Architectural Model of Localization in Multi-Scale Communication for Wireless Sensor Networks

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Abstract

There are several range-based localization algorithms that identify sensor's positions for different wireless sensor networks. In this paper we propose the approach that highlights a new method of localization scheme to achieve high localization accuracy in the presence of radio irregularity and obstacles effects for wireless sensor networks. We present the evaluation of complex localization scenario, by applying convex localization estimation algorithm with possible orientation of obstacle using Euclidean and Interior point algorithms for non-ideal transmission networks. It has been observed in the simulation results that the proposed scheme significantly improve the localization accuracy. The range-free localization algorithms evaluate the node ranging error accuracy in anisotropic networks to solve the localization inequalities problem when the feasible set is empty. Study demonstrates the simulation results for the effectiveness of this algorithm. Furthermore, this scheme evaluate infeasible points caused by a complex radio various rigid statistical analysis to validate the results.

Keywords: *Convex optimization Euclidean algorithms, Interior point algorithms, Localization, Mobile anchor, Wireless sensor network.*

1. Introduction

Localization is a process of finding location of the sensor nodes, which is very essential requirement for various reasons such as finding faulty node, re-configuration of the software or application requirements for target tracking etc. Numerous localization techniques have been proposed and implemented by various researchers [1], [2] in WSN. Localization techniques are basically divided into two categories (i) Range Based Localization and (ii) Range Free Localization [3]. The range based schemes estimate the distance between nodes for obtaining the node's location by using an additional hardware, where these types of protocol generate well-controlled events like light spots or sound waves in the network which is not economically feasible. On the other hand Range -free techniques do not estimate absolute distance, these types of protocols uses the radio connectivity to infer proximity, relative proximity, and location. These two localization categories have different trade-offs when both are considered by: hardware requirements, localization accuracy, communication overhead and the infrastructure [16].

The GPS (Global Positioning System) based localization techniques is one of the widely used method by most of the WSN applications like range to several satellites by evaluating the difference in the time of arrival (TOA) of signal from different satellites. Though GPS based localization scheme contains a soaring level of accuracy, but it considers that a line of sight exists among the devices to be localizes and satellites as well as the need of additional hardware which consumes the momentous power makes it infeasible in terms of economic viability and technical accuracy in various conditions. In contrast the basic approach in Range free Localization is on assumptions of close proximity by the radio connectivity of nodes.

This approach is applicable in various scenarios of WSN as it basically depends on radio connectivity. In recent past various range free localization techniques has been proposed by various researchers [12]. Many such correlated work is described in the section related Work. In various aspect due to power exhaustion of the nodes, animus interference, deployment failures or because of physical obstacles such as valley ,mountains, water or building a non connected or a WSN with obstacle synergy arises [4] [5] [15]. Among various other reasons to have obstacle in radio communication one of the obvious reason is a non-uniform distribution due to random deployment of WSN apart from other reasons of non - uniformity into network such as unbalanced power consumptions which leads communication failure between node to node , where most of the existing range free localization cease its accuracy.

In this proposed paper, Architectural Model of Localization in Multi-scale Communication for Wireless Sensor Networks it can achieve a high accuracy by introducing a mobile anchor node into an obstacle existence WSN. The node localization inequality is mapped as a convex optimization algorithm and a simulation is performed.

The rest of this paper is organized as follows. We discuss related work in Section 2. The Mobile Anchor assisted Localization and the convex optimization algorithm for localization is described in Section 3. Section 4 presents the Simulation Graphical user Interface and experimental results. Finally, Section 5 concludes this paper with some discussions on the future work.

2. Related Work

The research in WSN started in the 80s by DARPA [13]. The earlier sensor networks were used in the military application for example Sound Surveillance System (SOSUS). The various applications such as Physical security (Detecting intruders), Medical (Patients in a hospital, Habitat monitoring (Wildlife, plants), Environmental (Tracking forest fires, pollution, Smart buildings, Air traffic control and Surveillance, most of the applications require location of the sensor.

The TOA(Time of Arrival)[14] example GPS which uses a satellite constellation of at least 24 satellites with atomic clocks, where Satellites broadcast precise time and Estimate distance to satellite using signal TOA using Trilateration. The AOA(Angle of arrival)[15] uses antenna array to measure direction of neighbors , where special landmarks have compass + GPS, broadcast location and bearing is used and flood beacons, update bearing along the way then once bearing of three landmarks is known, it calculates the position.

