Journal of Analysis and Computation (JAC)
(An International Peer Reviewed Journal), www.ijaconline.com, ISSN 0973-2861
Volume XVII, Issue II, July-Dec 2023

Novel Self Localization Procedure for Wireless Sensor Networks

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Abstract: In this paper, a novelself-localizationprocedure for wireless sensor networks is accessible. Due to errors in calculatinguniversal coordinates andinappropriate relative pairwise distance assessment, the errors in the appraisal of localization mayhappen. Minimization of these errors is necessary for effectivelocalization arrangements.In irregular or sparse networks, the earlier proposed DV-Hop positioning procedureshows poor accuracy and not effective. To avoidthe weaknesses of this procedure,in this work anenhanced DV-Hop procedure for self- localization (EDVHPSL) is proposed.The anticipatedEDVHPSLmethoddelivers improvement in results in relations of localization error. MATLAB simulations have been performed to implement the proposed EDVHPSLby changing the benchmark parameters during simulation process. The parameters are number of beacon nodes, range, number of sensor nodes and hop count.

Keywords:Range, Wireless Sensor Network (WSN), Sensor Node, Beacon nodes, Minimization.

1.INTRODUCTION

In WSNs, the sensor nodes are deployed in an unplanned infrastructure where there is no prior knowledge of location. The problem of estimating the spatial coordinates of a sensor node (relative or absolute) is referred to as localization [1]. It is a term used to define the process of finding the geographic location of the sensor nodes in a coordinate system. The sensor nodes must be localized in space in order to identify the location of an event. The positioning of sensor nodes is accomplished using a localization system which is a key part of WSNs. Localization systems not only help to locate events but can also be used as a base for routing, density control, tracking, and network protocols. The straightforward localization approach gathers the information (e.g. connectivity or pair-wise distance measurement) about the entire network into one place, where the collected information is processed to estimate the location of sensor nodes [2]. Localization is an unavoidable challenge when dealing with WSNs and an important problem because many of the sensor network protocols and applications simply suppose that all sensor nodes in the network are aware of their individual locations. Secondly, if a sensor node is reporting a critical event or data by means of geographical routing technique, the location of individual sensor nodes must be known in prior [3].

Existing localization algorithms [4] estimate the locations of sensor nodes either by using knowledge of the positions of a few sensor nodes or their inter-sensor node measurements such as distance and angle. Sensor nodes with known location information are called anchors or beacons and their locations are obtained by using a GPS, or by their manual placement at points with known coordinates. While the GPS is one of the most popular technique and is widely accessible, the high cost, high energy consumption and restricted indoor usage makes it difficult for WSNs. Limitation of size, battery and hardware resources of sensor nodes prohibits the use of GPS hardware in every sensor node. The various localization methods have their own merits and demerits and their performance also depend on many other factors like, accuracy, coverage, complexity, scalability, robustness, fault tolerance, cost and energy.

1.1 Self Localization

Localization is a mechanism to establish spatial relationships between sensors in a wireless or wired sensor network. Many of these sensor network systems are embedded to monitor or control the behavior of physical systems (as compared with strictly virtual information systems), and therefore sensor nodes often need to determine their action based on their physical location. Networked applications are often implemented in the form of a layered network protocol stack and localization benefits span several layers of the protocol stack. Several issues render the localization problem more challenging for large scale, densely distributed sensor networks than in many other domains. Sensor networks must satisfy several physical constraints. Wireless sensor network consists of a large number of various mini integrated self powered sensor nodes, these nodes communicate wirelessly with neighboring nodes to form a wireless sensor network. The process of computing the physical locations of nodes in a wireless sensor network is known as localization, self localization becomes critical for large scale sensor networks because manual deployment is often impractical due to time requirements, economic constraints or inherent limitations. The spatial relationship of these sensors is typically an important factor and introduces a new challenge for the researchers working in this area.

1.2 Existing DV-Hop Positioning AlgorithmError Analysis

Errors in localization estimates can result from incorrect estimates of relative pairwise distances and errors in global coordinate calculations. These errors must be minimized for effective localization planning. Existing DV-Hop positioning algorithm is one of the representative algorithms of band-less localization technology [5, 6]. The main idea is to express the distance between the unknown sensor node and the beacon node as the product of the hop distance and the number of hops. Implementation of the algorithm consists of three steps.

