Volume 5, Issue 1, January 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

# An Improved Range-free Localization Algorithm for Wireless Sensor Networks

**Mamta Kanwal**
Student, ME, Department ECE
NITTTR, Chandigarh, India

**Kanika Sharma**
Assistant Professor, Department ECE
NITTTR, Chandigarh, India

***Abstract— In WSN, localization is very important issue. Localization of sensor nodes is required to know the location of origin of events. Because of cost-effectiveness, energy efficiency and no need of additional hardware for localization, Range-free localization algorithms are important research topic. This paper presents an improved localization algorithm in terms of localization error. MATLAB simulations are done for comparison with previous Range-free algorithms.***

***Keywords— WSN, localization, anchor nodes, Genetic algorithm***

## I. INTRODUCTION

A wireless sensors network consists of spatially distributed sensors nodes deployed in a given geographical area. The number of the deployed sensor nodes [1] can be from a few to several million of nodes according to the application. Each sensor node is capable of sensing, processing and storing. Sensor nodes collaboratively sense and gather information like temperature, sound, pressure, humidity etc. Each Sensor node can have single or multiple sensors on it. Sensors can be passive like seismic, magnetic, and acoustic or they can be active like RADAR. Sensors can be stationary like seismic sensors or mobile like robot vehicle. Typically in WSNs sensor nodes are grouped in clusters, and each cluster has a node that acts as the cluster head, which in turn routs it to a specialized node called sink node or base station through multi-hop communication. In small WSN there is single sink and in large WSN there are multiple sinks or mobile sinks. Then data is send from base station to the end users by wireless or wired channel.

WSN is used in various fields such as military affairs, medical field, target tracking, environmental and habitat monitoring, Precision Agriculture and many more applications where data gathering is done at proximity of origin of event. In all the applications sensor nodes detect events or gather data from particular locations. Therefore event gathering without the knowledge of locations is meaningless. In WSN node localization [2] is also essential for proper operation of a sensor network.

The straightforward method to know the position of sensor nodes is global positioning system (GPS). But GPS equipped sensor nodes become very costly and consume large energy. Line-of-sight with satellite is also a problem of GPS. Therefore for large scale wireless sensor networks GPS is not a good solution. As energy efficiency and cost are constraints of large scale wireless sensor networks, Localization algorithms are used to localize the sensor nodes in WSN. The nodes with knowledge of their position are known as anchor nodes. Anchor nodes are equipped with GPS or are manually configured. Other nodes those do not have position knowledge are called unknown nodes or normal nodes. Unknown nodes make reference of anchor nodes to know their position. For localization, energy efficient, cost-effective, robust and scalable localization algorithms are required. Broadly localization algorithms are classified as Range-free and Range based.

The Improved Range-free algorithm in this paper is based on Genetic algorithm. Genetic algorithms are nature inspired algorithm based on genetics. The paper is organised as follow: section 1 provides a brief review of Range-free algorithms; section 2 describes the proposed algorithm; section 3 gives simulation work and the paper is concluded in section 4.

## II. RELATED WORK

Localization of sensor nodes is done in two phases. First distance between the unknown node and anchor node is estimated, then the coordinates of sensor nodes are calculated. On the base of technique used to estimate distance between the unknown nodes and anchor nodes, localization algorithms are classified as Range based and Range-free. Several Range-free localization algorithms are proposed in recent years. DV-hop [3], APIT [4] and centroid are some typical Range-free localization algorithms. Basically Range-free algorithms are based on connectivity information between sensor nodes and no additional hardware is required for localization. In Range based techniques distance between the sensor nodes is estimated using ranging techniques [5] like AOA (angle of arrival), TOA (Time of arrival), TDOA (Time difference of arrival) and RSS (Received signal strength) are used. These techniques use additional hardware like directional antenna, therefore these techniques are expensive and require additional energy for localization but give more accurate results as compared to Range-free techniques.

Some Hybrid localization [6] algorithms are also proposed. Hybrid algorithms provide advantages of both the Range based and Range-free techniques. In [7] an anchor free localization algorithm is proposed. In anchor free technique, localization is done on the base of neighbourhood relation, distance, direction and connectivity between neighbouring nodes. In this technique no extra infrastructure is required for localization.

For optimizing the accuracy, several optimization algorithm based localization algorithms are proposed in literature. [8] Presented an artificial neural network (ANN) approach to localization in wireless sensor network through the adjustment of the ANN structures using genetic algorithm. The population of ANNs containing their structure in a genetic code is evolved during twenty generations in order to select the best parameters for a particular simulated WSN. The method was tested in an indoor simulation environment of 26×26 meters with eight anchor nodes.

In [9]localization algorithm based on HPSO and BBO algorithms was presented for distributed Range based localization. H-Best Particle Swarm Optimization (HPSO) and Biogeography based Optimization (BBO) are nature inspired algorithm for optimization.

