IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 18, Issue 2, Ver. II (Mar-Apr. 2016), PP 24-30
www.iosrjournals.org

Accurate Localization of Wireless Sensor Node Using Genetic Algorithm And Kalman Filter

Aditi Shrivastava[1] , Dr. Kavita Burse[2] , Saurabh Jain[3]
[1]*M.Tech. Oriental College of Technology, BHOPAL*
[2]*Director, Oriental College of Technology, BHOPAL*
[3]*HOD (CSE) ,Oriental College of Technology, BHOPAL*

Abstract: In wireless sensor network finding the node position is known as localization. Wireless sensor networks are widely adopted in many location sensitive applications including disaster management, environmental monitoring, military applications where the precise estimation of each node position is inevitably important when the absolute positions of a relatively small portion as anchor nodes of the underlying network were predetermined. Intrinsically, localization is an unconstrained optimization problem based on various distance/path measures. Most of the existing localization methods focus on using different heuristic-based or mathematical techniques to increase the precision in position estimation. The anchor nodes transmit some reference signals and other nodes utilize them with a few calculations to find their position. Generally the received signal strength indicator (RSSI) is used for distance estimation and angle of arrival (AOA) is used for direction estimation. However the estimation of distance from RSSI in not useful when number of channel are increase and the exact estimation of accurate angle requires complex reception apparatus, and even then it may influenced by multipath fading. Henceforth in this paper we are presenting the Kalman filter based approach which treats the RSSI as prior and AOA as measured and attempts to discover the best location by fulfilling both the criteria with insignificant slip.
Keywords: WSN, Localization, Optimization, Genetic Algorithm.

I. Introduction

WSN is a communication system which does not obliges any incorporated control or infrastructure for application regions where the foundations of such assets are trouble some like military, marine and in environmental monitoring, early warning and network for crisis circumstances, as of late its region of utilization is likewise developing in household and medical fields. The necessity and significance of localization for WSN could be seen by its application in atmospheric or geographic monitoring where the sensor readings are specific to sensor locations. Since the estimation of distance on the basis of RSSI in not exact due to the fading attributes of the path which significantly shifts with time and climate likewise the AOA estimation which requires a profoundly directional reception apparatus yet error can't be completely disregarded. The issue with the anchor based localization is its requirements of higher quantities of anchor nodes to precisely estimate the position of node in three dimensional space. There exist another methodology which utilizes just the network data between obscure nodes and anchor points. These strategies can be further divided into two classifications: nearby systems and hop count strategy. In hop count strategy node measures the distances to its neighbor anchor nodes by the hop numbers and the hop size from the nearest anchor node and after that measure its own particular position, while the nearby method node gathers the position data of its neighbor anchor nodes to measure its position. In this paper we are concentrating on the range based strategy due to its exactness and versatility and presented a Kalman filter based approach for combining the RSSI and AOA to measure the location of node An overview on diverse localization methods accessible is exhibited by Guangjie Han et al [1], they additionally rename the localization calculations on the portability condition of points of interest and obscure nodes perspective with an itemized examination. Conveyed Angle Estimation based methodology is exhibited in [2]. In the writing two receiving wire anchor are utilized to transmit straight twitter waves at the same time, and the point of takeoff (AOD) of the transmitted waves at every accepting node is assessed through recurrence estimation of the nearby got signal quality evidence (RSSI) signal. Estimation strategy is additionally enhanced with the adaption of numerous parallel exhibits to give the space differing qualities. The other preference of the strategy is depend just on radio handsets and synchronization is required. Zero- configuration indoor localization to measure connections between RSSI tests and the distance between nodes is displayed in [4]. A localization approach particularly for the mine surroundings proposed in [5]. They proposed a programmed methodology for concurrent refinement of sensors positions and target following by the utilization of an estimation model from a genuine mine, and apply a discrete variation of ongoing conviction proliferation to handle all non-Gaussian vulnerabilities ordinary for mining situations. Mohammad Abdul Azim et al [6] introduced a cross entropy (CE) system for localization of nodes. Their proposed unified calculation measures area of the nodes by measuring distances of the neighboring nodes. At long last the mistake minimization is finished by utilizing the CE system. The sensor localization for the circumstances where the anchor force is obscure is proposed in [9] which uses the semi-definite programming (SDP) unwinding procedure and the calculation does not obliges anchor power data it requires just an assessment of the way misfortune example .