In the first step, each beacon node transmits location information to all neighboring sensor nodes. At this time, the hop count is initialized to 0, and each receiving sensor node maintains the beacon node information and the minimum hop count value for each beacon. In the second step, once the sensor node has a relative hop count value to other beacons, it estimates the hop size for a single hop and then broadcasts it throughout the network. According the following equation (1), the hop size is estimated.

$$SizeHop_i = \frac{\sum \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}}{\sum s_{ij}} \quad (1)$$

wherever, s_{ij} is the total number of hops between the beacon nodes and $(x_i, y_i)$and (x_j, y_j) are the coordinates of beacon node *i* and *j*. In the last step, when the unknown sensor node receives 3 or more distance estimates from the beacon node, it calculates its position using trilateration.

2. ENHANCED DV-HOP PROCEDURE FOR SELF- LOCALIZATION (EDVHPSL)

The DV-Hop positioning algorithm has low accuracy and performs poorly in sparse or irregular networks. Considering the drawbacks of this algorithm, efforts were made to improve it and EDVHPSL is proposed. The assumptions taken into account for EDVHPSL are described in the following steps.

(a) Statistics Broadcasting

Each guidance node transmits position information to neighboring sensor nodes with a hop count initialized to one. The format of the broadcast information is (idi, xi, yi, sHopi), where idi is the ID of the beacon node and (xi, yi) are its coordinates. Each receiving sensor node maintains a record of the information received from the guidance node. If a sensor node receives a packet with the same ID, then it compares the sHopi of the packet and if the new sHopi is smaller than the already received sHopi table, it is considered to be otherwise dropped and the packet is no longer forwarded. Each sensor node will increase sHopi by one before transmitting it to other neighboring sensor nodes

(b)**: Calculation of Distance**

As per equation (1), the hop size is calculated to estimate the distance between the beacon node and unknown sensor node.

The average hop size is calculated as per equation (2).

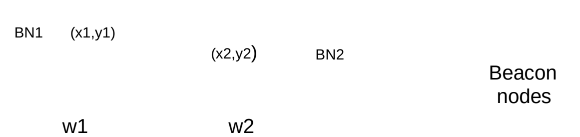
$$SizeHope_{avg} = \frac{\sum SizeHop_i}{Nos.of\ HopSize} \qquad (2)$$

As per equation (3), the distance W_i betweenthe beacon node and unknown sensor node is considered by multiplying by its hop count with the average hop size

$$W_i = SizeHop_{avg} \times Hopcount_i \qquad (3)$$

Step 3: Calculation of Location

According to the distance information obtained with respect to the beacon nodes of the unknown sensor node, the unknown node calculates its coordinates using trilateration as depicted in Fig. 1.



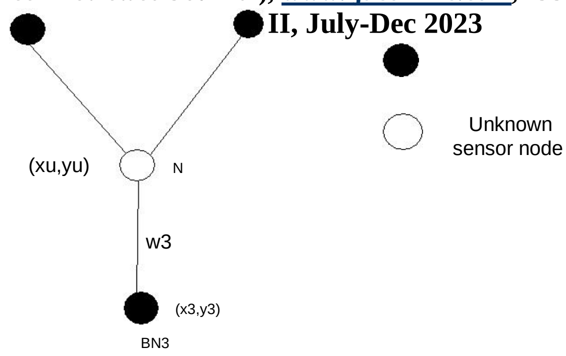


Fig.1 Trilateration method based calculation

Step 4: Assessment of localization error

Using equation (4), the localization error can be modestlypredictable.

$$E_i = \frac{\sum \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}}{L} \qquad (4)$$

Where, (x_i, y_i) and (x_j, y_j) are the coordinates of beacon node *i* and *j*. and L is the communication range.

The algorithm of the proposed EDVHPSL is as follows;

Steps: Algorithm: EDVHPSL

1: **START**

2: Area A is used to deploy sensor nodes

3: Nos.of beacon nodes =*BN* are defined

4: Position of beacon nodes acquires

5: BN coordinates are (x_i, y_i) then send this positions to all adjoining sensor nodes

6: Hop count will be compared

7: Case 1**:** hop count is lessassent the position packet acknowledged from the beacon

8: Case2: Else, discard

9: Wait for more position packets, appraisal the hop size between beacon node *BN* and *N*

