LOCALIZATION BASED RANGE MAP STITCHING IN WIRELESS SENSOR NETWORK UNDER NON-LINE-OF-SIGHT ENVIRONMENTS

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Abstract

This paper presents the node localization of static blind sensor nodes and the mobile anchor nodes. Each of the sensor nodes determines its own position by itself is localization. Obstacles blocking between the direct path, called as Non-Line-Of-Sight (NLOS), which causes NLOS error. The propagation of this error results in unreliable localization and significantly decreases localization accuracy. It is an important research topic because position information is a major requirement in many WSN applications. In the latest literature, localization of NLOS error is carried out using Semi-Definite Programming (SDP). Localization algorithms are used to estimate the position information of nodes in wireless sensor networks (WSNs). In the proposed work, Range Map Stitching (RMS) algorithm is used to overcome the disadvantages of SDP. This method can provide good localization accuracy and energy efficiency by mitigating the effects of NLOS measurements.

Keywords: *Localization, Non-Line-of-sight, Range Map stitching, Wireless Sensor Network.*

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1. INTRODUCTION

Node localization is the process through which each of the sensor nodes determines its own position by itself. Gang Wang [9] WLS approach for RSS-based localization in sensor networks. The WLS solution is used as a starting point for any local search routine to find the corresponding ML solution. The proposed method is easily applied to indoor localization although the exact ML formulation for indoor localization is hardly obtained. Simulations in both outdoor and indoor environments confirm the effectiveness of this method. Stefano Marono [5] a novel approach deals with the non-line-of-sight propagation that relies on features extracted from the received waveform. This technique does not require formulation of explicit statistical models for the features. Validate the techniques in realistic scenarios and performed an extensive indoor measurement campaign using FCC-compliant UWB radios. Chao-Tsun Chang [3] the minimizing and balancing the location inaccuracies of all sensors can be reached. A path construction algorithm is proposed to construct a path passing through the beacon locations and minimize the anchor's movement. The proposed mechanism outperforms the Snake-Like and Random movements and hence obtains better results in terms of mean location error, localization efficiency and balance index. Paolo Pivato [8] the accuracy of indoor localization based on RSS measurements collected by a WSN. The noise component of the error is inversely proportional to the square root of the product of the anchor number and the regression coefficient of the channel propagation model.

The rest of the paper is organized as follows. In Section 2, we discuss the related work based on node localization under NLOS conditions used. In Section 3, proposed method is described in detail. In Section 4, RSS techniques are discussed in detail. In Section 5, Simulation results of Performance analysis for localization accuracy, bandwidth and energy efficiency are presented. Conclusions are given in Section 6.

2. RELATED WORK

Development of localization algorithms for wireless sensor networks (WSNs) to estimate the node positions. It is an important research topic because position information and distance information is a major requirement in many WSN applications. Wireless sensor networks (WSNs) have widely been applied in many fields, such as military needs, industry applications and environmental monitoring. Hongyong Chen, et.al [1] proposed an idea of Non-line-of sight conditions based on semi definite programming to mitigate the NLOS errors. SDP and AML method is used for finding the position information. Oh-Heum Kwon, et.al [2] proposed an method of anchor free algorithm. For local map constructions, MDS approach performs better than the multilateration-based method. Best performance and no efficient distributed implementation of MCF stitching. Sayyed Majid Mazinani, et.al. [6] Proposed that the Castalia simulator is used for the simulation and validation purpose. In the obstacle environment mobile anchor plays an important role. Mobile anchor consumes lesser energy used the method of snake-like pattern.

Algorithmic approach is the best way for node localization. Many algorithms are proposed, but it is still difficult to node location estimation accurately and efficiently in WSN since the proposed algorithm should be low complexity and to reduce the communication cost for WSN. Node localization in wireless sensor network under non-line-of sight environment, RMS algorithm is not yet used. Hence we focus on the localization accuracy and energy efficiency in the case of static blind sensor nodes and mobile anchor nodes under NLOS environment.

