A GRADUAL LOCALIZATION WITH DYNAMIC PATH PLANNING ALGORITHM MECHANISM IN WIRELESS SENSOR NETWORK

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Abstract

Wireless sensor network (WSN) is employed to gather and forward information to the destination. It is very crucial to know the location of the event or collected information. This location information may be obtained using GPS or localization technique in wireless sensor networks. Randomly deployed WSN needs a large amount of GPS-enabled sensor nodes for localization, this necessitates progressive approach. However, nodes with sparse connectivity remain unlocalized. In this paper, a progressive mobile anchor based technique is presented for node localization. Initially, sensor nodes are localized using anchors in the neighborhood, then these localized nodes progressively localized remaining nodes using multilateration. Mobile anchor node moves randomly in field and broadcast position information. It localized nodes with sparse connectivity. Simulations results show that present approach localize all sensor nodes with good accuracy.

I. INTRODUCTION

In WSNs, sensor nodes are deployed in the real geo- graphical environment and observe some physical behaviors. WSNs have many analytical challenges. Sensors are a small device in size, low-cost accounting, and having low process capabilities. WSN's applications attracted great attention interest of researchers in recent years [1]. WSNs have a different application such as monitor environmental aspects and physical phenomena like temperature, audio and optical data, habitat monitoring, traffic control monitoring, patient healthcare monitoring, and underwater acoustic monitoring. Data collection without their geographical positions would be useless. Localization of nodes can be achieved by using GPS (global positioning system), but it becomes very expensive if a number of nodes are large in a given network. So far Many algorithms have been come up to solve the localization issue, but due to their application-specific nature, most of the solutions are not suitable for wide range of WSNs [2]. Ultra wideband techniques are useful for the indoor environment while extra hardware would be required for the acoustic transmission-based system. Both are accurate techniques but expensive in terms of energy consumption and processing. Unlocalized nodes calculate their location from anchor nodes beacon messages, which needs much power. Many algorithms have been proposed to reduce this communication cost. If one node calculates its wrong location, then this error propagates to overall network and further nodes, and this will lead wrong information of anchor nodes location is propagated [3]. Random deployment of the network also leads to sparse connectivity which decreases the probability of localization. In this paper, a progressive localization mechanism has been proposed for the sensor network. In this, the mobile anchor has been used to localized such nodes that have very less connectivity. Simulation results validate the performance of present approach.

The rest of the paper is organized as follows. Section 2 discusses related work of localization. Section 3 describes proposed approach in brief. Section 4 provides an overview simulation and results analysis. Section 5 concludes the paper.

II. RELATED WORK

Recently, many localization techniques have been proposed for WSNs, and simultaneously many studies have been done to analyze existing localization techniques and algorithms. In [4], Mao et al. first provide an overview of measurement techniques that can be used for WSN localization. Then the one-hop and the multi-hop localization algorithms based on the measurement techniques are presented in detail, respec- tively, where the connectivity-

based or range-free localization algorithms. In [5], an overview of localization techniques is presented for WSNs. The major localization techniques are classified into two categories: centralized and distributed based on where the computational effort is carried out. Based on the details of localization process, the advantages and limitations of each localization technique are discussed. In addition, future research directions and challenges are highlighted. This paper point out that the further study of localization technique should be adapted to the movement of sensor nodes since node mobility can heavily affect localization accuracy of targets. However, the localization techniques proposed for mobile sensor nodes are not discussed in [5].
In [6] Mustafa Ilhan Akbas, et al. proposed a localization algorithm for wireless networks with mobile sensor nodes and stationary actors. The proposed localization algorithm overcomes failure and high mobility of sensors node by a locality preserving approach complemented with the idea that benefits from the motion pattern of the sensors. The algorithm aims to retrieve location information at the actor nodes rather than the sensors and it adopts one-hop localization approach in order to address the limited lifetime of the WSN. The accuracy of the proposed algorithm can be further improved with RSS or other measurement techniques at the expense of increased energy consumption.

