A COMPARISON OF DISTRIBUTED METHOD OF LOCALIZATION FOR MWSN WITH AOA BASED ON ANTENNA

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ABSTRACT

The primary difficulty in sensor networks is localization, such that determining the position of the sensors node in dance area of wireless sensor network. Node localization is an enabling expertise for mobile wireless sensor networks (MWSNs) for the motive that sensor nodes deployed in an area of interest frequently necessitate position information for routing and purpose - specific tasks, for instance - temperature and pressure monitoring. In recent years, directional antenna scheme has been extensively used in designing protocols for wireless sensor networks because omni-direction antenna radiate energy in all directions and signal is easily interfered with wide range of environment noises which may increases localization error, In disparity a directional antenna concentrate its energy in a particular direction which increases localization efficiency.

Numerous localization schemes using anchor nodes equipped with low gain omni directional antenna have been proposed. Since the omni directional antenna radiate energy in all directions, wanted signal is easily interfered with wide range of environment noise. This paper outlines recent work and analyzes the accuracy of the directional antenna and omni directional antenna.

***Keywords**: Wireless sensor network, Localization, Directional antenna, Omni Directional Antenna, AOA.*

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I. INTRODUCTION

Wireless sensor networking is a rising technology that promises a wide range of possible applications in both civilian and military areas. A wireless sensor network (WSN) usually consists of a huge number of low cost, low power, and multifunctional sensor nodes that are deployed in a region of interest. These sensor nodes are small in size but are equipped with sensors, embedded microprocessors, and radio transceivers. Consequently, they have not only sensing, but also data processing and communicating capabilities. They communicate over short distance via a wireless medium and collaborate to accomplish a common task [1]. Node localization is an enabling technology for wireless sensor networks (WSNs) because sensor nodes deployed in an area of interest usually need position information for routing and application - specific tasks, for example, temperature and pressure monitoring [2] . In many applications, a WSN is deployed to help improve localization accuracy in environments where the channel condition poses a challenge on range estimation [3]. In such environments, cooperative localization provides a potential for many applications in the commercial, public safety, and military sectors [3, 4].

Numerous localization schemes using anchor nodes equipped with omni-directional antenna to transmit beacon information have been proposed. However, the radiated RF signal from an omni-directional antenna is easier to be interfered by wide range of environment noise, which leads to greater localization error. In this project, we tackle the problems in estimating location of randomly deployed sensor nodes with omni directional antennas and with directional antenna. Since directional antenna concentrates energy on a particularly direction with a high gain and narrow covering area, we propose a high accuracy, energy efficient, and low cost localization scheme using a mobile anchor node equipped with a directional antenna. After investigating the effect of directional antenna on wireless sensor networks, we show how the location estimation problem can be solved using geometric characteristics on a 2D plane with directional antenna. The aim is to compare it with scheme using omni directional antenna.

This paper is organized as follows : section 2 described basic Related work, section 3 deals with Problem Statement, Solution Domain is discussed in section4 , section 5 shows localization scheme with directional antenna, section 6 consist localization scheme with omni directional antenna, section 7 consist of comparison localization scheme with directional and omni directional antenna.

II. RELATED WORK

Rong Peng and Mihail L. Sichitiu[5] In this paper author focus on localization technique based on angle of arrival information between neighbor nodes they propose a new localization and orientation scheme that consider beacon information multiple hopes away such that the communication between sensor nodes and the base station require multiple hopes.

Clement Saad and Adberrahim Benslimane and Jean-Claude Konig[6] In this paper author concerned in new distributed technique for wireless sensor network they named their method AT-angle. This method is basically extended version of angle of arrival. This new method AT-angle facilitate two important properties first- a node detect if its estimated position is closed to its real position, second – Some wrong location information can be eliminated regarding to define sensor zone to minimize errors.