PAPER NAME	**TECHNIQUE NAME**	**PARAMETER**	**BENEFIT/ LIMITATION**
Using Micro-Genetic Algorithms to Improve Localization in Wireless Sensor Networks	heuristic search methods, micro genetic algorithms, distance measures.	Wireless sensor networks, localization, optimization techniques	An approach, namely a micro-genetic algo,is used as a post-optimizer into some existing localization methods such as the Ad-hoc Positioning System to improve the accuracy of their position estimation**.**
Distributed Angle estimation for Localization in wireless sensor networks	Distributed angle estimation method for WSNs in multipath propagation environment	Anchor node and sensor	Both the Performance analysis and Simulations have been presented
Target tracking using machine learning and Kalman filter in wireless sensor networks	Received Signal Strength Indication	Anchor node and sensor	The performance of the method is studied for different scenarios and a thorough comparison to well-known algorithms is also provided.
Towards Real-Time Indoor Localization in Wireless Sensor Networks	Time of Arrival, Time Difference of Arrival, Received Signal Strength Indication, Time of Flight,	Anchor node and sensor	Introduce the latest some solution, compare their Strengths and weaknesses. Finally, also give a recommendation about selecting algorithm from the viewpoint of the practical application need.

II. Genetic Algorithm

A straightforward Genetic Algorithm is an iterative technique, which keeps up a consistent size population P of hopeful arrangements. Amid every emphasis step three genetic operations (selection ,crossover and mutation) are performing to create new populations, and the chromosomes of the new populations are assessed through the estimation of the wellness which is identified with expense capacity. In view of these genetic administrators and the assessments, the better new populations of hopeful arrangement are shaped. With the above depiction, a straightforward genetic calculation is given as take after :

1. Produce randomly a population of parallel string.
2. Compute the wellness for every string in the population.
3. Make posterity strings through crossover and mutation operation.
4. Assess the new strings and ascertain the wellness for every string (chromosome).
5. On the off chance that the search objective is attained to, or an admissible generations is accomplished, return the best chromosome as the arrangement; overall go to step 3.

III. Proposed Methodology Implementation

1. RSSI Based objective function minimization by using GA

In this method the error function is based on the RSSI

$$\text{F1 } \text{obj}_{\text{fun}} \; \sum_{i=1}^{n} \left| \sqrt{(x_i - x_u)^2 + (y_i - y_u)^2 + (z_i - z_u)^2} - d_{i,est} \right|$$

Now using the GA for minimized above objective function by using the following steps

1. Randomly generate an initial population size 32.
2. Compute and save the fitness of objective function individual in the current population m(t).
3. Define selection probabilities for each individuals.
4. Generate m(t+1)by probabilities selecting individuals to produce offspring by a genetic algo.
5. After all these steps we calculate the value of objective function from each nodes.
6. Now we can compare the objective function from all nodes and find the minimum value.
7. If the objective function contain minimum value then stop the process otherwise repeat from step(2).

2. AOA Based objective function minimization by using GA

In this method the error function is based on the AOA

$$\text{F2 } \text{obj}_{\text{fun}} = \sum_{i=1}^{n} \left| 2 \; * \text{atan}\left(\frac{\text{norm}(v_u * \text{norm}(v_i) - \text{norm}(v_u) * v_i)}{\text{norm}(v_u * \text{norm}(v_i) + \text{norm}(v_u) * v_i)} \right) - \theta_{i,est} \right|$$

Now using the GA for minimized above objective function and process in similar to as RSSI based method for this repeat steps from 1 to 7.