In [10] presented a centralized localization algorithm based on genetic and simulating annealing. GA and SAA are both optimization algorithms. The proposed algorithm GSAA is optimized algorithm is optimized algorithm that integrates both GA and SAA. The proposed algorithm is implemented in centralized architecture. All the nodes send measurements to central station for localization.

In [11] localization technique based on fuzzy logic and genetic algorithm is presented. The author briefly described the RSS model. Then RSS values are divided into linguistic constructs. The Sinc membership function is used to assign values to the input values. Sinc membership function is selected because of best performance in most of the cases. Genetic algorithm is used to optimize the knowledge of fuzzy system.

## III. PROPOSED ALGORITHM

Localization of sensor nodes is done in two phases. First the distance between the sensor nodes and anchor node is estimated than the position of the sensor nodes is estimated. Distance estimation is done using connectivity information or based on absolute distance between the sensor nodes. Than the position of sensor nodes is estimated by set of simultaneous equations by multilateration [22], angulation or optimization techniques. In the proposed algorithm Genetic algorithm is used for optimal position estimation of unknown nodes.

***GENETIC ALGORITHM***: Genetic algorithms are nature inspired algorithms based on genetics. GA are used for optimization of results. First of all, some population is initialized. Population is comprised of some individuals or chromosomes. The number of individuals or chromosomes in a population depends upon the problem to be solved. The chromosomes are evolved toward the better chromosomes using the iterative process like mutation and crossover. Each iteration process to evolve the chromosomes is called generation. In each generation fitness of each chromosome is evaluated using a fitness function for the selection process. Then the selected chromosomes participate in next generation. In the proposed algorithm a set of individuals or chromosomes are initialized and a fitness function is based on metrics, RSS and hop count is used for selection process.

***RSS (Received signal strength)***: Received signal strength is the simplest and inexpensive metric to estimate the distance between the sensor nodes for the purpose of localization. Several localization algorithms based on RSS are proposed. [12] – [14] are RSS based localization algorithms. The signal strength received at the sensor node is mapped into distances using some channel model. The most popular channel model is log normal shadowing model. The received power at sensor nodes using log normal shadowing model is expressed as:

$$L = L_0 - 10\alpha \log_{10}\left(\frac{d}{d0}\right) + n$$

Where Lis power in dB received at sensor node, α is path loss exponent, $d_o$ is reference distance, $L_o$ is received power at reference point and *n* is Gaussian random variable. Values of α and *n* depends on propagation environment. But the reliability of RSS is affected by the environmental factors such as noise, obstacles and multipath.

***HOP COUNT:***In a wireless network Hop count metric between source node S and destination node D can be defined as number of intermediate nodes between source node S and destination node D including the source node. Localization techniques which are based on hop count information need less number of anchor nodes because the position of anchor node is propagated in the network by packet forwarding. [15]- [21] Algorithms are based on hop count metric.

## IV. SIMULATION RESULTS

In order to verify performance of the proposed algorithm with DV-Hop, and other DV-Hop based algorithms, simulations are conducted on MATLAB. In all the simulation experiments, the network region is assumed as square area of 100m×100m. The sensor nodes are randomly deployed in a square region. All the anchor nodes and unknown nodes have the same communication radius of 15m.

The localization error is calculated using the equation given below

$$LE = \frac{\sum_{i=M+1}^{N} \sqrt{(x_i' - x_i)^2 + (y_i' - y_i)^2}}{R \times (N - M)}$$

In the equation for node *i*, $(x_i,y_i)$ is the actual coordinate of the unknown node and $(x_i',y_i')$ is the estimated coordinate of unknown node. R is the communication radius of sensor nodes. N is the total number of sensor nodes in the sensor field and M is the total number of anchor nodes. Lower localization error value shows the better performance. The performance of localization algorithm is affected by the number of unknown nodes, anchor nodes and communication radius of sensor nodes. In this paper simulation results are analysed for total number of nodes. In real WSN networks, radio signals are affected by environment through which these propagate.

.Therefore performance of the proposed algorithm is compared and evaluated in three different scenarios, considering 0-10%, 0-20% and 0-30% communication ranging error. In all the simulations the total number of nodes are varied from 200 to 500. Communication radius of all nodes is same and equal to 15m. Anchor nodes are 10% of the total number of nodes.

