these networks [1]. The centrally localized base station can gather all such information. The computation power and storage capacity of the sensor nodes are very high. Thus, there is a need of very less amount of time to process such amount of information. An interface between the internal and external environments of these networks is provided through gateway. Here, the role of gateway is played by a base station. The feasibility of wireless sensor networks is positively possible due to the latest advancements made in the technology. There are several applications within use WSN and provide huge research developments. However, there are several technical issues being faced by the researchers [2]. There are several issues and challenges being faced by WSNs which are enlisted here. The networks are deployed underwater for providing communication such that the important information can be easily transmitted across regions. Due to the presence of limited bandwidth, higher multi-path, higher fading, huge time-variations as well as Doppler shifts, it is difficult to perform high-speed communication within underwater acoustic channels. Within the sea waters, the propagation of electromagnetic waves is very poor. Originally for the terrestrial wired and wireless channels, the communication techniques were designed. Thus, in order to make them appropriate for underwater channels, there is a need to modify these techniques. Due to the dynamic nature of WSNs, one of the major issues that arise is known as node localization. For ensuring efficient data communication, the location of sensor nodes is shared through node localization mechanism [3]. By proposing efficient solution to the node localization issue, the data aggregation issue is resolved. For performing several tasks like tracking of target, monitoring the environmental conditions, WSNs are deployed in various applications. To fulfill the various applications of WSN, an important requirement is node localization. Due to the dynamic nature of these networks, node localization is known to be the major issue. The task in which the coordinates of nodes are collected for identifying unknown nodes is known as node localization. The distance approaches can be utilized to perform this technique along with the coverage area in which sensor nodes are deployed [4]. For generating queries from sensor nodes for several events, forwarding data within the groups, and routing the data, the generation of queries is important within this technique. Anchor nodes are deployed within the network for localizing the position of sensor nodes. Thus, an estimated value is calculated to determine the localization distance amongst the sensor node and anchor. Several optimization approaches are implemented on anchor nodes for estimating the exact position of sensor nodes. Ranging errors is the major issue of node localization in which the exact position estimation of unknown nodes is to be minimized. There is reduction of mean square error due to the identification of position of unknown nodes [5]. For estimating the exact location of sensor nodes, there is a need to minimize the optimization issue using the fitness value known as mean square error. There are two major issues that occur within the network due to the node localization problem. Establishing secure and efficient path from source to destination is the initial issue which is known as route establishment issue. The range issue that defines coverage area of sensor nodes is the secondary issue. Node localization is the solution to these two issues. There are several issues that arise within node localization that are presented in this chapter along with the solutions that can be applicable to it [6]. Several techniques that are proposed by different researchers are included within the node localization mechanism. On the basis of mobility and nature of swarms, a stochastic mechanism is proposed that has high flexibility. It is known as Particle swarm optimization (PSO). An algorithm that is used for optimizing the functions through the enhancement of candidate solution in stochastic and repeated manner is known as Biogeography-based optimization (BBO). The sensor nodes of WSNs are localized using Bee Optimizations Algorithm (BOA). The normal allocation of Time of Arrival (TOA) measurements and received signal strength (RSS) measurements are used for various topologies by conducting various tests.

II. LITERATURE REVIEW

Ranjit Kaur, et.al, (2017), presented a study related to node localization which plays a very important role within wireless sensor networks. On the basis of distance, the location of sensor nodes is estimated within the localization approach. The important information from base station is very difficult to be generated in case if the estimation of position of node is not correct. Because of huge sizes of the sensor networks, the complexity of node localization is very high also. An optimization issue caused here commonly is node localization. For node localization, a nature inspired optimization approach is proposed by author [7]. Comparisons are made amongst various optimization algorithms in order to identify appropriate mechanisms with respect to accuracy and computation time they provide.

S. R. Sujatha, et.al, (2017), proposed in this paper a novel dynamic weight based mechanism for node localization in WSN. Mainly, a hybrid approach is proposed here through which the improvements are achieved. When there is equality of the estimated and measured positions of nodes, the bit error rate is minimized. For gathering the accurate locations of nodes, the anchor nodes are utilized. For localization, DE algorithm is proposed by author here with whom the accuracy of localization is increased here [8]. With respect to accuracy and execution time, the proposed algorithm provides better simulation results.

