ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

Localization Range Improvement in Wireless Sensor Network using Genetic Algorithm

Anuj Kumar[1], Arvind Negi[2], Sumit Chaudhary[3], Anchit Bijalwan[4]

M.Tech, CSE, Uttaranchal University, Dehradun (U.K), India[1,2]

CSE Dept., Uttaranchal University, Dehradun (U.K), India[3,4]

Abstract: Wireless sensor network is numerous exercises utilized as a part of our society, so they have turn into the epic technology. Numerous utilization of wireless sensor network is requires the area of a sensor system. Node localization is usually utilized in wireless network. It is used to enhance routing what's more, upgrade security. Localization algorithms can be distributed as rang-free or rang-based. Rang-based algorithms use area measurements. Range-based algorithms use location metrics such as ToA, TDoA, RSS, and AoA to estimate the distance between two nodes. In this paper, Authors proposed a new range-based algorithm which is based on the Genetic Algorithm. A Genetic Algorithm for wireless sensor network limitation is proposed to tackle the issue that the situating precision is low with least grapple hubs or nodes. Thus in this paper authors are displaying a Genetic Algorithm for advancement approach which tries to locate the ideal area by fulfilling both the criteria or techniques (TOA, AOA) with minimal error.

Keywords: WSN, AOA, TOA, TDOA, RSSI.

1. INTRODUCTION

Improve range of localization is an important issue of wireless sensor network. Localization Techniques [1] divided in to two type first Range – based localization and second is Range free localization. In range based localization we discuss TOA (time of arrival) [2], TDOA (time difference of arrival), RSSI (received signal strength indicator) and AOA (angel of arrival).

Wireless Sensor Network (WSN) consists of a large number of tiny low cost, low-power, multifunctional sensors which are capable of sensing, Computing and communicating between these wireless devices which are deployed in a large geographic area [3]. WSN can be applied to a wide variety of diverse areas[4], such as environmental monitoring, military applications, target tracking, medical care, space exploration, location based services such as Emergency 911 (E-911) [5], Location sensitive billing, fraud detection, intelligent transport systems, location based Social Networking and Mobile yellow pages etc, [6]. Due to the developments in wireless communication WSN have been a new area of research [7-8]. In this paper authors use TOA (time of arrival) and AOA (angle of arrival). In Range free localization are based on information between sensor node and nor require additional hardware for localization of wireless sensor network. Genetic algorithms are also used for improved range localization.

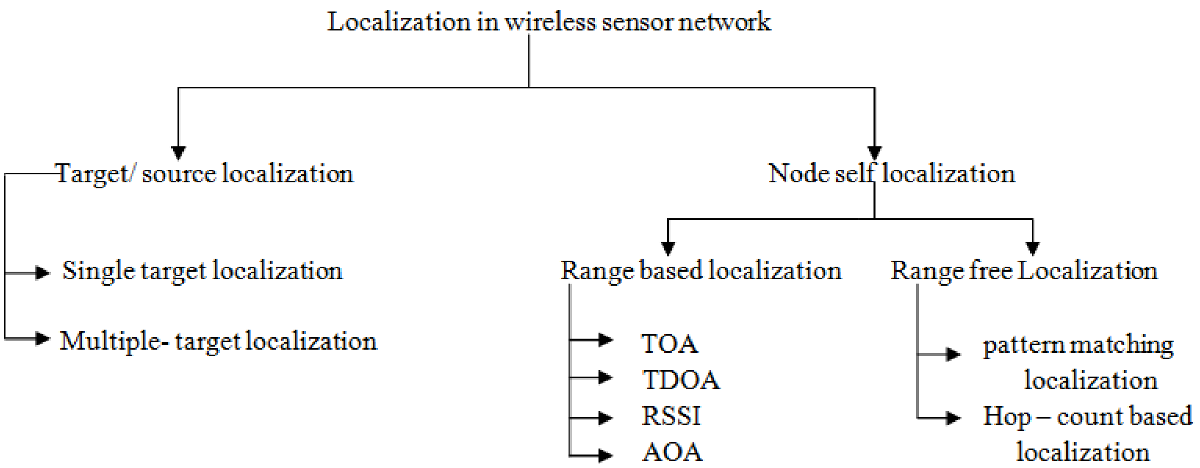

Fig.1 Localization in wireless sensor network

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

1.1. Rang Based Algorithm

a) TOA (Time of arrival)

It is a method that tries to estimate distance between 2 node using time based measured TOA node synchronization.

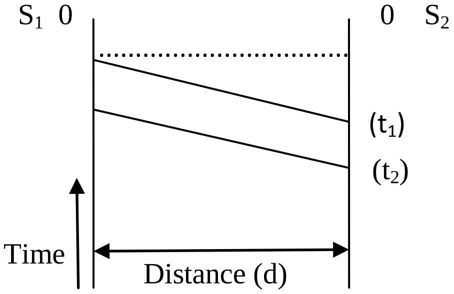

Fig 2. Time of arrival

b) TDOA (time difference of arrival)

It is a method for determining the distance between a mobile station and a nearly synchronization base station. No synchronization need but it's costly.