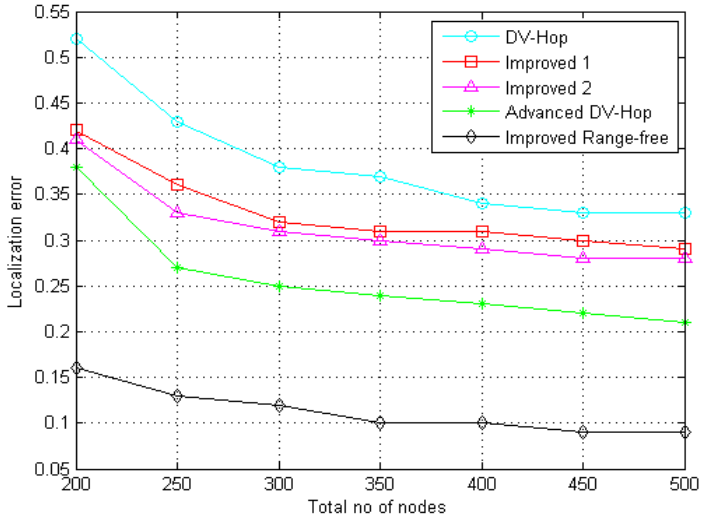


Fig. 1

*Localization error verses total number of nodes for 0-10% ranging error.*

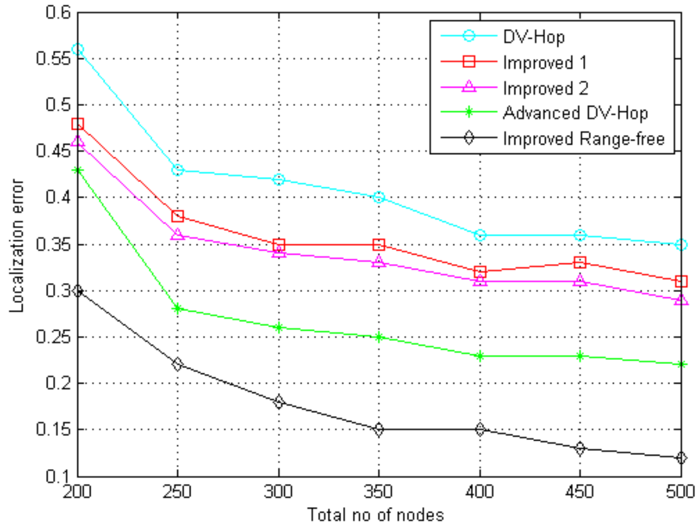


Fig. 2

*Localization error verses total number of nodes for 0-20% ranging error.*

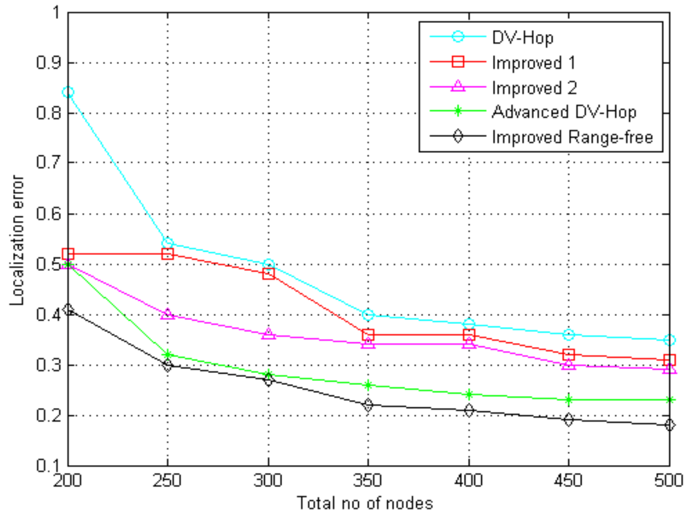


Fig. 3

*Localization error verses total number of nodes for 0-30% ranging error.*

Simulation results show that the improved Range-free localization algorithm based on genetic algorithms reduced localization error in all the three scenarios with 0-10%, 0-20% and 0-30% ranging error. Figs 1, 2, and 3 show the localization error in three different considered scenarios. In all the three simulation results, it is found that localization error is reduced as compared with previous Advanced DV-hop algorithms and other DV-Hop algorithms at same number of nodes. It is observed that the localization error is affected on varying total number of sensor nodes. Localization error of sensor nodes is reducing with increase in total number of nodes. Improvement in reducing the localization error is 58% in case of 0-10% error. In case of 0-20% ranging error 35% improvement is achieved and for 0-30% ranging error 13% improvement in reducing localization error is achieved.

## V. CONCLUSION

Range-free localization has become an important research topic because of its advantages like cost-effectiveness and no need of extra hardware requirement for localization purpose. But the accuracy of Range-free algorithms is less as compared to Range based algorithms. The proposed improved Range-free algorithm is based on genetic algorithm for optimal results of localization. The simulation results show that the improved range-free localization algorithm has reduced the localization error as compared to DV-Hop, Improved DV-Hop 1, Improved DV-Hop 2 and Advanced DV-Hop algorithms.