Meng Joo Er, et.al, (2016), presented research related to node localization within WSNs. To provide highly accurate position of nodes, the density of network needs to high. The accuracy of node localization is directly affected due to the node density. There is minimization of number of hops of network when the density of nodes is minimized in the area. Thus, the accuracy of network is also minimized here. For providing node localization, node density based estimation approach is proposed [9]. The node density is calculated for anchor nodes and regions within sub-regions are divided on the basis of node density of anchor node. To estimate the position of nodes, the distance amongst the anchor node and sensor node is computed. In comparison to already existing approaches, the performance of proposed approach is shown to be better as per the simulation results.

Eva Tuba, et.al, (2016), presented that an important part of WSNs is the estimation of position of sensor nodes. A mechanism in which the location of unknown nodes can be estimated is known as node localization. On the basis of firework swarm intelligence optimization algorithm, the node localization mechanism is proposed in this paper [10]. From several anchor nodes, the gathering of estimated data is done using this algorithm. In the form of input, this data is provided to the system. There are three different phases in which this algorithm performs. The location of each node is compared within the initial phase. Further, the best location is computed within the second step. Further, for node localization, the value of MSE is estimated within the final phase. It is seen through the comparisons that with respect to accuracy and execution time parameters, the performance of proposed algorithm is better that already existing approach.

Chin-Shiuh Shieh, et.al, (2016), presented study related to node localization which is a major issue. The gathering of data from the network becomes difficult in case when the position as well as identification of sensor nodes is not estimated. The optimization issue faced within WSNs is node localization which is mainly caused due to the estimation of positions of nodes [11]. Several optimization algorithms that are proposed for node localization are compared within this research to evaluate the performances of each other in comparison to each other. The various optimization algorithms are compared with respect to accuracy as well as execution time. It is seen as per the simulation results that the firefly algorithm performance better in comparison to other algorithms.

Suman Bhowmik, et.al, (2016), presented the study related to node localization issue within WSNs. For node localization, an efficient technique to be applied is the received signal strength. On the basis of received signal strength, the position of node is estimated within RSSI technique. A fuzzy logic based node localization approach is proposed in this research work [12]. Using distance parameters, fuzzy rules are generated within the fuzzy logic approach. Amongst the anchor node and sensor nodes, the distance is computed. The position estimation is done using the calculated distance that follows the define rule. Within Omneet++, the simulation of proposed algorithm is done and the accuracy of node localization is also evaluated when proposed algorithm is applied.

III. RESEARCH METHODOLOGY

The Artificial Bee Colony (ABC) algorithm is a swarm based meta-heuristic algorithm that was introduced by Karaboga in 2005 for optimizing numerical problems. It was inspired by the intelligent foraging behaviour of honey bees. The algorithm is specifically based on the model proposed for the foraging behaviour of honey bee colonies. The model consists of three essential components: employed and unemployed foraging bees, and food sources. The first two components, employed and unemployed foraging bees, search for rich food sources, which is the third component, close to their hive. The model also defines two leading modes of behaviour which are necessary for self organising and collective intelligence: recruitment of foragers to rich food sources resulting in positive feedback and abandonment of poor sources by foragers causing negative feedback.

In ABC, a colony of artificial forager bees (agents) search for rich artificial food sources (good solutions for a given problem). To apply ABC, the considered optimization problem is first converted to the problem of finding the best parameter vector which minimizes an objective function. Then, the artificial bees randomly discover a population of initial solution vectors and then iteratively improve them by employing the strategies: moving towards better solutions by means of a neighbor search mechanism while abandoning poor solutions.

Artificial Bee Colony Algorithm

1. Calculate probabilities of the selected sensor nodes
2. for each anchor node

2.1. Produce new coordinates of the sensor nodes with coordination estimation

2.2.Define the objective function $f(x) = [(x-x_i)^2+(y-y_i)^2]^{1/2}$

2.3. Calculate fitness of the coordinate of sensor node by

Fitness function: $fit_i = \{1/ 1+ f_i$ if $f_i>=0$

$1+ abs(f_i)$ if $f_i< 0\}$

2.3. If the fitness of coordinate of sensor node is better than old one, memorize new position and reset trial counter; otherwise increase its trial counter by 1.

3. Save the best solution obtained so far.

4. Return best solution as termination criteria

IV. EXPERIMENTAL RESULTS

The proposed work is implemented in MATLAB and the results are evaluated by making comparisons against proposed and existing work in terms of several parameters.