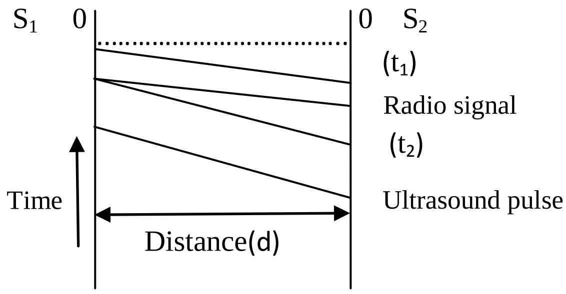

Fig. 2 Time difference of arrival

RSSI (received signal straight indicator)

Techniques to translate signal strength in to distance low cost but very sensitive to noise.

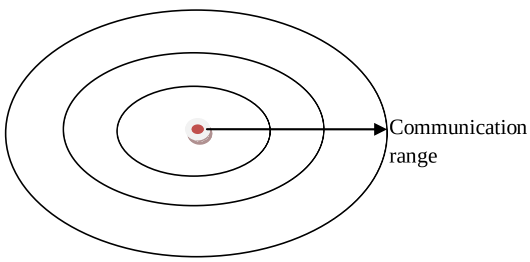

Fig 4. Received signal straight

c) AOA (angel of arrival)

It is a method that allows each sensor each sensor to evaluate the relative angels between radio signals.

Units of power: W(watt)

1 KW = 10^3 W
1MW = 10^{-3} W
1μW = 10^{-6} W
1 NW = 10^{-9} W

dB = 10 log10 $\left(\frac{P}{P_{ref}}\right)$, dB_m = 10 $\log_{10}$ $\left(\frac{P}{1mw}\right)$

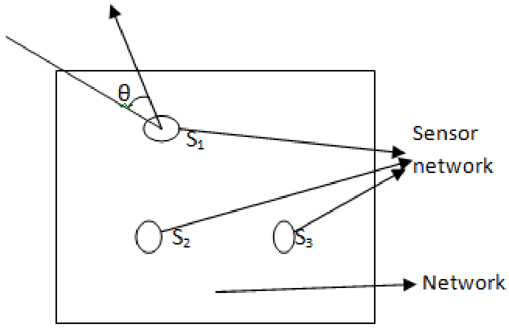

Fig. 5 angle of arrival

2. RELATED WORK

Authors are displaying a Genetic Algorithm for advancement approach which tries to locate the ideal area by fulfilling either the criteria or techniques (TOA, AOA) with minimal error. Implementation of techniques is as follows:

2.1. TOA based localization

Determine the location information of a node deployed in wireless sensor network. The mathematical measurement model for TOA based source localization algorithm is:

$$r = f(x) + n \quad (1)$$

x_1 = source position

n = zero noise vector

r = measurement vector

f(x) = known non linear function of x measurement of synchronization is important for TOA. Synchronization between source/ sender or receiver because TOA is one way prorogation time of signal travelling.

The measured TOA represents a circle with its center at the receiver & the source must lie on the circumference in a two dimensional 2D space. Three or all the more such circles acquired from the noise free TOAs bring about an unmistakable crossing point which represents the source position and is as demonstrated in Figure 5(a) and 5(b), indicating that at least three sensors is vital for two dimensional position estimate [9]. Hence, a minimum of three sensors is required to obtain the intersection and these can be represented as a set of circular equations, based on the optimization criterion the source position can be estimated with the knowledge of the known sensor array geometry [10, 11].

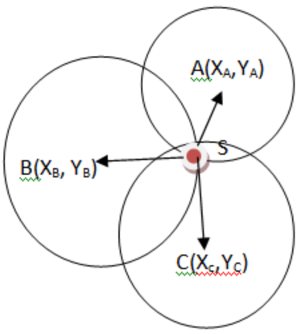

Fig 5(a): Trilateration

DOI 10.17148/IJARCCE.2015.4777

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

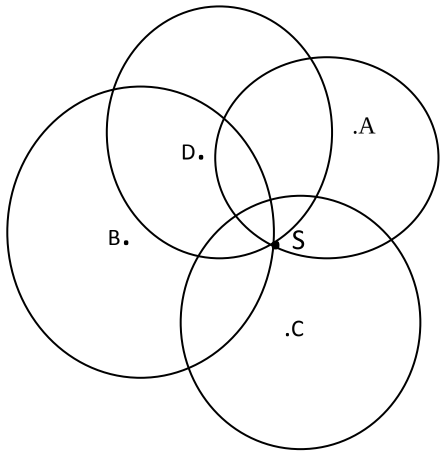

Fig 5(b): Multilateration

TOA measurement model is developed a follow :

Let $X_i = (X_i \; Y_i)^r$

$i = 1, 2, 3, \ldots\ldots\ldots\ldots i$ & $X = [x\; y]^N$ be the unknown position of the source to be estimated,

The number of receiver I must be equal or greater than 3 $(I \geq 3)$

This distance between source & sensor

so, di = $|X\text{-}X_i| = \sqrt{(x-x_i)^2 + (y-y_i)^2}$

$i = 1, 2 \ldots\ldots\ldots i_A$ (2)

i^{th} sensor receiver at time t_i, relationship between t_i and d_i,

$t_i = \frac{di}{c}$ (3)