In proposed scheme [7], a subsurface current mobility model is adopted and tailored according to the requirements of the scenario. These mobile anchor nodes move in the network space and periodically broadcast beacon messages about their location. Static sensor nodes receive these messages as soon as they come under the communication range of any mobile anchor node and compute their position based on the range based technique. Another contribution of this paper is to identify the importance of mobile anchor node over static anchor node in localization. The simulation result shows that mobile anchor node provide better accuracy as compared to static anchor node for sensor node localization.
In [8] CamLy Nguyen et al. proposed a maximum- likelihood-based multihop localization algorithm called kHopLoc for use in wireless sensor networks that is strong in both isotropic and anisotropic network deployment regions. Compared to other multihop localization algorithms, the pro- posed kHopLoc algorithm achieves higher accuracy in vary- ing network configurations and connection link-models. The algorithm first runs a training phase during which a Monte Carlo simulation is utilized to produce accurate multihop connection probability density functions (described later). In its second phase, the algorithm constructs likelihood functions for each target node based on their hop counts to all reachable anchor nodes which it then maximizes to produce localization information. The main advantage of the algorithm is the use of a Monte Carlo initial training phase to generate the multihop connection probability density functions. These are then used to build likelihood functions whose maxima estimate each target node location. Since the algorithm uses full statistical information for the multihop connection probabilities, localiza-tion results are significantly more accurate for both in isotropicand anisotropic networks.
In [9] Slavisa Tomic, et al. addresses node localization problem in a cooperative 3-D wireless sensor network (WSN), for both cases of known and unknown node transmit power by investigating the target localization problem in a cooperative 3-D WSN, where all targets can communicate with any node within their communication range. In this by using RSS propagation model and simple geometry a novel objective function derived which is based on the LS criterion, which tightly approximates the ML one for small noise. The results show that the derived non-convex objective function can be transformed into a convex one by applying semidefinite pro- gramming (SDP) relaxation technique and the generalization of the proposed SDP estimator is straightforward for the case when the nodes transmit power is not known. Cooperative localization is a very difficult problem, particularly useful for large-scale WSNs with limited energy resources. The proposed scheme involves an efficient estimator based on SDP relaxation technique to estimate the locations of some target nodes simultaneously. The new estimator exhibited excellent performance in a variety of scenarios, as well as robustness to not knowing.
In [60] Kulkarni ,et.al compared to the other path planning methods,Σ-Scan provides the highest ratio of localization accuracy and coverage to path length. Σ-Scan saves the power of both mobile beacon and sensor nodes. Power-saving is significantly important for sensor network especially when the scale is large. Sensor localization is energy consuming especially when sensor nodes are mobile and dynamically changes their coordinates with time, such as underwater wireless sensor network. Besides, Σ-Scan is easy to implement and more applicable for ROI with arbitrary shaped. Common localization problems, such as accuracy, coverage and collinear problems, are not solved or evaluated in their methods for the arbitrary obstacle presence environment. However, Σ-Scan still has some constraints. Σ-Scan can only perform ideally in rectangles of which the side length is measured in units of s. Σ-Scan can only be used for 2D areas. We aim to solve these problems in our future work[6].
In [58] Kannadasan ,et.al.presented the trajectory of Z-curve with dual mobile beacon method is proposed. The study proves that this Z-curve trajectory is able to procure higher range of localization accuracy, reduced time consumption and minimized localization error. Hence it can be said that proposed Z-curve enables accuracy in terms of

localization by yielding minimum localization error, when compared to the existing SCAN algorithm. In the future, we will further study the mobile anchor node assisted localization problem, including analyzing the impact of anchor mobility on localization, design an optimal path planning for anchor nodes to improve localization performance, etc[4].

In [59] Tsai et.al presented a trajectory named ‘M-Curves’ for the mobile anchor based localization approach by considering the key features for localization and we adopted DSA to the problem of localization with novel fitness function. Our proposed path planning model assures full coverage, high localization accuracy and localization ratio. DSA optimized the position of the nodes by minimizing the localization error. It is evident from the results that, optimization gives better performance as compared to the traditional techniques.Compared with other static models such as SCAN,HILBERT, LMAT, Z-Curves, our model shows superior results in terms of metrics such as localization ratio, localization accuracy. Though SCAN and HILBERT has comparatively lesser path length, these two models are affected by co linearity problem. Due to which the localization accuracy of the models are high. Z-Curves model resolved the co linearity issue and it has comparatively lesser path length. However, experimental results shows that M-Curves outperforms SCAN,HILBERT, LMAT, Z-Curves models in terms of localization accuracy[5].