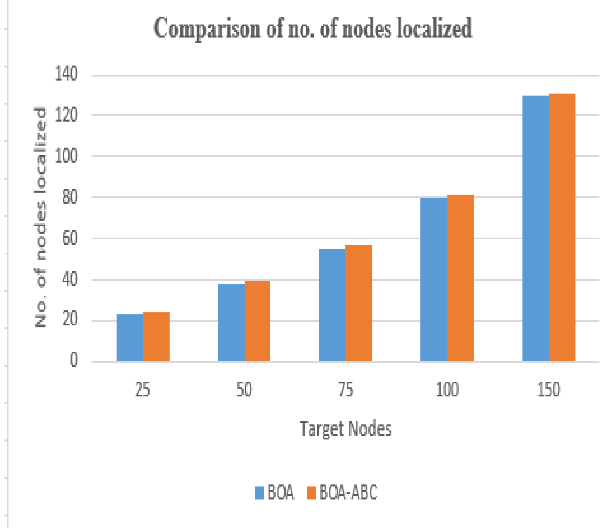

Fig.1: Number of nodes localised versus target nodes

The graph shows the number of nodes localized with the optimization algorithms (BOA and BOA-ABC). It shows that the nodes localized with the (BOA-ABC) are comparatively more than the BOA optimization algorithm.

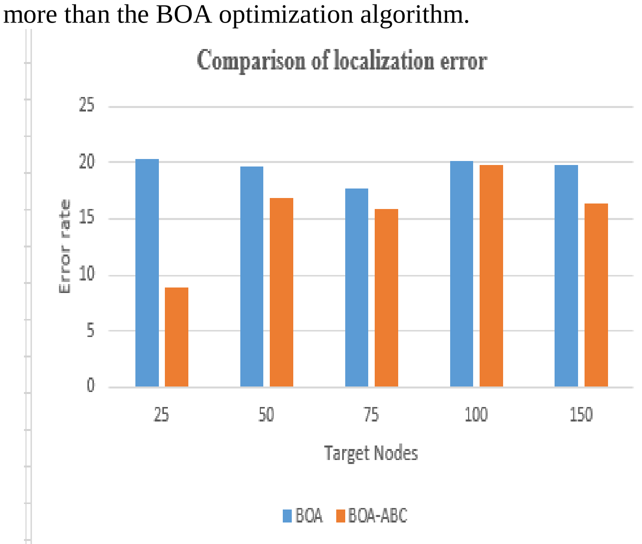

Fig.2: Error rate versus target nodes

The graph shows the results of localization error calculated by BOA and BOA-ABC. It shows that the hybrid optimization algorithm (BOA-ABC) reduces the Mean Square Error(MSE) to the greater extent as compared to the BOA optimization algorithm. Thus, the node localization in the network is improved.

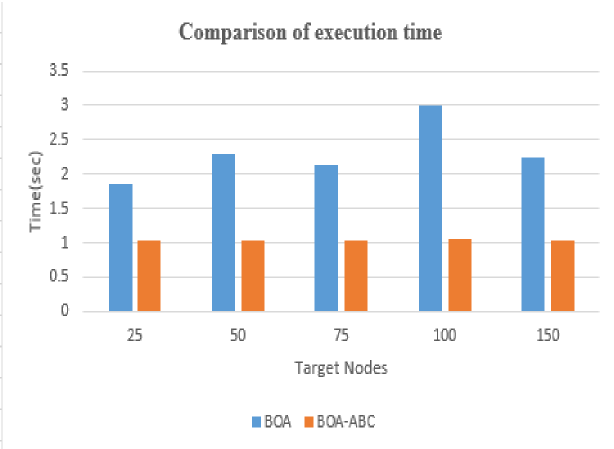

Fig.3: Execution time versus target nodes

The graph shows the computing time used by the optimization algorithms (BOA and BOA-ABC) to calculate the distance between the anchor nodes and the target nodes with the help of beacon messages, to calculate the co-ordinates of the nodes and finding the best solution by reducing the error value. It shows that the computing time of BOA-ABC is almost same and less in comparison to the computing time of BOA. Also, execution time of BOA varies considerably.