Patryk Mazurkiewicz and Kin K. Leung[7] This paper author presented a distributed and scalable algorithm referred to as COBALT (Clique Of Node Based Localization Technique) produces a unique solution for any topology of connected nodes which solves the problem of localization for 3-D network of wireless sensor. They focus in this work is an enhancing the local map prior to stitching them to the global map. Enhancing the local map results in achieving much better accuracy COBALT has no rigidity conditions this property was achieved by using rich spatial measurement including : range, angle of arrival, and earth gravity direction.

Baoli Zhang and Fengqi Yu[8] This paper tackle the problem in estimating localization of randomly deployed sensor nodes and increases equipped with directional antenna. This approach is energy efficient because sensor network uses the property of when if received the signal enough to calculate the location it stops receiving signal from beacons which made it energy efficient.

Fu-Kai Chan and Chih-Yu Wen[9] This paper presented a network based positioning system, describe a distributed AOA aided TOA positioning algorithm and outline recent work in which author developed an efficient principal approach to localize a mobile sensor using time of arrival and angle of arrival information employing multiple seed in the line of sight scenario.

III. PROBLEM STATEMENT

Making a right choice of the scheme for narrow network. It is important to be having proper comparisons of both the schemes. The proper comparison leads the analyze and implementation of the localization schemes using a mobile anchor node equipped with a directional antenna and using omni directional antenna too. However, there are very little comparative studies available, which could show the advantages and weakness of individual schemes. The purpose of the present project is to show important differences in performances of the two localization schemes.

IV. SOLUTION DOMAIN

To solve problem described in "problem statement" required to find the quality of service parameters like accuracy, error rate, power consumed etc. for complete analysis required to implement both the localization schemes. After test evaluate different factors related to the schemes. To get decision which scheme is best fit for particular problem?

V. LOCALIZATION SCHEME USING DIRECTIONAL ANTENNA

i. Our consideration

In the localization schemes using stationary anchor node, each sensor node needs to collect the location information of its neighboring anchor nodes and then compute its location. Therefore a certain percentage of anchor nodes are necessary, which increases the cost of the network. On the other hand, the localization schemes using mobile anchor node are cost effective because only one or a few mobile anchor nodes are needed.

However their performance is seriously affected by environment noise. Directional antenna offers a potential solution to the problem. It has the advantages of counteracting interference, long transmission range, and spatial reuse. Many of these advantages come at cost of increasing complexity in communication protocols, such as DMAC[14]. Localization with a mobile anchor node using directional antenna, some common problems in conventional communication protocols, such as hidden terminal and deafness, are automatically resolved[15].

ii. Algorithm Implementation

In this section, we propose a localization scheme that allows a sensor node to estimate its location by using a mobile anchor node equipped with a directional antenna and GPS receiver. It moves along a straight line in the sensor area to ensure that all unallocated sensor nodes can receive the location information of the mobile anchor node.

iii. Antenna Model

A directional antenna transmits and receives data only in one direction with a high gain (Gd), where Gd is typically greater than $G0$. Directional antenna can point its main lobe towards a specified direction. We approximate the radiation Pattern of the side lobes as a sphere with the node at its center. The gain of the side lobes is assumed to be very small (approximate zero)[16].