The method, basic APIT scheme Anchors are location aware sensors in the sensor network. APIT employs area based approach to isolate triangular regions between beaconing nodes. Once the area is known the COG calculation is performed for the location. In the Range Free Schemes the Centroid Localization is a simple and easy to implement where nodes receive beacon from anchor nodes. In another method such as DV -Hop localization which maintains a running hop count from beacon nodes and finds the average hop length and finally using trilateration unknown nodes are localized. In Amorphous localization which is similar to DV-Hop algorithm except that different approach used to estimate the average distance of a single hop [13].

3. Proposed System

3.1 Mobile Anchor assisted localization

The preface of Mobile Anchor assisted localization is described in this section [6]. In wireless sensor networks, node can be determined by accepting the beacon signal from the one-hop anchor depending upon whether the node falls in the transmission range or not. The Anchor node can adjust its range according to the adjustment of transmission radius by tuning the transmission power [7]. The algorithm for the protocol assumes L level for transmission power and related transmission range ($t_{ri,\ \text{where}\ i}= 1\ldots$ L), for the Anchor nodes. It is being assumed that the location of the mobile anchor node is known either by GPS receiver or by any other means. While movement of Anchor nodes, it transmits the beacon signals uninterruptedly with the attachment of its ID, Current Status, Transmission Radius and Transmission Power by the variation of power level, as shown in figure number 2(b). Based on the information received from beacon the unknown position sensor node's effective parameters for its state or location can be evaluated as shown in Figure 2(c), 2(d), 2(e).

3.2 Localization Algorithm Using Convex optimization

In lack of isotropic properties and heterogeneity of devices the actual transmission range differs, because of this reason the communication are intervallic among the nodes in the instance when the nodes distance is within their superlative transmission radius. The other possibilities of communication of two nodes arise when the node's comparative distance is larger than their transmission range. The consequence of any localization algorithm limits its assurance for full coverage due to radio indiscretion and obstacles and hence yields to an infeasible solution [8]-[9].To achieve optimized localization accuracy in both the cases of wireless sensor network with an obstacle and without an obstacle, a narrative approach of Range Free Based Convex Method has been proposed.

TABLE 1 NOTATION AND ACRONYMS

s_p	Unknown position of sensor
c_p	Current Position of Mobile Anchor
t_r	Transmission radius of Mobile Anchor
r	Internal Radius

3.3 Formulation of Problem and Mapping with Convex Optimization:

Let C_p be the current position for the Mobile Anchor with transmission radius is t_r, and the unpredicted-positioned sensor receives beacon signals at position $S_{p,}$ It will be satisfying the equation number (1) else equation number (2). The unpredicted -positioned sensors can obtain a set of dissimilarity by varying transmission power levels of Mobile Anchor node at different positions S_p, should satisfy equation number (3).

$$||S_p - C_p|| \leq tr \qquad (1)$$

$$||S_p - C_p|| > tr \qquad (2)$$

$$r_i < ||S_p - C_p|| \leq tri \, , \ i = 1,2,\ldots\ldots\ldots,L \qquad (3)$$

Therefore Mobile Anchor assisted localization approach with multi-scale communication range can be mapped as a problem of a set of quadratic intolerance.

The localization approach based on the Mobile Anchor with variable transmission power can be successfully converted into the problem of solving a group of quadratic in tolerance (3). Whereas due to convoluted transmitted environment situation of set of intolerance may have a solution or it may not have a solution. For the scenario like network with obstacle in the boundary [10] and without obstacle a localization algorithm mapped as convex optimization is proposed, where the conceptualization of architecture checks the condition where, r < Mode (unknown position of sensor – Current Position of Mobile Anchor) < Transmission radius of Mobile Anchor and calculate the optimal position at circumference of a circle having center point as current location of MA and radius as an average of transmission radius of Mobile Anchor and Internal radius. Further non convex minimization for localization is estimated by estimate by equation number (4).