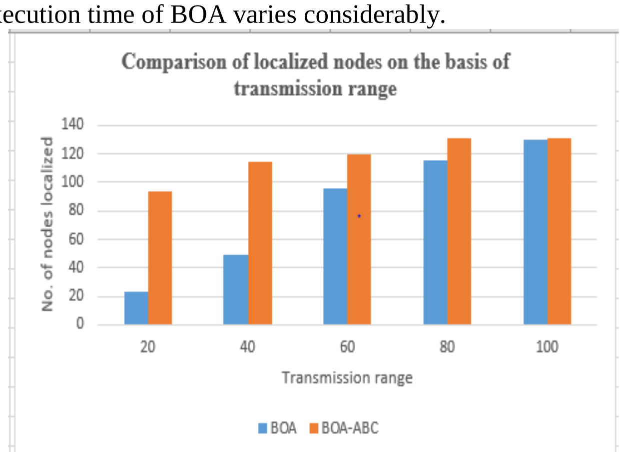

Fig.4: Number of nodes localized versus transmission range

The graph shows that the number of nodes localized increases with the increase in the transmission range that is; with the increase in the transmission range of the anchor nodes the localization of the target nodes also increases.

V. CONCLUSION

In WSN location awareness is one of the important, critical and challenging issues. Knowledge of location among the participating nodes is one of the crucial requirements in designing of solutions for various issues related to wireless sensor networks. Node localization is also one of the problems in WSN. It is the process of identifying the position coordinates of unknown nodes which can be achieved by using the distance information, and radius of wireless communications. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the network coverage. The fry fly algorithm is the optimization for the node localization. The fry fly algorithm need large number of iterations for the node localization. In this research work, distance based technique is applied for the node localization. The proposed algorithm is implemented in MATLAB and results are analyzed in terms of certain number of parameters.

VI. REFERENCES

[1]. Avinash Kaur, Sonu Agrawa, "Location detection in wireless sensor network using classical optimization methodology," 2012, IJCST, vol. 3, pp.108-115.

[2]. Asma Mesmoudi, Mohammed Feham, Nabila Labraoui, "Wireless sensor networks localization algorithms: a comprehensive survey", 2013, International Journal of Computer Networks & Communications (IJCNC) vol.5, pp. 112-120.

[3]. Z. Mary Livinsa, Dr. S. Jayashri, "Performance analysis of diverse environment based on RSSI localization algorithms in wsns", 2013, Proceedings of 2013 IEEE conference on Information and Communication Technologies, vol.3, pp.627-628.

[4]. A. Nasipuri and K. Li, "A directionality based location discovery scheme for wireless sensor networks," 2002, In Proceedings of ACM WSNA, vol. 4, pp.105-111

[5]. D. Niculescu and B. Nath, Ad Hoc Positioning System (APS) using AoA," 2013, In Proceedings of IEEE INFOCOM '03, vol. 3, pp. 1734-1743

[6]. M. Broxton, J. Lifton and J. Paradiso, "Localizing a Sensor Network via Collaborative Processing of Global Stimuli," 2005, IEEE Workshop on Wireless Sensor Networks, vol.5, pp. 321-332.

[7]. Ranjit Kaur, Sankalap Arora, "Nature Inspired Range Based Wireless Sensor Node Localization Algorithms," 2017, Springer, vol.4, pp7-17

[8]. S.R.Sujatha, Dr.M.Siddappa, "Node Localization Method for Wireless Sensor Networks Based on Hybrid Optimization of Particle Swarm Optimization and Differential Evolution," 2017, IOSR-JCE, vol.19, pp.7-12

[9]. Meng Joo Er, Shi Zhang, Baihai Zhang, Chiang-Ju Chien, and Feifan Wang, " A novel localization approach towards anchor to node in wireless sensor networks," 2016, IEEE, vol.4, pp.143-148

[10]. Eva Tuba, Milan Tuba, Marko Beko, "Node Localization in Ad Hoc Wireless Sensor Networks Using Fireworks Algorithm," 2016, IEEE, vol.3, pp. 130-137

[11]. Chin-Shiuh Shieh, Van-Oanh Sai, Yuh-Chung Lin, Tsair-Fwu Lee* , Trong-The Nguyen and Quang-Duy Le, "Improved Node Localization for WSN using Heuristic Optimization Approaches," 2016, IEEE International Conference on Networking and Network Applications, vol.3, pp.95-98

[12]. Suman Bhowmik, Rajib Kar, Chandan Giri, "Fuzzy Node Localization in Wireless Sensor Network," 2016, IEEE WiSPNET 2016 conference, vol.8, pp.1112-1116