3. RSSI +AOA Based objective function minimization by using GA

In this method the error function is based on the RSSI +AOA

$$\text{obj}_{\text{fun}} = \sum_{i=1}^{n} \left| \sqrt{(x_i - x_u)^2 + (y_i - y_u)^2 + (z_i - z_u)^2} - d_{i,est} \right| + \left| 2 * \text{atan}\left(\frac{\text{norm}(v_u * \text{norm}(v_i) - \text{norm}(v_u) * v_i)}{\text{norm}(v_u * \text{norm}(v_i) + \text{norm}(v_u) * v_i)} \right) - \theta_{i,est} \right|$$

Now using the GA for minimized above objective function and process in similar to as RSSI based method for this repeat steps from 1 to 7

4. Using Kalman Filter and GA for minimization of objective function

In this method objective function is created on the basis of kalman algo which are used for prediction and measurement.

1. For the measurement state the objective function consider in term of RSSI for this general equation is given as

$$Z_t = H_t x_t + v_t$$

Minimization of objective function is calculated by following equation

$$\textbf{F1 obj} = H_t \; \text{F1obj}_{\text{fun}} + v_t$$

2. For the prediction state the objective function consider in term of AOA for this general equation is given as

$$x_t = F_t x_{t-1} + B_t u_t + w_t$$

Minimization of objective function is calculated by following equation

$$\textbf{F2 obj}= F_t F2obj_{fun} + B_t u_t + w_t$$

Now obtain the objective function by combining prediction state and measurement state function.

Fobj = F1 obj+ F2 obj

This **Fobj** is used as a objective function for GA for minimizing it process is similar to as RSSI based method for this repeat steps from 1 to 7.after all this process we find the minimum error.