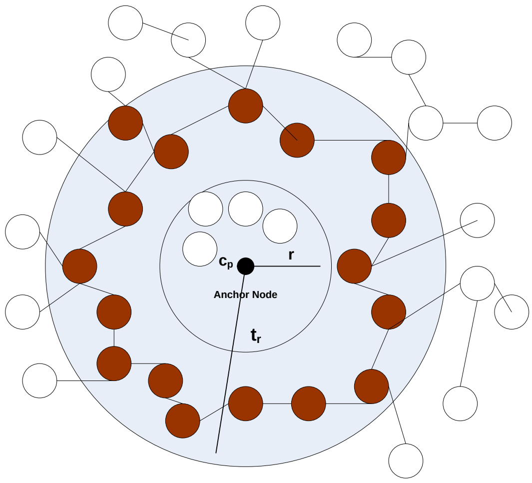
$$(||S_p - C_p|| - r)^2 + (||S_p - C_p|| - t_r)^2 \qquad (4)$$

The optimal localization is evaluated under the inequalities constraints by equation number (5). Min @ Sp for all i

$$\sum [(||S_p - C_p|| - r_i)^2 + (||S_p - C_p|| \, t_{ri})^2] \qquad (5)$$

The equation (5) remains a non-convex, which needs to be transforming as a problem of convex as it cannot be approximated by implementing convex relaxation techniques. The equation number is turned into a convex problem which is finally transformed to the epigraph as convex cone programming problem, which is being solved by Euclidian distance algorithm and interior point algorithm. The architectural network model is shown in Figure-(1).

The range free algorithm proposed in [11], author claims it as the only algorithm using convex optimization to solve the problem of localization when feasible set is empty. In this paper an addition possible orientation of obstacle is placed in simulation and simulation is performed with 100 nodes and two different algorithms Euclidian distance and interior point has been implemented with and without obstacles. The GUI is shown in section 4.



Node Not in Range of Anchor Node	Node in the Range of Anchor Node	Anchor Node

Fig -1 Architectural computational Model

4. Simulation Work

The simulation in this section proposed has been carried on Intel Pentium Dual Core E2160 CPU with 1.8 GHz and 2 GB RAM. The designed using Matlab 7.2 is considered where 100 sensor nodes will be distributed randomly with specific transmission radii (R) and transmission area (r) deployed for mobile anchor nodes.

The Simulation is preformed in the area of A X A with random deployment of 100 nodes as shown in figure number 2(a). The provision of changing anchor node transmission radius is provides with an initial value of 15.

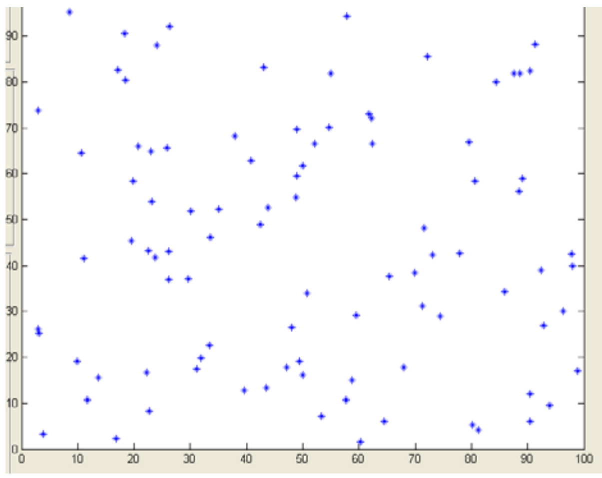


Fig -2(a) Deployment of the node (Network Deployment)

The Anchor node has been given a random path to move across the network as shown in Figure 2(b). The simulation is performed with both Euclidian distance and interior point with varying option of non- physical obstacle and with physical obstacle, which has been shown in Figure 2(c), 2(d), 2(e) and 2(f).

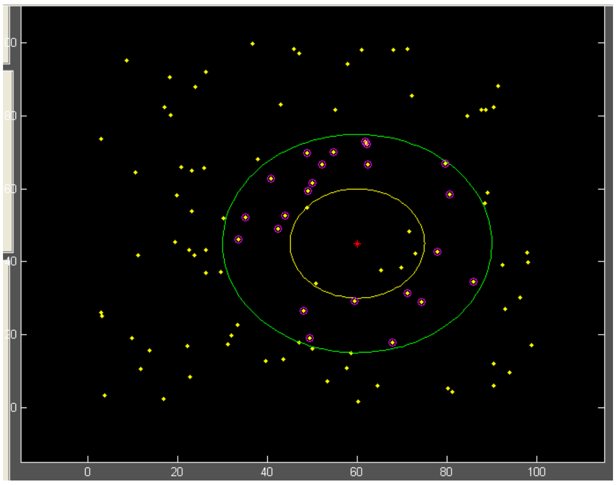


Fig - 2(b) Anchor Node Deployment

4.1 Simulation Scenario one:

The Euclidian Distance algorithm is implemented without obstacle as shown in the Figure-2(c) and the result set is shown in Table no 2.