In [61] Das, Tisan, et.al.[2020], In this paper author presented Traversal technique is one of the most fundamental requirements associated with the localization schemes in the wireless sensor network. As the reduction in mobile anchor node decreases the cost associated with the deployment of the wireless sensor network in a manifold, hence optimization of mobile anchor node traversal by minimizing the total traversed path and average localization error has become an emerging field of study. None the less, further research activity is needed in deterministic path planning mechanism so that existing models can be optimized or novel approaches can be proposed which will further reduce the total traversed path as well as the average localization error by further use of various polygonal approach and fine-tuned pattern along With linear traversal scheme[3].

In [62]Kaur, Pardeep et.al invented a range-based, distributed method where randomly deployed sensor nodes in the en sing area are localized with the help of single mobile anchor nodes. The mobile anchor node follows an optimal new path trajectory i.e. spiral Pentagon Trajectory by utilizing the application of SSA. This paper proved that SPT has minimum path length as compares to exiting literature work and SSA has not been used before with this path trajectory. The proposed algorithm can be implemented for single hop/ multi-hop range-free localization for a fully mobile scenario. Future work is focused on the hybrid algorithm with different path planning and different optimization algorithm which can be used to gain high accuracy[1].

The related word clearly shows that an optimal algorithm could not be defined yet, and thus a suitable localization algorithm needs to be designed on the specificities of the situations, taking into account the size of the network, as well as the deployment method with node density and the expected results. Our present method delved into mobile anchor nodes and established that they are energy efficient as well as require less in number than only static nodes. In those systems, only a small number of anchors are necessary for constructing the global coordinates, which significantly reduces the system cost.

III NETWORK MODEL

In this section assumption about the network model is described.

- Sensor nodes and base station are static.
- The base station does not limit by energy.
- Anchor nodes are aware of their geographic location.
- The distributions of sensor nodes are random over thesensing area.
- The sensor nodes are densely deployed in the sensingarea.
- Sensor nodes are homogeneous in energy level.
- A mobile node work as anchor node and do not limit toenergy.

IV PRESENT METHOD

In this section, a range-based iterative distributed localization method has been proposed. In this work, we categories all the sensor nodes into two types viz. anchor (blue plus sign) and non-anchor node (red circle) shown in figure 4.2. Initially, non-anchor nodes are localized using multilateration technique. After that, an iterative mechanism is used to localize remaining non-anchor nodes progressively. Nodes with less connectivity (less than three neighbors) are localized using a mobile beacon. The proposed method consists three phases: Initial, progressive and mobile. In the first phase, nodes with more than two anchor neighbors are localized using multilateration. In the second phase, localized non-anchor nodes are used as a pseudo-anchor for nodes localization. These pseudo-anchor broadcast their coordinates in proximity. On reception of coordinates, non-localized nodes localize themselves using multilateration. In the last phase, a mobile anchor node moves dynamically and broadcast its position for node localization.

Phase 1: **Initial phase:** At the very beginning, all the anchor nodes initially broadcast their Position beacon packets within communication range. This beacon packet consists of the anchor node location and the node ID. Once a non-anchor node receives the beacon packet, it stores the beacon location along with the RSSI value. After receiving beacon packet from minimum three anchor nodes, each non-anchor sensor node calculates. Positional coordinates using the multilateration method. The distance between non-anchor and anchor is calculated through the RSSI value of the corresponding anchor node and its coordinates. Fig. 1 shows that the nodes with three anchor successfully localize themselves using multilateration. After that, broadcast computed coordinates within communication range.

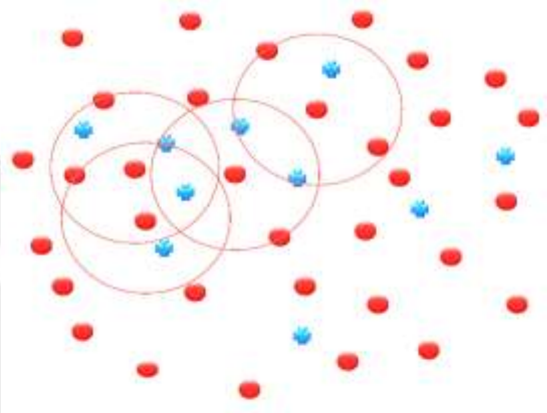


Fig 1 Initial phase localization.

Phase 2: Iterative phase: In this phase, non-anchor nodes are localized using already localized neighbors. This is an iterative phase in which each non-anchor node wait for three beacon packet, as soon as it gets required a number of the packet, computes their coordinate using multilateration. After that, broadcast coordinates which help to other neighbor nodes to compute their location coordinates.