3. PROPOSED WORK

In the case of channel parameters, obstacles blocking the direct path between nodes cause some error, called as Non-Line-Of-Sight (NLOS) errors, which positive biases the location estimates and affects the localization accuracy. The main objective of the project is to identify and mitigate the NLOS errors and provide good localization accuracy in the case of static blind sensor nodes and the mobile anchor nodes. A novel algorithm, called as Range Map Stitching (RMS) algorithm is proposed. The algorithm has two steps basically: 1) Creating local maps using geometric properties; 2) Stitching the local maps iteratively. Received Signal Strength (RSS) ranging technique used to create local maps under NLOS environments. RMS algorithm is used to estimate the position information of the static blind sensor nodes using the mobile anchor nodes.

Received RF signal   Location Metrices RSS, AOA, TOA,....   Location Coordinates (x,y,z)

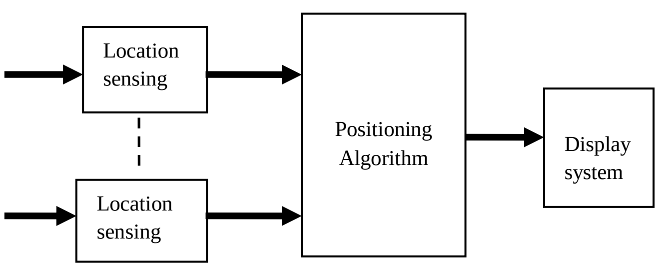

Fig-1: Block diagram of localization system

3.1. Range Map Stitching Algorithm

The map stitching is a type of localization algorithm in which the network is divided into small overlapping sub regions, each of the mobile anchor node creates a local map, and then the local maps are stitched together to form a single global map. Although there are several methods of constructing local maps, every existing algorithm uses the same method for stitching two maps, called the absolute orientation method. The proposed method achieves a good localization accuracy and energy efficiency under NLOS conditions.

Range Map Stitching (RMS) is a different way of approaching the same problem.

The RMS algorithm works as follows:
Step 1: Split the network into small overlapping maps. Very often each map is simply a single node and its one-hop neighbours.
Step 2: For each sub region, compute a “local map”, which is essentially an embedding of the nodes in the sub region into a relative coordinate system.
Step 3: Finally, merge the sub regions using a coordinate system registration procedure.
Following steps are to form a single coordinate system:
Step 1: Let the node responsible for each local map chooses an integer coordinate system ID at random.
Step 2: Each node communicates with its neighbours; each pair performs the following steps.
Step 2a: If both have the same ID, then do nothing further.
Step 2b: If they have different IDs, then register the map of the node with the lower ID with the map of the node with the higher ID. Afterwards, both nodes keep the higher ID as their own.
Step 3: Repeat step 2 until all nodes have the same ID; now all nodes have a coordinate assignment in a global coordinate system.

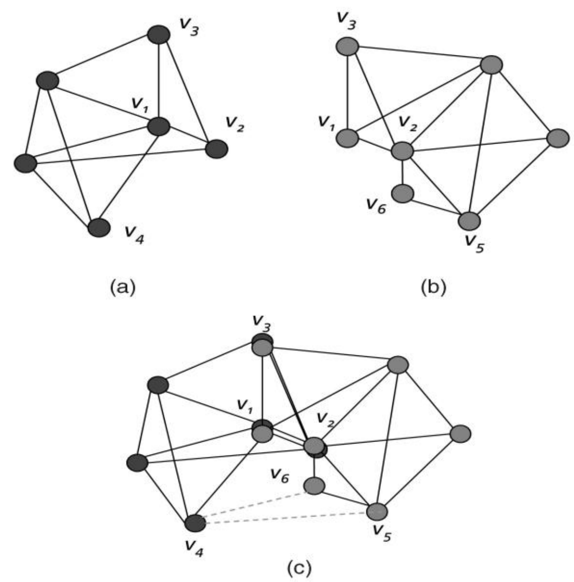

Fig-2: Nodes v1, v2, and v3 are common to two local maps (a) and (b).Two maps can be rigidly stitched by overlapping three common nodes as shown in (c).