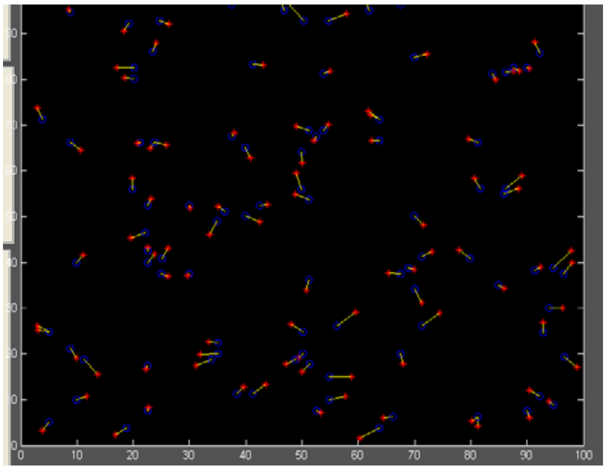


Fig -2(c): Localization using Euclidian Distance Algorithm without obstacle

TABLE 2

No. of Nodes	*Algorithm*	*Obstacle*	*Simulation Time (in Sec)*	*Localization error (%)*
100	Euclidian Distance	No	33.5013	0.14996

4.2 Simulation Scenario two:

The interior point algorithm is implemented without obstacle as shown in the Figure-2(d) and the result set is shown in Table no 3.

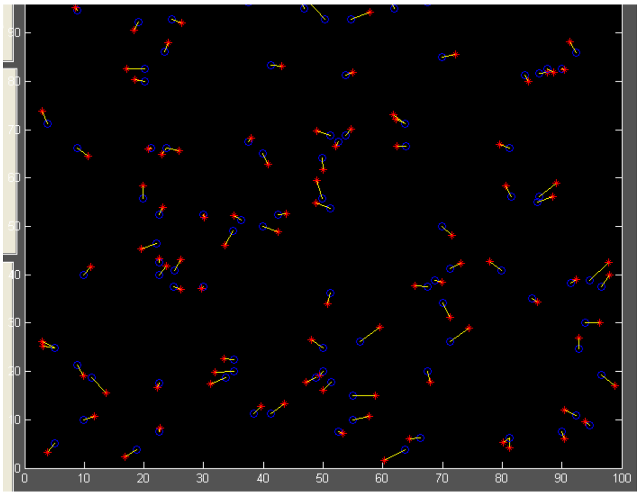


Fig -2(d): localization using interior distance algorithm without obstacle

TABLE 3

No. of Nodes	*Algorithm*	*Obstacle*	*Simulation Time (in Sec)*	*Localization error (%)*
100	Interior Point	No	10.2275	0.14997

4.3 Simulation Scenario three:

Implementation of Euclidian distance algorithm with obstacle at location of 40, 60 of size 20as shown in the Figure-2(e) and the result set is shown in Table no 4.

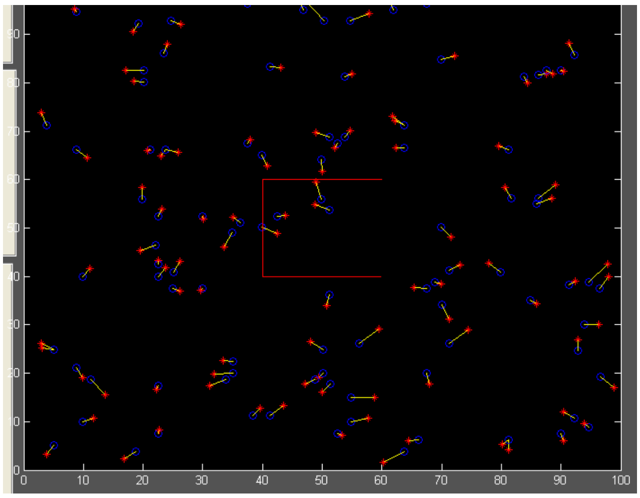


Fig -2(e): Localization using Euclidian distance algorithm with obstacle

TABLE 4

No. of Nodes	*Algorithm*	*Obstacle*	*Simulation Time (in Sec)*	*Localization error (%)*
100	Euclidian Distance	yes	34.1901	0.14996

4.4 Simulation Scenario four:

The interior point algorithm is implemented with the obstacle at location of 40,60 of size 20 as shown in Figure-2(f) and the result set is shown in Table no 5.