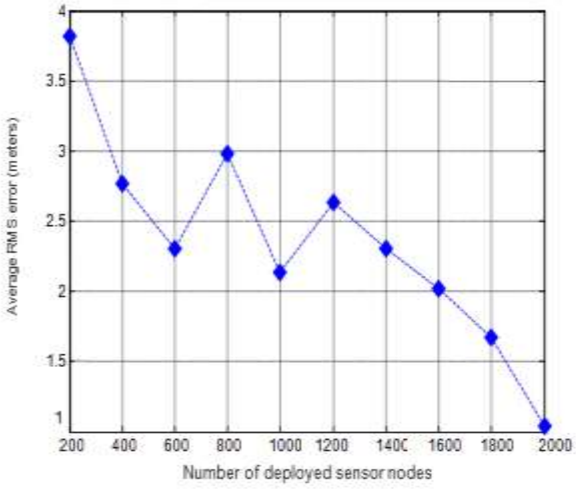
Phase 3: Mobile phase: A non-anchor with less connectivity is not able to compute their location. To solve this problem we used a mobile node as an anchor, which moves dynamically in field and periodical broadcast location coordinates.As soon as non-anchor node get three beacon packet from the static or moving anchor, it computes position coordinate. The selection of beacon coordinates depend on the RSSI value degrades localization accuracy. The topological arrangement of the node is not a constraint. Hence, the all beacon packet considers for location computation. Localized non-anchor nodes may also use new position coordinates to update their estimated location.

V SIMULATION RESULT

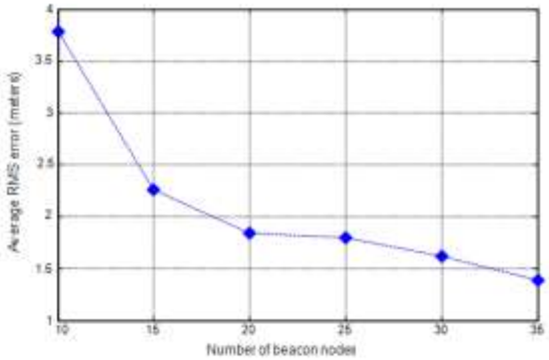
We simulate a network of sensors in a 400m×400m sensing field. There are four hundred sensor nodes (n = 400) and they are randomly distributed in the field. For doing this, the vertical and horizontal coordinates on every sensor are randomly taken between 0 and 400. The beacon nodes are also randomly distributed. This is a distributed approach; it does not need interruption of sink node. The mobile node can move randomly within sensing field with maximum speed up to fifteen meters per second.

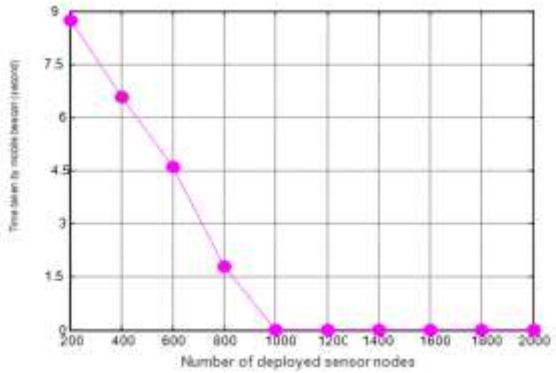
(a) Number of deployed nodes in the field

To observe the performance of proposed approach, we simulate with anchor nodes as 10% of the total node, deployed area 400m ×400m, node communication range is taken as 10% of deployed area. The error in the distance is considered as 10% of the respective distance.

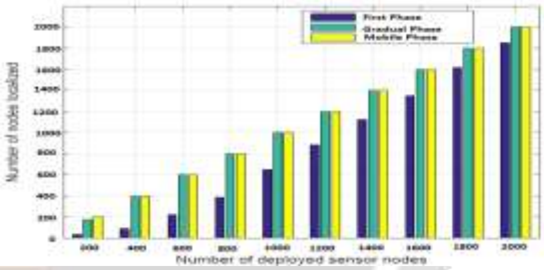


(a) Average RMS





(b) Time for mobile node



(c)Number of node localized

Figure 2 Number of node localized with total number of deployed nodes

(b) **Anchor nodes**

To observe the performance of proposed approach for varying anchor nodes, we deploy 400 sensor nodes in 400m ×400m area with 10 meters radio range. The error in the distance is considered as 10% of the respective distance.It is observed that the localization error decreases with increase in anchor nodes.