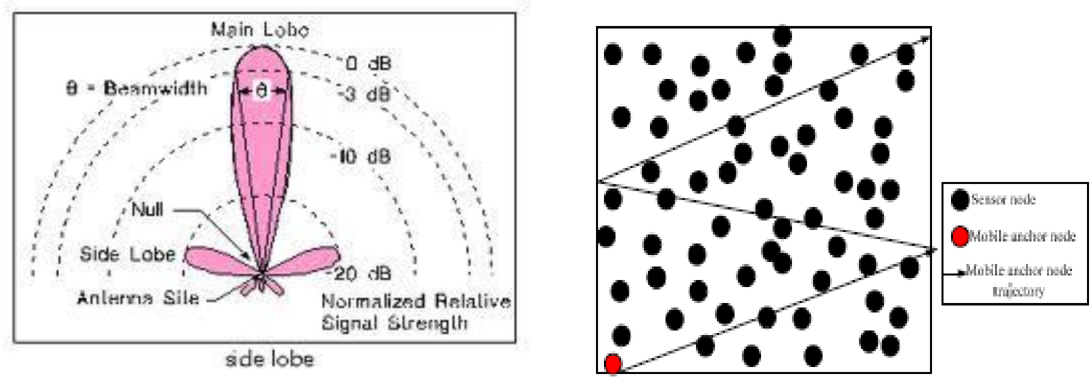


Figure 1: (a)Directional antenna, (b) Network model

Directional antenna can concentrate electromagnetic energy into a certain direction (main lobe) while cancel the energy in other directions, resulting in an amplified signal in a certain direction. Directional mode is used only for a mobile anchor node to broadcast beacon message.

iv. Network model

The network model in the proposed localization scheme is shown in Fig. 1(b). We assume two-tier network architecture with a set of sensor nodes *S* which are randomly deployed in a certain area *A*. A mobile anchor node *AS*, equipped with a single beam directional antenna and GPS, moves through or flies over the area *A* with a certain or random speed to transmit beacon message. The mobile anchor node has a transmission range *R* and an open angle βm. For a sensor node *Si* in the open area βm, *Si* can receive beacon message from the mobile anchor node. On the contrary, *Si* cannot receive any beacon message[15].

v. Location Determination

Sensor nodes use beacon message from mobile anchor node to determine their locations. Each mobile anchor node broadcasts beacon message with single directional antenna, which contains: 1) the mobile anchor node's coordinate and timestamp of beacon message; 2) the angle βm of the sector boundary lines defined by the directional antenna and the angle ά between border line *L1* and *X* axis, as shown in Figure.2. Based on the collected beacon message, a sensor node determines its location by using the geometric characteristics of the confined area. The mobile anchor node moves through the sensor area and broadcasts beacon message for sensor nodes to determine their locations.

vi. Beacon Point Selection

Beacon point is defined as follows. A mobile anchor node travels to point *P* and broadcasts messages. When SNR of received signal by a stationary node is greater than a threshold, point P is defined as a beacon point for the stationary sensor node. Each unallocated sensor node records messages of different beacon points. Each message includes the location of beacon point and RSSI. Based on the received beacon message, a sensor node S in the coverage area of a mobile anchor node defines a sector

Area $S(j)$ that is the coverage area of the *jth* beacon point. During the *nth* transmission, sensor S selects a beacon point to define a sector. The intersection of n sectors is the most likely location of the sensor. By computing the cancroids of the intersection, we can get the location of S. In the proposed localization scheme, a sensor node obtains beacon points as follows[17].

A mobile anchor node moves through the sensor area and broadcasts beacon messages periodically. The beacon message includes the position of the anchor node, timestamp, α and βm[8].

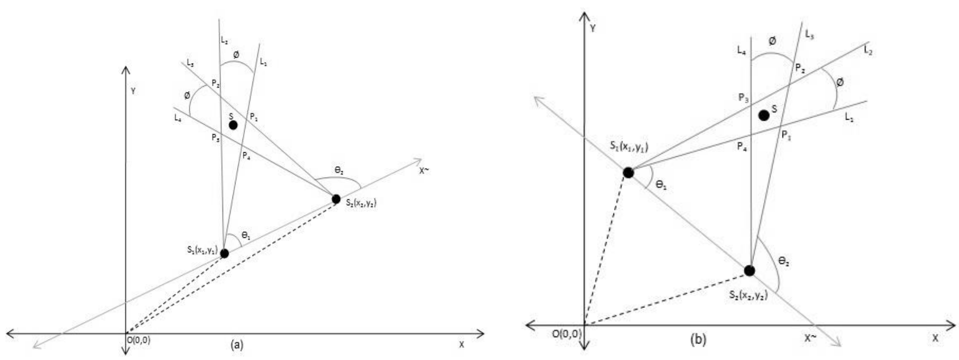


Fig 2 (a) When auxiliary reference convene with x axis behind to zero, (b) When auxiliary reference convene with x axis in front to zero[18]

Step 1: Node Distribution: Sensor nodes are placed in ad-hoc fashion in a particular region.