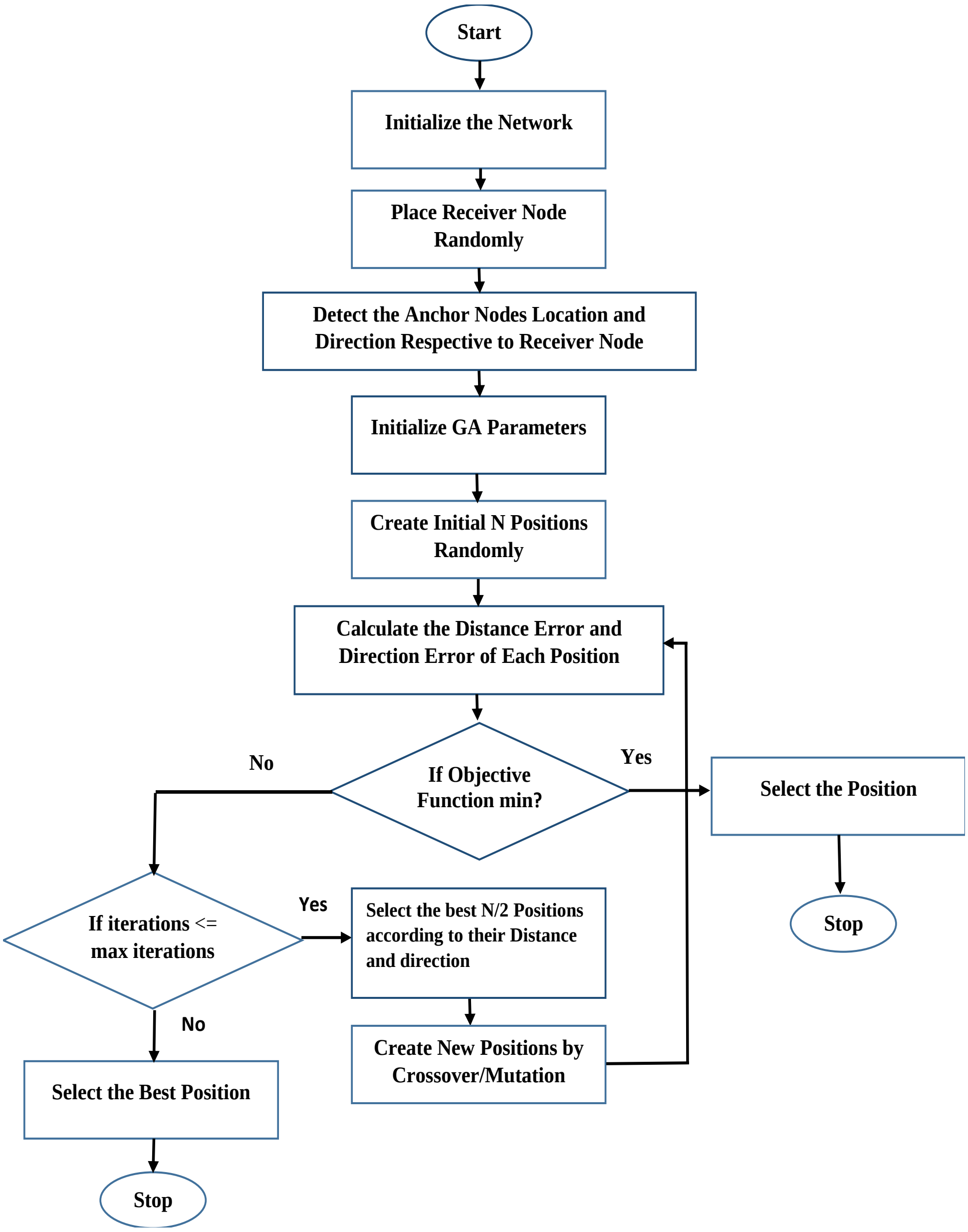

Fig- Flow Chart For Proposed Methodology

IV. Simulation Results

The evaluation of the proposed work is done by simulating it for different scenarios and configuration

Scenario 1:

Table 1: Configuration used for scenario 1 to evaluation of the proposed algorithm.

Properties	**Value**
Width	50 m
Height	50 m
Length	50 m
Number of Anchor Nodes	2
Error in Distance Calc. (%)	5
Error in Angle Calc. (%)	5
GA Population Size	32
Maximum Iterations	30
Number of Trials	20

Table 2: Results for Scenario 1

Technique	X	Y	Z	Error(m)	Time (Sec.)
Original	10.98	34.88	36.55	0	0
RSSI	6.18	12.99	1.35	4.87	19.34
AOA	20.71	39.56	2.53	3.56	15.29
RSSI+AOA	28.48	26.58	37.28	2.93	29.81
Proposed	22.00	34.94	21.93	1.93	30.86

Scenario 2:

Table 3: Configuration used for scenario 2 to evaluation of the proposed algorithm.

Properties	**Value**
Width	50 m
Height	50 m
Length	50 m
Number of Anchor Nodes	3
Error in Distance Calc. (%)	5
Error in Angle Calc. (%)	5
GA Population Size	32
Maximum Iterations	30
Number of Trials	20

Table 4: Results for Scenario 2

Technique	X	Y	Z	Error(m)	Time (Sec.)
Original	17.44	8.94	49.82	0	0
RSSI	3.31	34.82	14.74	4.59	28.14
AOA	12.39	2.13	43.47	3.44	12.13
RSSI+AOA	10.48	14.08	43.79	2.56	17.43
Proposed	12.00	12.77	48.53	1.41	17.51

Scenario 3:

Table 5: Configuration used for scenario3 to evaluation of the proposed algorithm.

Properties	**Value**
Width	50 m
Height	50 m
Length	50 m
Number of Anchor Nodes	4
Error in Distance Calc. (%)	5
Error in Angle Calc. (%)	5
GA Population Size	32
Maximum Iterations	30
Number of Trials	20

Table 6: Results for Scenario 3

Technique	X	Y	Z	Error(m)	Time (Sec.)
Original	40.73	45.28	6.34	0	0
RSSI	47.92	20.00	14.50	4.61	13.59
AOA	25.85	15.86	37.37	3.12	11.81
RSSI+AOA	31.52	41.20	2.34	2.38	17.48
Proposed	46.65	40.64	11.26	1.19	17.16

Scenario 4:

Table 7: Configuration used for scenario 1 to evaluation of the proposed algorithm.