Local map construction: Split the network into small overlapping components. For each component, compute a “local map” that is a coordinate assignment of the nodes in the component in a relative coordinate system.

Stitching maps: Merge the local maps through a range map stitching procedure. The procedure continues until all local maps are merged into a single global map.

4. RSS TEECHNIQUES

4.1. Distance Estimation

Received signal strength indicator (RSSI) has become a standard feature in most wireless devices and the RSS based localization techniques have attracted considerable attention in the literature for obvious reasons. The RSS based localization techniques eliminate the need for additional hardware, and exhibit favourable properties with respect to power consumption, size and cost.

In general, the RSS based localization techniques can be divided into two categories: the distance estimation and the RSS profiling based techniques.

In free space, the received signal strength at a receiver is given by the Friis equation:

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\prod)^2 d^2 L}$$

Where P_t is the transmitted power, $P_r(d)$ is the received power at a distance d from the transmitter, G_t is the transmitter antenna gain, Gris the receiver antenna gain, L is a system loss factor not related to propagation and λ is the wavelength of the transmitter signal.

The gain of an antenna is related to its effective aperture, Ae, by

$$G = \frac{4\prod Ae}{\lambda^2}$$

The effective aperture Ae is determined by the physical size and the aperture efficiency of the antenna.

4.2. Statistical Model of RSS

Stochastically, the received mean power in wireless radio channel decays proportional to d^{-n}, where n is typically between two and four. Based on a wide variety of measurements, the difference between a measured received power and its stochastic mean can be modelled as a log-normal distribution (i.e., Gaussian if expressed in decibels). Thus, the received power, in terms of dBm, at the receiver is distributed as:

$$f(p) \sim N(p; \overline{p}(d)\sigma_{dB}^2)$$

Where N denotes normal distribution

$$\overline{p}(d) = p_o - 10n\log\frac{d}{d_o}$$

Where P_o is the received power at a short reference distance, d_o.

A range independent constant standard deviation in dB means that any deviation from the actual value leads to a multiplicative factor which has a different impact on the measurement error depending on the actual range. Due to the a aforementioned model of measurement, RSS errors are referred to as multiplicative, contrary to the additive behaviour of the errors in the other techniques (e.g., TOA, TDOA).

In a realistic environment, obstacles may appear in the sensing field and thus obstruct the radio connectivity between the anchor node and the sensor nodes during this occasion the sensor node identifies its location through diffraction of RSS signal on the neighbour nodes. And from the neighbour nodes the sensor nodes identifies its distance and location.

4.3 RSS based RMS Algorithm

Received-signal-strength (RSS) is defined as the power measured by a power detector circuit implemented in the receiver. The RSS of RF signals can be obtained during normal signal transmission without demanding additional bandwidth. RSS measurement is relatively inexpensive and can be simply implemented in the receiver; however, it is unreliable because of its unpredictable and not well modelled (i.e., large variance) sources of error. The RSS method is based on the fact that the average power of a received signal decays as a function of the distance between transmitter and receiver. Hence, a unique relationship between signal power and range can be established.

In free space, signal power decays proportionally as d^{-2}, where d is the distance between transmitter and receiver. In a wireless channel, shadowing and multipath are two major error sources in RSS measurement which deteriorate with the quadratic property of free space attenuation. Reflection and refraction of the radio wave from objects are associated into multipath and shadowing phenomena, respectively. Due to the multi-component nature of the multipath, its effect can be constructive or destructive in RSS measurement but shadowing always causes the destructive (i.e., attenuative) effect on the signal. The shadowing effect can be modelled stochastically and some RSS techniques take advantage of the a priori stochastic models to enhance the performance of the RSS method.

5. SIMULATION RESULTS

5.1 Node Creation

The simulation is performed with 59 sensor nodes, 5 anchor nodes and 6 obstacles. The node simulation in ns2 and the node creation are shown in Fig-3. The node shown in red colour is an anchor node; black colour denotes blind nodes and grey colour are obstacles. Data sink is act as a base station. Fig-3 shows the random deployment of static blind and the mobile anchor nodes with NLOS error. Nodes start the process of localizing. Each node determines its own position by itself.