(c) Communication range

To observe the performance of proposed approach with varying connectivity, a different value of communication range has been taken for simulation. For this four hundred sensor nodes with beacon nodes as 10% of the total node are deployed in 400m×400m area. The error in the distance is considered as 10% of the respective distance.It is observed that the localization error decreases with increase in communication range of the sensor nodes. This is because the probability of getting more anchor nodes as a neighbor is increased.

Figure 3 The performance of Present approach with anchor nodes

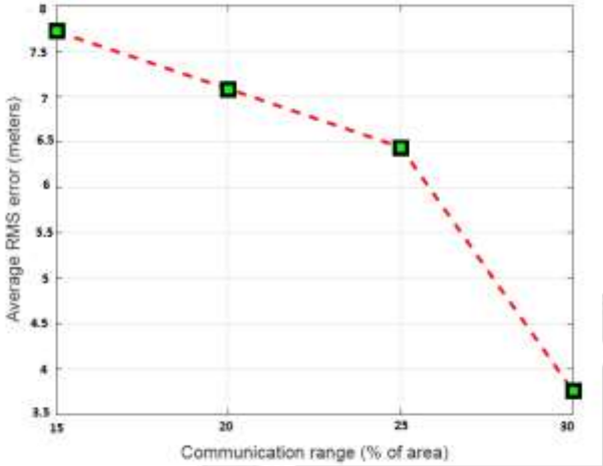


Figure 3 The performance of Present approach with varying communication range

(d) Deployed area

To observe the performance of proposed approach for scalability, different size of deployed area has been taken for simulation. For this four hundred sensor nodes with beacon nodes as 10% of the total node are deployed in sensing area. The communication range of a node is taken as 10% of deployed area. The error in the distance is considered as 10% of the respective distance. It has been observed that increase in deployed area increases the localization error drastically. It happened due to significant error increment in distance estimation.

(e) Error in distance estimation

To observe the performance of proposed approach for noise tolerance, a different value of measurement noise has been taken for simulation. For this four hundred sensor nodes with beacon nodes as 10% of the total node are deployed in 400m×400m area. The communication range of a node is taken as 10% of deployed area. It is observed that the localization error increases with increase in measurement error in distance estimation. This is because the probability of getting true distance decreases with measurement error. Although, error in distance estimation do not merely affect the time for localization some time significant variation in RSSI decreases the node connectivity cause fewer nodes localized in the initial phase. Due to this time required for the mobile node is vary for different value of errors.