10: Determine$SizeHope_{avg} = \frac{\sum SizeHop_i}{Nos.of\ HopSize}$

11: Refer$SizeHope_{avg}$to all neighbours

12: Estimate$W_j = s_j \times SizeHop_{avg}$

13: Unknown sensor node position is computed

14: Determine$E_i = \frac{\sum \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}}{L}$

15: END

3. EDVHPSLSIMULATION RESULTS

EDVHPSL is realized in MATLAB7, and to verify the performance of the proposed algorithm, 500 nodes (beacon nodes = 100 and sensor nodes = 400) are randomly distributed in a 100m x 100m area. All nodes (beacons and sensor nodes) have an adjustable communication range L. The layout of beacon nodes and sensor nodes is shown in the fig. 2

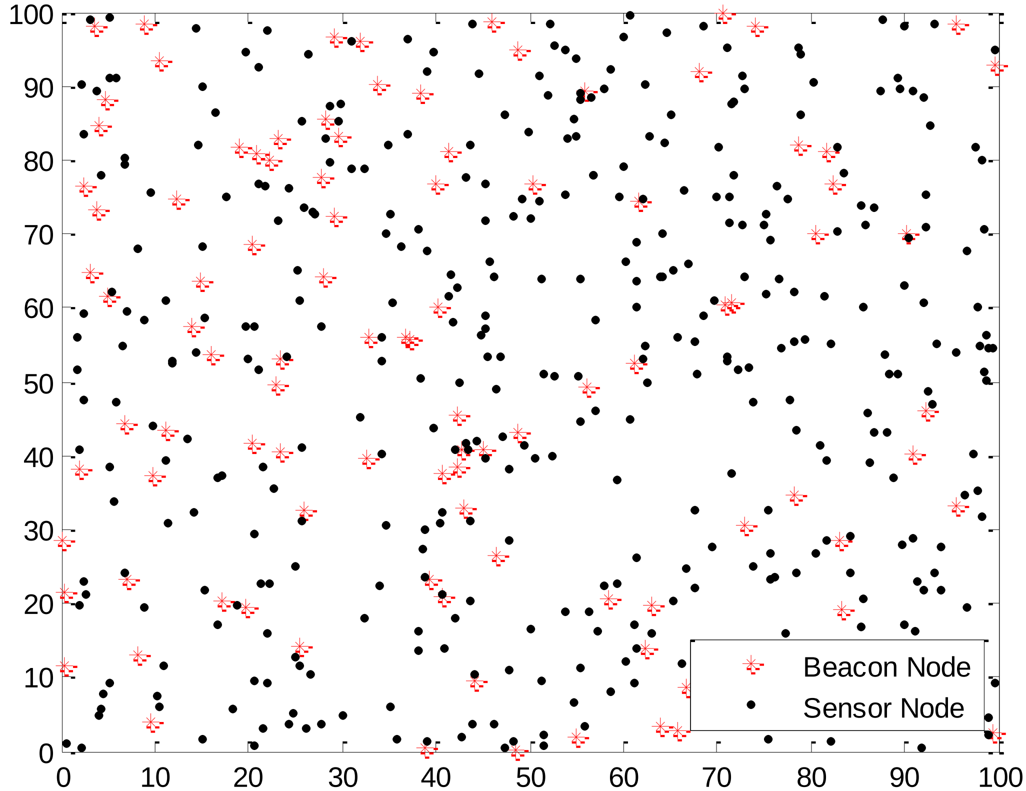


Fig. 2: Deployment randomly sensor nodes and beacon nodes

Simulations has been done by variationsin number of beacon nodes and communication range. The enactment of the DV-Hop positioning procedure and the proposed EDVHPSL are matched.

3.1COMMUNICATION RANGEVARYING EFFECT

Observance the number of beacon nodes = 100 and the number of sensor nodes = 400, the communication range is changed to 80m, 70 m, 60 m, 50 m, 40 m, 30 m,20 m, and 10 m, and the performances of DV-Hop and proposed EDVHPSL positioning algorithm are analysed. . It can be seen from Fig. 3that the localization error of EDVHPSL is lower than that of the DV-Hop positioning algorithm. The reasons for the low errors are due to the fact that at the maximum communication range (80 m) most nodes are able to directly communicate with each other in a simpler way.