Properties	**Value**
Width	50 m
Height	50 m
Length	50 m
Number of Anchor Nodes	5
Error in Distance Calc. (%)	5
Error in Angle Calc. (%)	5
GA Population Size	32
Maximum Iterations	30
Number of Trials	20

Table 8: Results for Scenario 4

Technique	X	Y	Z	Error(m)	Time (Sec.)
Original	30.92	11.59	43.57	0	0
RSS	44.25	31.50	21.38	3.81	11.86
AOA	32.78	15.55	41.38	2.89	11.96
RSSI+AOA	29.77	11.81	41.48	1.64	17.27
Proposed	31.20	13.37	44.38	1.01	17.42

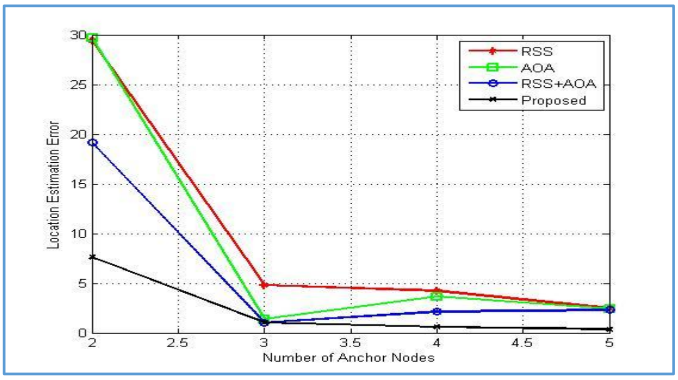

Figure 1: Comparison of the proposed algorithm (RSSI+AOA) with RSSI and AOA for the Location Estimation Error .

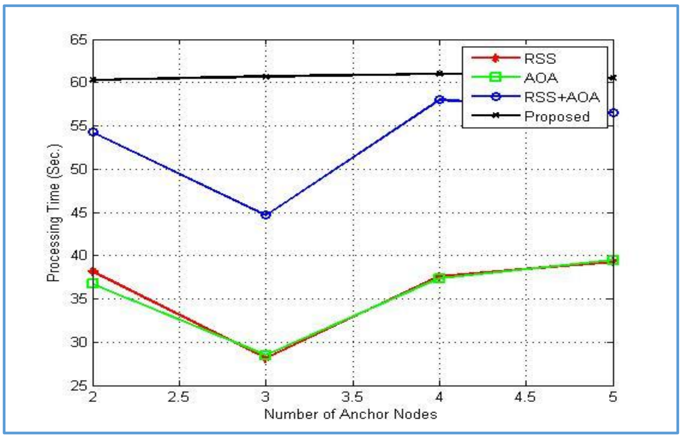

Figure 2: Comparison of the proposed algorithm (RSSI+AOA) with RSSI and AOA for the Location Estimation Time .

V. Conclusion and Future Aspects

Wireless sensor networks are widely applicable to many practical applications including environmental monitoring, military applications, disaster management, etc. in which the geographical locations of sensors are important. Accordingly, various localization algorithms have been developed with a few anchor nodes having their own positions precisely determined. Undoubtedly, most of the existing works focus on increasing the accuracy in position estimation by using a joint RSSI + AOA based algorithm which are at the same time enhanced by the Kalman Filter to discover the exact location of the sensor node utilizing some anchor nodes. The simulation results with diverse situation demonstrates that the presented algorithm gives the most astounding exactness with an average error of 1.01 with is superior to the nearest contender RSSI + AOA. The outcome additionally shows that just three anchor node are sufficient to give accurate estimation the further increment in anchor node does not shows significant improvement. The present results also demonstrates that the calculation time for the proposed calculation is much higher than others this is on account of standard genetic algorithm is utilized however as a part of future some dedicated calculation method can be produced.