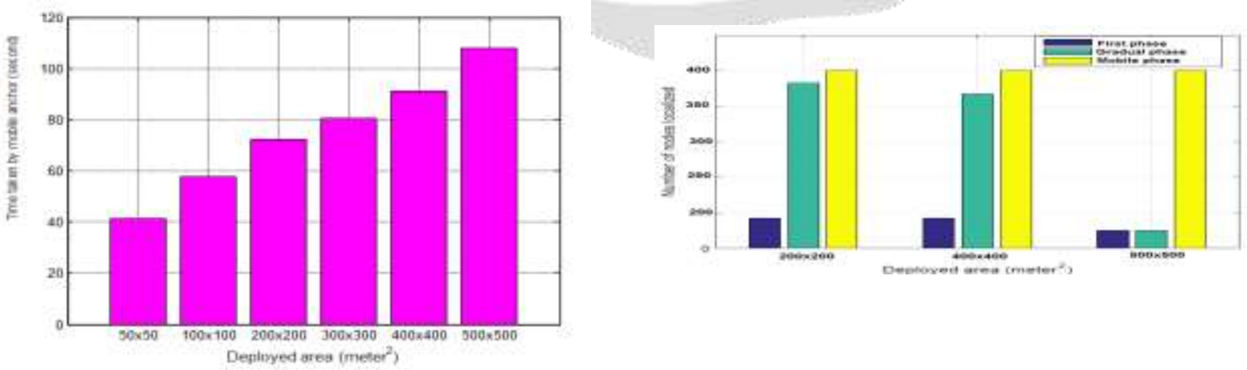


Figure 4 The performance of present approach with deployed area

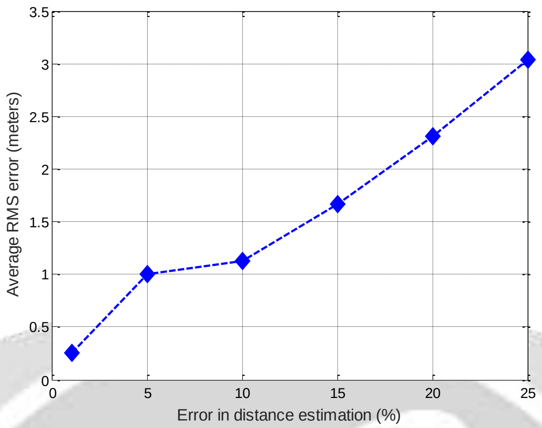
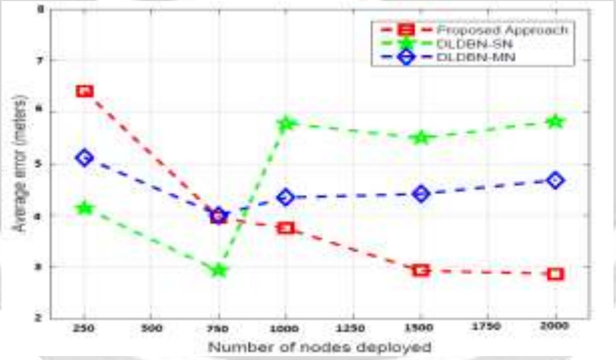


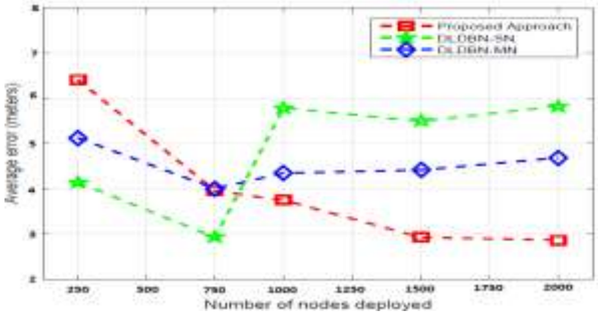
Figure 5. The performance of present approach with varying error in distance estimation

(f) Performance comparison

In this section, we compare the performance of proposed approach with other existing techniques. The Distributed Localization using a Dynamic Beacon Node (DLDBN) [42] taken two scenarios for performance analysis. In the first scenario, the static anchor is considered for localization and in second, mobile nodes as taken as anchor nodes for localization. We simulate the present approach with same parameters used in [42]. It has been observed that the increase in node density decrease error in localization in all three techniques. It is also observed that increase in deployed area increases localization error.



(a) Area 300x300 m^2



(b) Area 500x500 m^2

(g) Conclusion

In this dissertation, we Present a new localization algorithm Gradual localization with dynamic Path Planning (GLDPP).to localize sensor nodes with less error while managing time and reliability for node localization. The GLDPP is a progressive localization based on mobile anchor node, consist initial, progressive and mobile phases. Firstly, sensor nodes with more than two anchor nodes in the neighborhood are localized using multilateration. After that, in progressive phase, nodes are localized in an iterative fashion. Nodes with less connectivity still not localized because multi lateration needs at least three anchors or pseudo-anchor for location computation. In GLDPP, a mobile anchor moves randomly in sensing field and broadcast their coordinates which enable nodes with low connectivity to localize themselves. In GLDPP, sensor nodes compute coordinates itself independently which in not centralized unlike [4] where global knowledge of the network topology is required. GLDPP is very simple to implement in the short range sensor nodes.