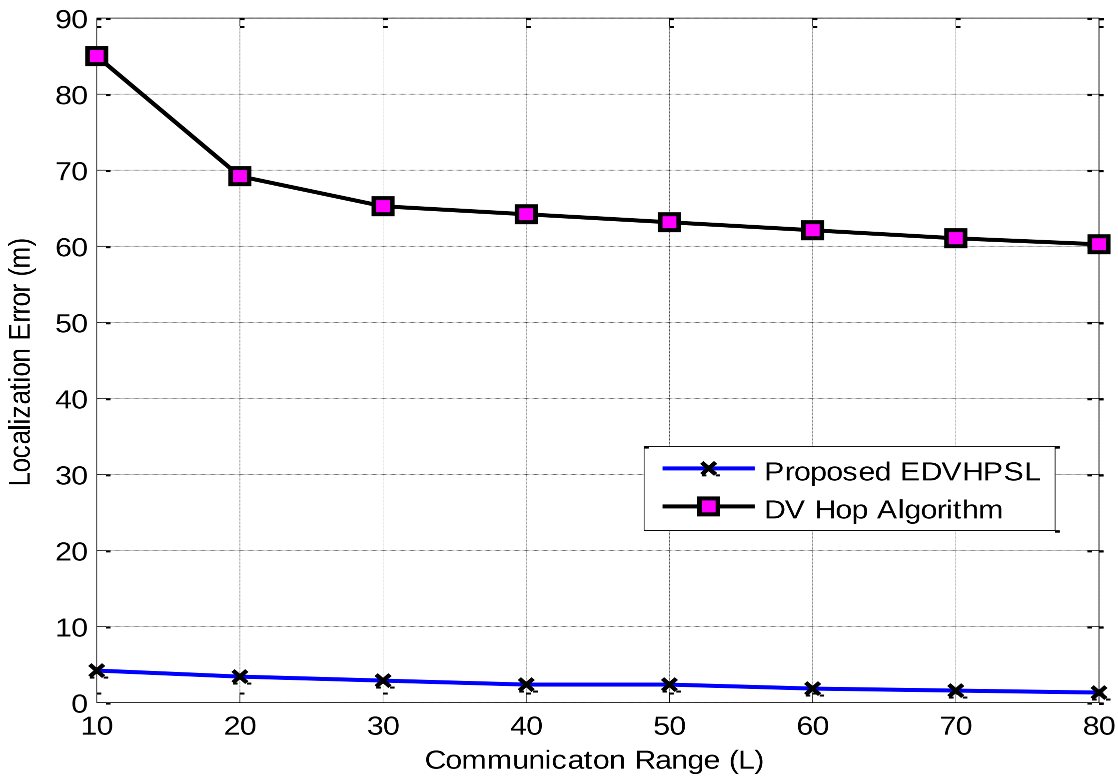


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Fig.3: Localization error verses communication range

3.2 BEACON NODESVARYING EFFECT

Number of beacon nodes are changed to 100, 90, 80, 70, 60, 50, 40, 30, 20 and 10 while keeping L = 50 m, simulations are performed for DV-Hop and EDVHPSL positioning algorithm. Fig. 4 depicts that the localization error of the proposed EDVHPSL is lower than that of the DV-Hop positioning algorithm, if the beacon nodes are increased.