References

[1]. Guangjie Han, Huihui Xu, Trung Q. Duong, Jinfang Jiangand Takahiro Hara "Localization algorithms of Wireless
[2]. Sensor Networks: a survey", Telecommunication Systems
[3]. Modelling, Analysis, Design and Management ISSN 1018-4864Telecommun System, DOI 10.1007/s11235-011-9564-7.
[4]. Y. Zhang, S. Liu, and Z. Jia, "Localization using joint distance and angle information for 3D wireless sensor networks," IEEE Commun. Lett., vol. 16, no. 6, pp. 809–811, Jun. 2012.
[5]. B.-C. Liu and K.-H. Lin, "Accuracy improvement of SSSD circular positioning in cellular networks," IEEE Trans. Veh. Technol., vol. 60, no. 4,pp. 1766–1774, May 2011.
[6]. J. Yan, C. Tiberius, G. Janssen, P. Teunissen, and G. Bellusci, "Review ofrange-based positioning algorithms," IEEE Aerosp. Electron. Syst. Mag.,vol. 28, no. 8, pp. 2–27, Aug. 2013.
[7]. Wang, Y., Cui, H., Guo, Q., Shu, M.: ' Obstacle-avoidance path planningof a mobile beacon for localization ' , IET Wirel. Sensor Syst., 2013, 3,(2), pp. 126 – 137
[8]. Roufarshbaf, H., Castro, J., Schwaner, F., Abedi, A.: ' Sub-optimum fastBayesian techniques for joint leak detection and localisation ' , IET Wirel.Sensor Syst., 2013, 3 , (3), pp. 239 – 246
[9]. Rasool, I., Kemp, A.H.: "Statistical analysis of wireless sensor networkGaussian range estimation errors" , IET Wirel. Sensor Syst., 2013, 3 , (1),pp. 57 – 68.
[10]. Kuo-Feng Ssu, Chia-Ho Ou, and Hewijin Christine Jiau, "Localization with Mobile Anchor Points inWireless Sensor Networks", IEEE Transactions on Vehicular Technology, Vol. 54, No. 3, May 2005.
[11]. Ramsey Faragher "Understanding the Basis of the Kalman Filter Via a Simple and Intuitive Derivation", IEEE Signal Processing Magazine [128] September 2012.
[12]. Jan Blumenthal, Frank Reichenbach, Dirk Timmermann"Minimal Transmission Power vs. Signalal Strengthas Distance Estimation for Localization in Wireless Sensor Networks", International Workshop on Wireless Ad-hoc and Sensor Networks (IWWAN 2006), New York.
[13]. Guoqiang Mao, BarısFidan, Brian D.O. Anderson "Wireless sensor network localization techniques", Computer Networks 51 (2007) 2529–2553.
[14]. Liu, R., Sun, K., Shen, J.: ' BP localization algorithm based on virtualnodes in wireless sensor networks ' . Proc. Sixth Int. Conf. WirelessCommunications, Networking and Mobile Computing, 2010, ArticleNo. 5601391.
[15]. RaduStoleru, Tian He and John A. Stankovic "Range-Free Localization", Secure Localization and Time Synchronization for Wireless Sensor and Ad Hoc NetworksAdvances in Information Security Volume 30, 2007, pp 3-31.
[16]. AsmaMesmoudi, Mohammed Feham, Nabila Labraoui "Wireless Sensor Networks Localization Algorithms: A Comprehensive Survey", International Journal of Computer Networks & Communications (IJCNC) Vol.5, No.6, November 2013.
[17]. A. Faheem, R. Virrankoski and M. Elmusrati "Improving RSSI based distance estimation for 802.15.4 wireless sensor networks", Wireless Information Technology and Systems (ICWITS), 2010 IEEE International Conference onAug. 28 2010-Sept. 3 2010Page(s):1 – 4.
[18]. Hady S. AbdelSalam, Stephan Olariu "Towards Enhanced RSSI-Based DistanceMeasurements and Localization in WSNs", INFOCOM Workshops 2009, IEEE19-25 April 2009Page(s):1 – 2.
[19]. EnyangXu, IEEE, Zhi Ding, and SouraDasgupta "Source Localization in Wireless Sensor Networksfrom Signalal Time-of-Arrival Measurements", IEEE Transactions on Signalal Processing, Vol. 59, No. 6, June 2011.
[20]. Khalid K. Almuzaini, Aaron Gulliver "Range-Based Localization in Wireless Networks Using Density-Based Outlier Detection", Wireless Sensor Network, 2010, 2, 807-814.