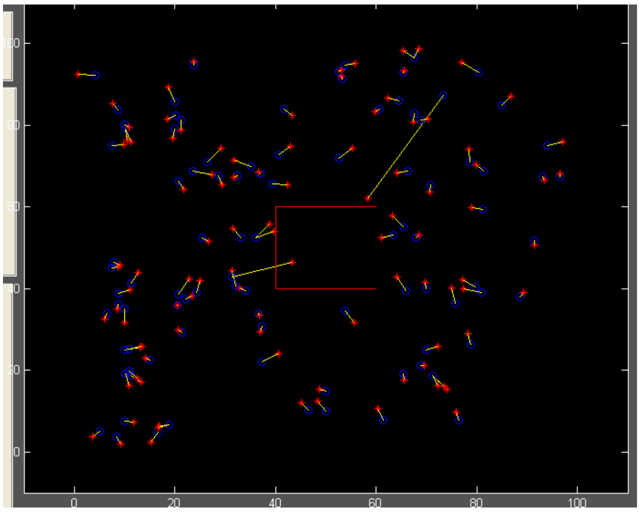


Fig -2(f): Localization using interior point algorithm with obstacle

TABLE 5

No. of Nodes	*Algorithm*	*Obstacle*	*Simulation Time (in Sec)*	*Localization error (%)*
100	Interior Point	yes	9.8746	0.18091

Graph generation for the %error for proposed method form the simulation data by Euclidian method with obstacle and without obstacle along with Interior point method with obstacle and without obstacle. The graph for all data is given in Figure-3(a).

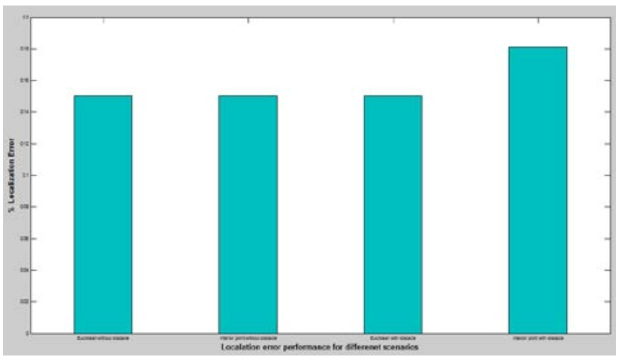


Fig 3(a): Localization error performance in different scenario

Graph generation for the simulation time (sec.) for proposed method form the simulation data by Euclidian method with obstacle and without obstacle along with Interior point method with obstacle and without obstacle. The graph for all data is given in Figure-3(b).

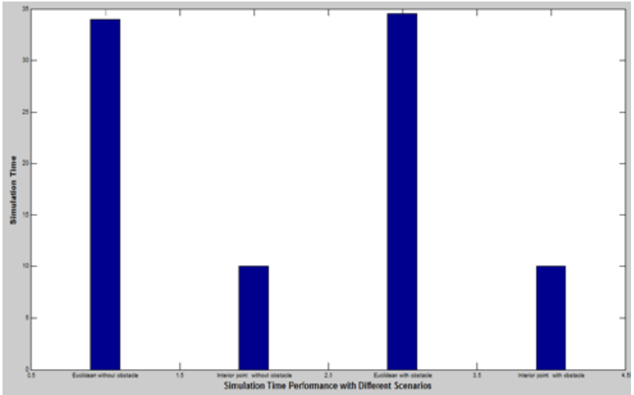


Fig 3(b): Simulation Time Performance with different scenarios

5. Conclusion and Future works

The mobility aided mobile anchor node based WSN in the presence of obstacles has been implemented for new accommodating localization system. A convex localization algorithm has been presented to address the effects of non-ideal transmission of radio signals. It has been shown in the simulation results that the proposed accommodative localization system can appreciably get better the localization accurateness by including a mobile element. In future work, we intend to verify and improve the proposed accommodative localization system using real sensors in a mobility assisted wireless sensor networks for the design of energy efficient architecture.

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PROFILE


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