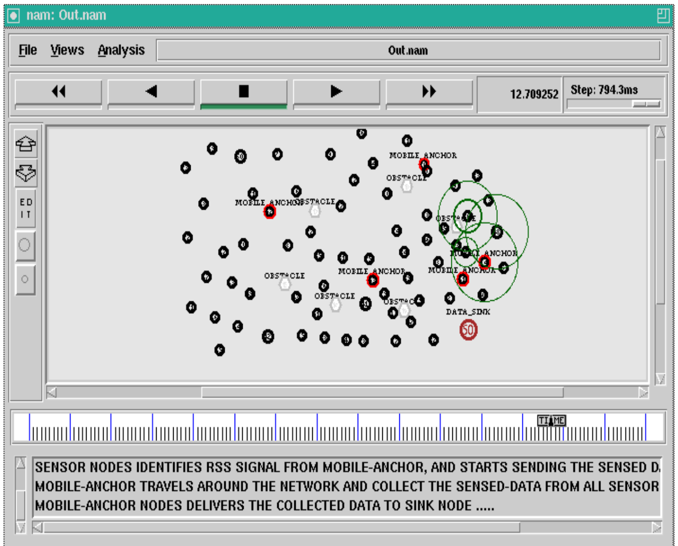

Fig-3: Node Creation

5.2. Position Estimation of Nodes

Fig- 4 shows that the random deployment of the nodes. An NLOS error presents between the sensor and the anchor nodes. From the anchor node, sensor node identifies the position of the each node its forms a single local map. Common nodes of the local maps are merged for stitching. Procedure continues all the local maps come to a global map. After stitching process, estimate the position information of the static blind sensor nodes using the mobile anchor nodes.

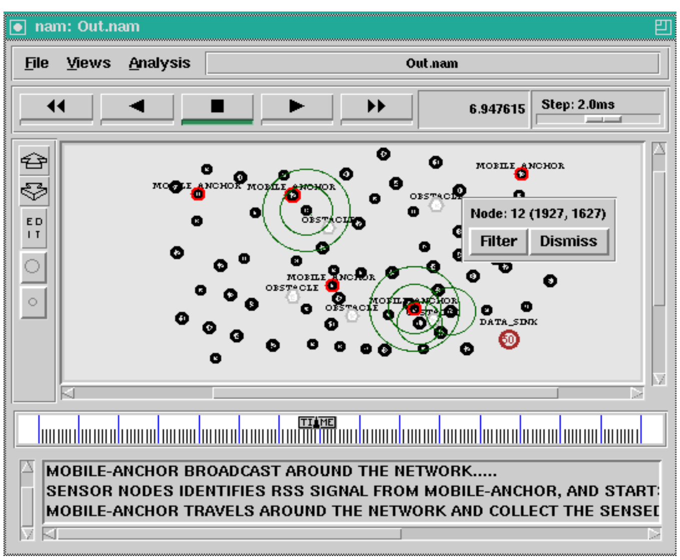

Fig-4: Position Estimation of Nodes

5.3. Bandwidth Analysis

Number of bit rate is the reciprocal of the transmission time of the bit rate. Fig-5 shows that the performance of the bandwidth analysis. RMS algorithm is efficient when compared to SDP. The efficiency is increased by 35.7% in terms of bits per second. Where, R_b is the number of bit rate, T_b is the transmission time of bit rate.