REFERENCES

[1] Mustafa Ilhan Akbas, Melike Erol-Kantarc_, and Damla Turgut. Localization for wireless sensor and actor networks with meandering mobility. IEEE Transactions
on Computers, 64(4):1015{1028, 2015.
[2] Ian F Akyildiz, Dario Pompili, and Tommaso Melodia. Underwater acoustic sensor networks: research challenges. Ad hoc networks, 3(3):257{279, 2005.
[3] Ian F Akyildiz, Weilian Su, Yogesh Sankara subramaniam, and Erdal Cayirci. Wireless sensor networks: a survey. Computer networks, 38(4):393{422, 2002.
[4] Cesare Alippi and Giovanni Vanini. A rssi-based and calibrated centralized localization technique for wireless sensor networks. In Pervasive Computing and Communications Workshops, 2006. PerCom Workshops 2006. Fourth Annual IEEE International Conference on, pages 5{pp. IEEE, 2006.
[5] Nabil Ali Alrajeh, Maryam Bashir, and Bilal Shams. Localization techniques in wireless sensor networks. International Journal of Distributed Sensor Networks, 2013, 2013.
[6] Isaac Amundson and Xenofon D Koutsoukos. A survey on localization for mobile wireless sensor networks. In Mobile Entity Localization and Tracking in GPS-less Environnments, pages 235{254. Springer, 2009.
[7] MS Aruna, R Ganesan, and A Pravin Renold. Optimized path planning mechanism for localization in wireless sensor networks. In Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), 2015 International Conference on, pages 171{177. IEEE, 2015.
[8] Azzedine Boukerche, Horacio ABF Oliveira, Eduardo F Nakamura, and Antonio AF Loureiro. Localization systems for wireless sensor networks. IEEE wireless Communications, 14(6), 2007.
[9] Nirupama Bulusu, John Heidemann, and Deborah Estrin. Gps-less low-cost outdoor localization for very small devices. IEEE personal communications, 7(5):28{34, 2000.
[10] Vijay K Chaurasiya, Neeraj Jain, and Gora Chand Nandi. A novel distance estimation approach for 3d localization in wireless sensor network using multi dimensional scaling. Information Fusion, 15:5{18, 2014.
[11] Long Cheng, Chengdong Wu, Yunzhou Zhang, Hao Wu, Mengxin Li, and Carsten Maple. A survey of localization in wireless sensor network. International Journal of Distributed Sensor Networks, 2012, 2012.
[12] Jose A Costa, Neal Patwari, and Alfred O Hero III. Distributed weighted- multidimensional scaling for node localization in sensor networks. ACM Transactions on Sensor Networks (TOSN), 2(1):39{64, 2006.
[13] Juan Cota-Ruiz, Pablo Rivas-Perea, Ernesto Sifuentes, and Rafael Gonzalez-Landaeta. A recursive shortest path routing algorithm with application for wireless sensor network localization. IEEE Sensors Journal, 16(11):4631{4637, 2016.
[14] Kevin A Delin. The sensor web: A macro-instrument for coordinated sensing.Sensors, 2(7):270{285, 2002.
[15] Deepak Ganesan, Ramesh Govindan, Scott Shenker, and Deborah Estrin. Highly resilient, energy-e_cient multipath routing in wireless sensor networks. ACM SIGMOBILE Mobile Computing and Communications Review, 5(4):11{25, 2001.
[16] Di He. A novel wireless sensor networks multilateration positioning method based
on quartic double-well bistable stochastic resonance technique. Nonlinear Theory and Its Applications, IEICE, 8(1):49{57, 2017.
[17] Mohamed Hefeeda and Majid Bagheri. Wireless sensor networks for early detection of forest fires. In Mobile adhoc and sensor systems, 2007. MASS 2007. IEEE international conference on, pages 1{6. IEEE, 2007.

[18] Wendi B Heinzelman, Anantha P Chandrakasan, and Hari Balakrishnan. An application-specific protocol architecture for wireless microsensor networks. IEEE Transactions on wireless communications, 1(4):660{670, 2002.
[19] Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan. Energy efficient communication protocol for wireless microsensor networks. In System sciences, 2000. Proceedings of the 33rd annual Hawaii international conference on, pages 10{pp. IEEE, 2000.
[20] Jeffrey Hightower and Gaetano Borriello. Location systems for ubiquitous com-puting. Computer, 34(8):57{66, 2001.
[21] Xiang Ji and Hongyuan Zha. Sensor positioning in wireless ad-hoc sensor networks using multidimensional scaling. In INFOCOM 2004. Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies, volume 4, pages 2652{2661. IEEE, 2004.
[22] Philo Juang, Hidekazu Oki, Yong Wang, Margaret Martonosi, Li Shiuan Peh,and Daniel Rubenstein. Energy-e_cient computing for wildlife tracking: Design tradeoffs and early experiences with zebranet. In ACM Sigplan Notices, volume 37,pages 96{107. ACM, 2002.
[23] Holger Karl and Andreas Willig. Protocols and architectures for wireless sensor networks. John Wiley & Sons, 2007.
[24] Brad Karp and Hsiang-Tsung Kung. Gpsr: Greedy perimeter stateless routing for wireless networks. In Proceedings of the 6th annual international conference on Mobile computing and networking, pages 243{254. ACM, 2000.