## REFRENCES

[1] Pradnya Gajbhiye, Anjali Mahajan, "A Survey of Architecture and Node deployment in Wireless Sensor Network", IEEE Conference application of digital information and Web technology, pp.426-430, 2008

[2] Mert Ba, Min Liu, Weiming Shen, Hamada Ghenniwa, "Localization in Cooperative Wireless Sensor Networks: A Review", IEEE international conference on computer Supported Cooperative Work in design, pp.438-443, 2009.

[3] Niculesu, Nath B, "Ad-hoc positioning system", IEEE Global telecommunication conference, Vol.5, pp.2926-2931,2001

[4] Ji zeng Wang, Hongxu Jin, "Improvement on APIT localization algorithm for Wireless Sensor Networks", IEEE international conference on network security, wireless communications and trusted computing", pp.719-723, 2009

[5] Sunita Chaurasia and Ashish Payal, "Analysis of Range-based localization Schemes in Wireless Sensor Networks: A Statistical Approach", IEEE Conference on advanced communications technology, pp.190-195,2011.

[6] Lijun Liu, Yuankun Wei, Guoyi, "An Adaptive Hybrid Localization Algorithm for Wireless Sensor Networks", IEEE International conference on Instrumentation & Measurement, Computer, Communication and Control, pp.1579-1582, September 2012.

[7] Yuan Zhang, Yuehui Chen, Yue Liu, "Towards Unique and Anchor-Free Localization for Wireless Sensor Networks", Journal of wireless personal communications, VOL. 63, pp. 261-278, 2012.

[8] Stephan H Chagas, Joao B. Martin, Leonardo L. de Oliveira, "An Approach to Localization Scheme of Wireless Sensor Networks Based on Artificial Neural Networks and Genetic Algorithm", IEEE International conference on new circuits and systems, pp. 137-140, 2012.

[9] Anil Kumar, Arun Khosla, Jasbir Singh, Satvir Singh, "Meta-Heuristic Range Based Node Localization Algorithm for Wireless Sensor Networks", IEEE international conference, 2012.

[10] Qingguo Zhang, Jinghua Wang, "Localization Algorithm for Wireless Sensor Network Based on Genetic Simulated Annealing Algorithm", IEEE international conference, 2008.

[11] Ashutosh Patri, Aghijit Nayak, " A Fuzzy-Based Localization In Range-free Wireless Sensor Network Using Algorithm & Sinc membership Function", IEEE international conference, pp.140-145, 2013.

[12] Lie Wang, Maciej Zawodniok, "RSSI-based localization in Cellular Networks", IEEE conference on LNC workshop, pp. 820-826, 2012.

[13] Frorough Yaghoubi, Ali-Azam Abbasfar, and Behrouz Maham, "Energy-Efficient RSSI-Based Localization for Wireless Sensor Networks",IEEE communication letters, VOL.18, NO.6, 2014.

[14] Pratap Kumar Sahu, Eric Hsiao-Kuang Wu and Jarruti Sahoo, "DuRT: Dual RSSI Trend Based Localization for Wireless Sensor Networks", IEEE Sensors Journal, VOL.13, NO. 8, 2013.

[15] Chen, Sezaki,Png Deng, So, "An Improved DV-Hop Localization Algorithm for Wireless Sensor Networks",IEEE International Conference On Industrial Electronics and Application, pp.1557-1561, 2008.

[16] Shrawan Kumar, D.K.Lobiyal, "An Advanced DV-Hop Localization Algorithm for Wireless Sensor Networks" , Springer, Journal of Wireless Personal Communications, Vol.71, No 2, pp.1365-1384, 2013.

[17] Shrawan Kumar, D.K. Lobiyal, "Power efficient range-free localization algorithm for wireless sensor networks", Springer Journal of Wireless Networks, Vol.20, No 4, pp.681-694, 2014.

[18] Sarita Gurang, A.K.M. Mahtab Hossain, "A hop-count based positioning algorithm for wireless ad-hoc networks", Springer journal of wireless networks, Springer, wireless networks, Vol. 20, No 6, pp.1431-1444,2014.

 

[19] Sungwon Yang, Jiyoung Yi, Hojung Caha, "HCRL: A Hop-Count-Ratio based localization in Wireless Sensor Networks",IEEE SECON proceedings, pp.31-40, 2007

[20] Quanrui Wei, Dexing Zhong, Jiuziang Han, "Improved localization method based on multi-hop distance unbiased estimation", IET Comunications, Vol.8, No 16, pp.2797-2804, 2014.

[21] Sangwoo lee, Jaehoon Choi and Sunwoo Kim, "Multihop Range-free Localization with Approximate Shortest Path in Anisotroic Networks", IEEE Ad-hoc and sensor networking symposium, pp.154-159, 2014.

[22] Rajive Misra, Shailendra Shukla, Vivek Chandel, "Lightweight Localization Using Trilateration for Sensor Networks", VOL. 21, NO. 2, 2014.

 