Step 2: Anchor node location calculations: Initially some anchor nodes location is known it was hand placed or calculated by GPS system

Step 3: Calculations through RSSI weight factor: Calculate weight (W_{ab}) of both anchor nodes in accordance to current selected unknown node.

Step 4: Beacon point S_1 and S_2 with location (x_1,y_1) and (x_2,y_2) relatively

$$\left.\begin{aligned} L_1&: y - y_1 = k_1 (x - x_1) \\ L_2&: y - y_1 = k_2 (x - x_1) \\ L_3&: y - y_2 = k_3 (x - x_2) \end{aligned}\right\}$$

$$(1) L_4: \; y - y_2 = k_4 (x - x_2)$$

Where $k_1 = \tan(\theta_1)$, $k_2 = \tan(\theta_1 + \varnothing)$, $k_3 = \tan(\theta_2)$, $k_4 = \tan(\theta_2 + \varnothing)$

The coordinate of P_1, P_2, P_3 and P_c can be calculated by solving above equations

The coordinate of P_1 (with the help of L_1 and L_3)

$$X_{P1} = (a - b) / (k_3 - k_1),\ Y_{P1} = (a \times k_3 - b \times k_1) / (k_3 - k_1). \quad (2)$$

Where $a = y_1 - (k_1 \times x_1)$ *and* $b = y_2 - (k_3 \times x_2)$

The coordinate of P_2 (with the help of L_2 and L_3)

$$X_{P2} = (a - b) / (k_3 - k_2),\ Y_{P2} = (a \times k_3 - b \times k_2) / (k_3 - k_2). \quad (3)$$

Where $a = y_1 - (k_2 \times x_1)$ *and* $b = y_2 - (k_3 \times x_2)$

The coordinate of P_3 (with the help of L_2 and L_4)

$$X_{P3} = (a - b) / (k_4 - k_2),\ Y_{P3} = (a \times k_4 - b \times k_2) / (k_4 - k_2). \quad (4)$$

Where $a = y_1 - (k_2 \times x_1)$ *and* $b = y_2 - (k_4 \times x_2)$

The coordinate of P_4 (with the help of L_1 and L_4)

$$X_{P4} = (a - b) / (k_4 - k_1),\ Y_{P4} = (a \times k_4 - b \times k_1) / (k_4 - k_1). \quad (5)$$

Where $a = y_1 - (k_1 \times x_1)$ *and* $b = y_2 - (k_4 \times x_2)$

Then use centroid method

$$X_s = (X_{P1} + X_{P2} + X_{P3} + X_{P4}) / 4 \quad (6)$$

$$Y_s = (Y_{P1} + Y_{P2} + Y_{P3} + Y_{P4}) / 4 \quad (7)$$

VI. LOCALIZATION SCHEME USING OMNI DIRECTIONAL ATENNA

i. Our consideration

In this study, unlike other approaches, the major breakthrough is that we can achieve accurate localization of sensor nodes solely using omni directional antenna even if only one reference node exists. Besides, we can be benefit from the advantages of using omni directional antennas, e.g., low-cost (simplicity) and easy deployment (efficiency).

ii. Algorithm Implementation

In this work, a robust correlation is incorporated in analyzing the relative positions between two sensor nodes using the received signal strength indication (RSSI) pattern. A cooperative localization scheme is also developed to improve the accuracy of the estimation as multiple reference nodes are available. The performance of the proposed framework has been evaluated by computer simulations and real world experiments under various experimental conditions.

iii. Antenna Model

According to beam pattern (beam-radius, beam width, and beam orientation), antenna models are classified into two types: Omni-directional antenna (as shown in Fig. 3(a)) and directional antenna (as shown in Fig. 3(b)). An Omni-directional antenna transmits and receives data in all directions with a gain (Go).On the contrary, We approximate the radiation pattern of the side lobes as a sphere with the node at its center, the gain of the side lobes is assumed to be very small (approximate to zero).