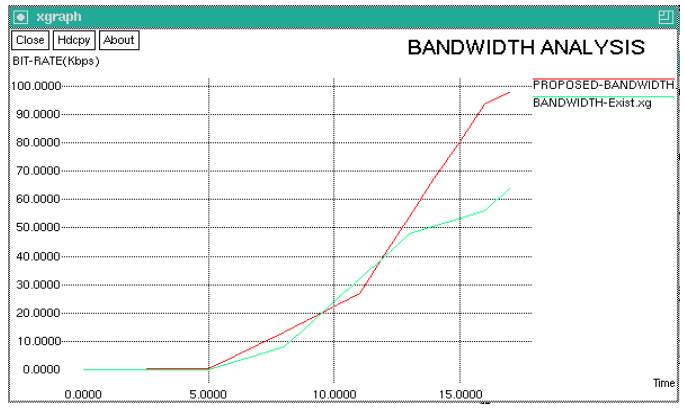

Fig-5: Performance of bandwidth analysis

5.4. Comparison of Mobile and Static Anchor Nodes

Fig-6 shows that the mobile anchor nodes of route length localization is efficient than the static blind sensor nodes. Route length localization of mobile anchor node is increased by 50%.

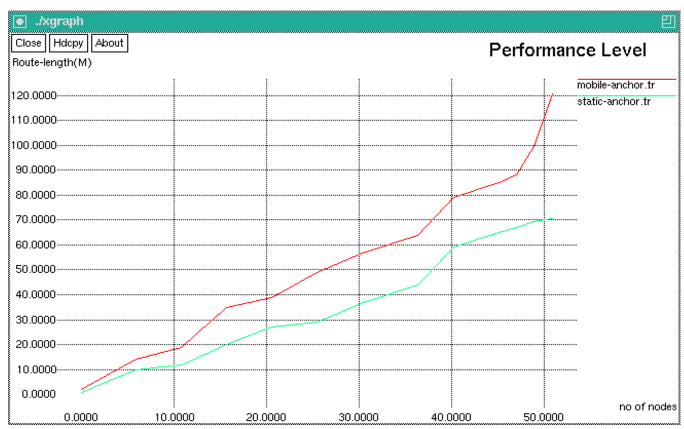

Fig-6: Mobile anchor Vs Static anchor of nodes

5.5. Performance of Energy Efficiency

Fig-7 shows that the energy efficiency for the localization. When compared to the static and the mobile anchor, mobile anchor only consumes lesser energy. So the mobile anchor only the best of energy efficiency for localization under NLOS conditions. The energy efficiency of mobile anchor consumes 72.3% in terms of joules.

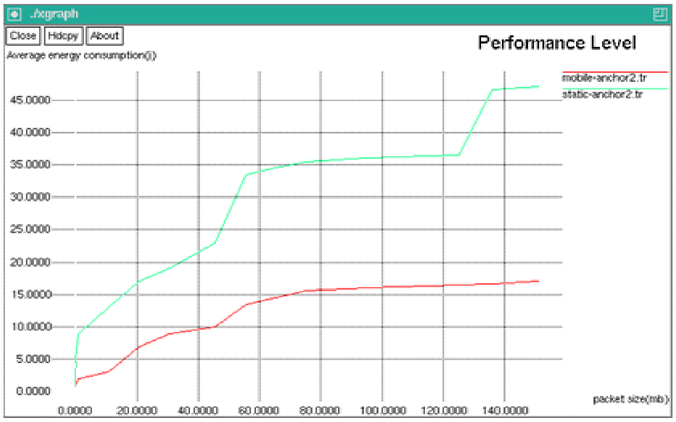

Fig-7: Performance of energy efficiency

6. CONCLUSIONS

Range map stitching based node localization algorithm has been proposed. In particular, the problem of node localization in WSN under NLOS environments has been approximated by a convex optimization problem using this technique. Given a mixture of LOS and NLOS range measurements, our method is applicable in both cases without discarding any range information. Simulation results demonstrate the effectiveness of our method. Many localization algorithms have been developed and used to find the position of sensors. Although a lot of algorithms are proposed, it is still difficult to node location estimation accurately and efficiently in WSN since the proposed algorithm should be low complexity and to reduce the communication cost for WSN. It has been shown in the simulation results that the proposed localization scheme can achieve the good localization accuracy and energy efficiency in NLOS environments.

Range map stitching algorithm is used to provide good localization accuracy and energy efficiency under the NLOS conditions. This method can provide good estimate by mitigating the effects of NLOS measurements. RMS localization algorithm is proposed which achieves performance improvement over the existing algorithms.

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