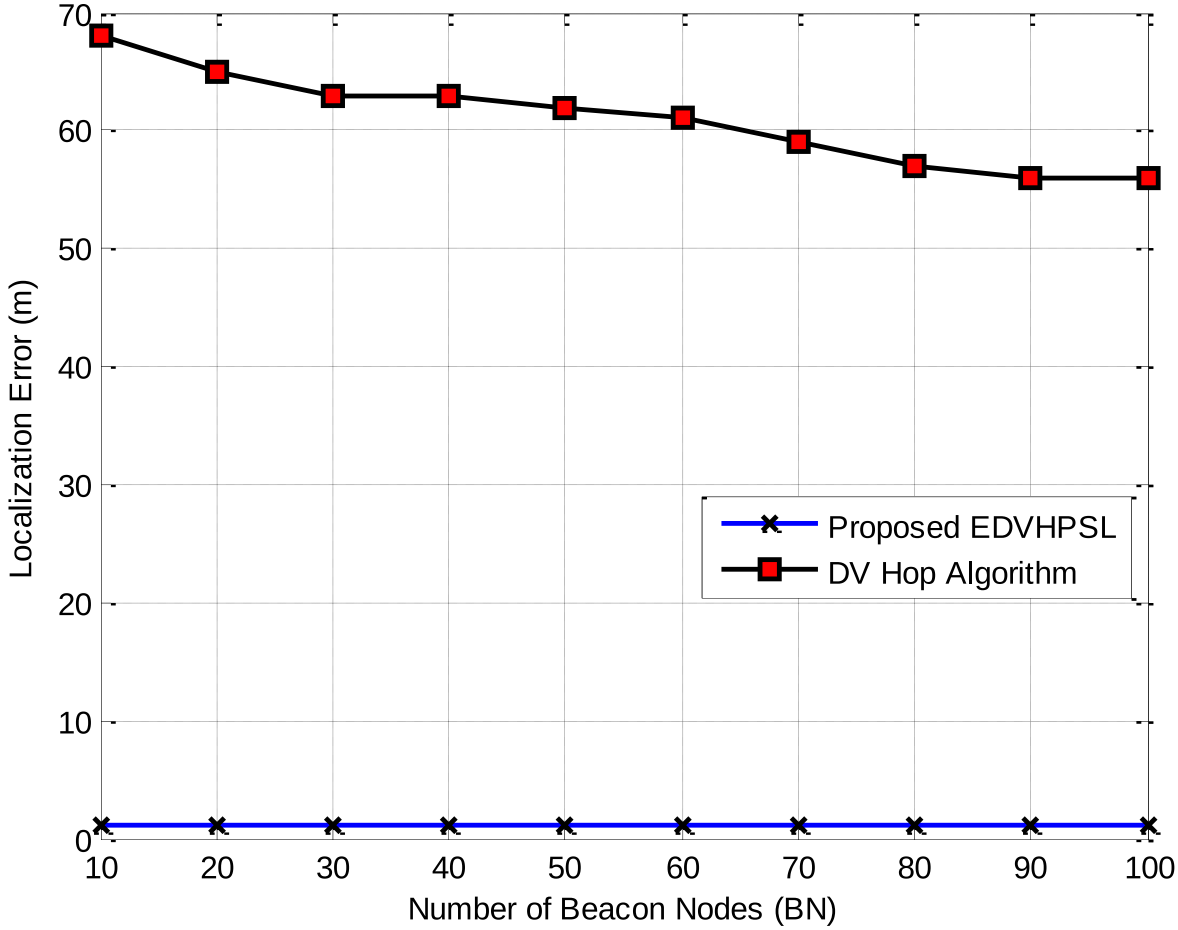

Fig. 4 Localization error verses beacon nodes

4. CONCLUSIONS

In this paper, the causes for the localization error in the existing DV-Hop positioning algorithm were described and an enhanced DV-Hop positioning algorithm is proposed. The proposed EDVHPSL technique, which is a amendment in the DV-Hop positioning algorithm, deliversupgraded results in terms of localization error. During the simulation process,EDVHPSL is implemented by alteringessential parameters named as hop count, range, number of beacon nodes, and number of sensor nodes.

5. REFERANCES

[1] H. Liu, M. Bolic, A. Nayak and I. Stojmenović, "Taxonomy and Challenges of the Integration of RFID and Wireless Sensor Networks," IEEE Network, Vol. 22, No. 6, pp. 26 – 35. (2008)

[2] N. Bulusu, J. Heidemann, and D. Estrin, "GPS-less low cost outdoor localization for very small devices," IEEE Personal Communication, Vol. 7, pp. 28-34. (2000)

[3] C. Savarese, J. Rabaey, and J. Beutel, "Location in distributed ad-hoc wireless sensor networks," In Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing, Vol. 4, pp. 2037-2040. (2001)

[4.] Santar Pal Singh and S. C. Sharma, "A modified DV-Hop algorithm for wireless sensor network localization," Int. J. Communication Networks and Distributed Systems, Vol. 21, No. 2, 2018.

[5.] Fengrong Han, Izzeldin Ibrahim Mohamed Abdelaziz, Xinni Liu and KamarulHawariGhazali, " An Enhanced Distance Vector-Hop Algorithm using New Weighted Location Method for Wireless Sensor Networks," (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 11, No. 5, pp 486-495, 2020.

[6.] Qihong Tao and Linghua Zhang, "Enhancement of DV-Hop by weighted hop distance," IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), pp. 1577-1580.(2016)

[7.] M. Wu, L. Zhong, L. Tan and N. Xiong, "The Sequential Fusion Estimation Algorithms Based on Gauss-Newton Method Over Multi-Agent Networked Systems," in IEEE Access, vol. 8, pp. 114315-114329, 2020.