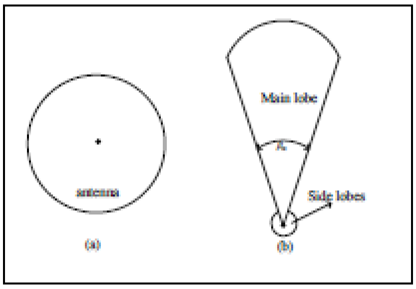


Figure 3:- Antenna model: (a) omni directional antenna (b) single beam

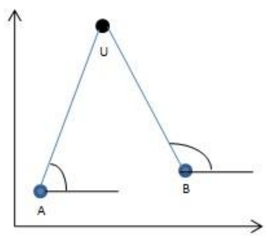
In Omni-antenna, signal electromagnetic energy is speeded over a large region of space, while only a small portion is received by an intended receiver.

Omni directional radiation patterns are produced by the simplest practical antennas, monopole and dipole antennas, consisting of one or two straight rod conductors on a common axis. Antenna gain (G) is defined as antenna efficiency (e) multiplied by antenna directivity (D) which is expressed mathematically as: $G = eD$. A useful relationship between omni directional radiation pattern directivity (D) in decibels and half-power beam width (HPBW) based on the assumption of a sin $b\theta$ / $b\theta$ pattern shape is[8]

$$D = 10\log_{10}\left(\frac{101.5}{HPBW - 0.00272(HPBW)^2}\right)\ dB$$

Step 1 Node distribution in specific area: Sensor nodes are placed in ad-hoc fashion in a particular region.[17]

Step 2 Anchor node location calculations: Initially some anchor nodes location is known it was hand placed or calculated by GPS system[14]. A and B are anchor nodes and its coordinates are (xa,ya) and (xb,yb), unknown node is U and its unknown coordinate is (xu,yu). Unknown node U does not its location, A and B sends their coordinate information to U.



Step 3 Location calculations through AOA: Unknown node U does not its location, A and B sends their coordinate information to U.

Angle A=Ø_a and B= Ø_b

i) Select unknown sensor node $U(x_u,y_u)$

ii) Select Anchor node $A(x_a,y_a)$ and $B(x_b,y_b)$

iii) Calculate Angle of arrival and location of unknown node $\tan Ø_i = (y_u - y_i)/(x_u - x_i)$

Step 4 Compute weighted factor anchor nodes:

i) Anchor nodes RSSI are $RSSI_a$ and $RSSI_b$.

ii) Calculate weight (W_{ab}) of both anchor nodes in behalf of current selected unknown node

Step 5 Improved AOA = AOA + RSSI weight

Improved AOA = $(x_u, y_u) + W_{ab}$

VII. COMPARISON ANALYSIS OF LOCALIZATION SCHEME

In the basis of above two methods we conclude this comparison and analysis have done

i) Energy Efficiency

In the localization algorithm of Angle of arrival with Omni directional antenna has less energy efficient because it radiates its signal in all directions and consumes more battery power. but in the other hand directional antenna radiates its signal in a particular direction and consume less power therefore it is more energy efficient.

ii) Location determination accuracy

When we use Omni directional antenna there is less accuracy because of angle of arrival method firstly found the angle between incident signal and reference axis so directional antenna more accurate than Omni directional antenna.

iii) Secure

Omni directional antenna there is less secure because of angle of arrival method its signal radiate in all directional so there is some difficulty to manage but directional antenna radiates its signal in a particular direction so this is easily manageable.

iv) Scalable

Omni directional antenna used angle of arrival method is more Scalable because more sensor node can calculate its position simultaneously.

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This work is under process and will fully satisfactory result there soon.

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