[8] C. Y. Chang, C. Y. Lin and C. T. Chang, "Tone-Based Localization for Distinguishing Relative Locations in Wireless Sensor Networks," IEEE Sensors Journal, Vol. 12, No. 5, pp. 1058 – 1070. (2012)

[9] W.Z.Q. Yin, H. Chen, F. Gao and N. Ansari, "Distributed Angle Estimation for Localization in Wireless Sensor Networks," IEEE Transactions on Wireless Communications, Vol. 12, No.2, pp. 527 – 537. (2013)

[10] M. E. Kantarci, H.T. Mouftah and S. Oktug, "A Survey of Architectures and Localization Techniques for Underwater Acoustic Sensor Networks," IEEE Communications Surveys & Tutorials, Vol.13, No. 3, pp. 487 – 502. (2011)

[11] Q.S.C. He, H. Chen and L. Jiang, "Distributed Wireless Sensor Network Localization Via Sequential Greedy Optimization Algorithm," IEEE Transactions on Signal Processing, Vol. 58, No. 6, pp. 3328 – 3340. (2010)

[12] I.F. Pu Wang Akyildiz, "Spatial Correlation and Mobility-Aware Traffic Modeling for Wireless Sensor Networks," IEEE/ACM Transactions on Networking, Vol. 19, No. 6, pp.1860 – 1873. (2011)

[13] N. Salman, M.Ghogho and A.H. Kemp, "Optimized Low Complexity Sensor Node Positioning in Wireless Sensor Networks," IEEE Sensors Journal, Vol. 14, No. 1, pp. 39 – 46. (2013)

[14] D. Estrin, L. Girod, G. Pottie, and M. Srivastava, "Instrumenting the world with wireless sensor networks," In Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing, Vol.4, pp.2033 -2036. (2001)

[15] R. John Stephen, K. Rajanna, VivekDhar, K. G. Kalyan Kumar and S. Nagabushanam, "Thin film strain gauge sensors for ion thrust measurement," IEEE Sensors Journal, Vol.4, No.3, pp. 373-377. (2004)

[16] [4] J. N. Al Karaki and A. E. Kamal, "Routing Techniques in Wireless Sensor Networks: A Survey," IEEE Journal of Wireless Communications, Vol. 11(6), pp. 6-28. (2004)

[17] D. Puccinelli and M. Haenggi, "WSN: Applications and Challenges," IEEE Circuits and Systems Magazine (CAS), pp.19-29, September (2005)
[18] F. Wang and J. Liu, "Networked Wireless Sensor Data Collection: Issues, Challenges, and Approaches," IEEE Communications Surveys & Tutorials, Vol. 13, No. 4 , pp. 673 – 687. 2011
[19] V.C. Gungor, Bin Lu and G.P. Hancke, "Opportunities and Challenges of Wireless Sensor Networks in Smart Grid," IEEE Transactions on Industrial Electronics, Vol. 5 , No. 10, pp. 3557 – 3564. (2010)
[20] W. Dong, C. Chen, X. Liu and J. Bu, "Providing OS Support for Wireless Sensor Networks: Challenges and Approaches," IEEE Communications Surveys & Tutorials, Vol. 12 , No. 4, pp. 519 – 530, (2010)
[21] S. Guolin, C. Jie, G. Wei and K.J.R. Liu, "Signal processing techniques in network-aided positioning: a survey of state of the art positioning designs," IEEE Signal Processing Magazine, Vol. 22 (4), pp.12-23. (2005)
[22] Y. Charfi, N. Wakamiya and M. Murata, "Challenging issues in visual sensor networks," IEEE Wireless Communications," Vol. 16, No. 2, pp. 44 – 49. (2009)
[23] M. Conti, J. Willemsen and B. Crispo, "Providing Source Location Privacy in Wireless Sensor Networks: A Survey," IEEE Communications Surveys & Tutorials, Vol. 15, No. 3, pp. 1238 – 1280. (2013)
[24] L. Lazos and R. Poovendran, "HiRLoc: High Resolution Robust Localization for Wireless Sensor Networks," IEEE Journal on Selected Areas in Communications, Vol.7, No.5, pp. 28-34. (2000)