$i = 1, 2, \ldots\ldots\ldots i_A$

C = constent

As a solution , the range based measurement based on multiplying t_i by C, denoted by r_{TOA} i,

$r_{TOA,i} = di + E_{TOA,i}$

Put the value of di from the equation (2)

$r_{TOA,i} = \sqrt{(x-x_i)^2 + (y-y_i)^2} + E_{TOA,i}$ (4)

$i = 1, 2, \ldots\ldots\ldots i_A$

$E_{TOA,}$ i is a range error in r_{TOA}, i which is resulted from TOA disturbance

From equation (1)

$r_{TOA} = f_{TOA}(x) + E_{TOA}$ (5)

where,

$$\begin{cases} r_{TOA} = [\, r_{TOA,1}, r_{TOA,2} \ldots\ldots\ldots r_{TOA,I}]^T \\ E_{TOA} = [E_{TOA,1}, E_{TOA,2} \ldots\ldots\ldots E_{TOA,I}]^T \\ F_{TOA}(x) = d \\ d = [\sqrt{(x-x_1)^2 + (y-y_1)^2}, \sqrt{(x-x_2)^2 + (y-y_2)^2} \ldots \\ \ldots\ldots\ldots \sqrt{(x-x_i)^2 + (y-y_i)^2} \end{cases}$$

Put the value in equation (5) and take $\sum$ for equation.

$$\sum_{i=1}^{n} r_{TOA,}\, i = \sum_{i=1}^{n} E_{TOA,}\, i + \sum_{i=1}^{n} \sqrt{(x-x_i)^2 + (y-y_i)^2}$$

$$\sum_{i=1}^{n} r_{TOA,}\, i = \sum_{i=1}^{n} \sqrt{(x-x_i)^2 + (y-y_i)^2} + E_{TOA,i} \quad (6)$$

$$obj_{fun} = \sum_{i=1}^{n} \sqrt{(x-x_i)^2 + (y-y_i)^2} + E_{TOA,i} - r_{TOA,i} \quad (7)$$

From equation (5) we calculate the position information of an unknown sensor node using non- linear techniques.

2.2. AOA based techniques

AOA based localization based on antenna arrays for wireless sensor network, in this techniques we found a antenna array and measure (AOA) angle of arrival.

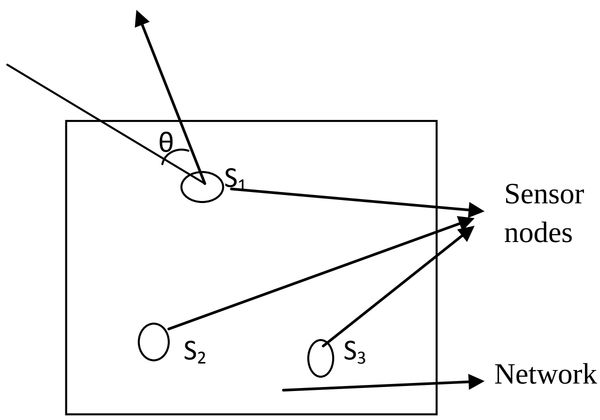

Fig 6. Angle of arrival

In this network, each anchor in the considered network be equipped with an array of 4 antennas ($\frac{\lambda}{2}$ dipoles) arranged in a square with a diagonal equal $\frac{\lambda}{2}$ (6.25 cm for the 2.4 GH_z band). By changing the direction of maximum radiation of the antenna array, a relation be is created. In order to do that the phase of the signal at all 4 antennas are objected to have 4 radio waves interfering at a specific direction according to the well-known scanning phased array (beamforming) technique [12].

In this techniques synchronization of anchors are not perfect but the transmission should be separated.

The main direction of decamp is changed every T second by a constant $\Delta\propto$. A differences in time between reception of the initial pulse and the maximum of the decamp power (Δt) allows calculating the angle of arrival of the signal -

 DOI 10.17148/IJARCCE.2015.4777

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

$$\alpha = \Delta\propto . \frac{\Delta t}{t} \quad (8)$$

The angle X_i(from the i^{th} anchor) can be used in an equation binging the coordinates of the anchor & the sensor -

$$(x-x_i) = (y-y_i) \tan \propto_i \quad (9)$$

[X, Y] or [x_i y_i] are the coordinates of the sensor & the i^{th} anchor.

For n anchor, the sensor can estimate its position using a standard least-squares approach –

$$A .C^r = b \quad (10)$$

Where

$$\begin{cases} A = \begin{bmatrix} 1 - \tan \propto_1 \\ 1 - \tan \propto_2 \\ . \\ . \\ . \\ 1 - \tan \propto_i \end{bmatrix} \\ C = [X\ Y] \\ b = \begin{bmatrix} x_1 - y_1 \tan \propto_1 \\ x_2 - y_1 \tan \propto_2 \\ . \\ . \\ . \\ x_i - y_1 \tan \propto_i \end{bmatrix} \end{cases}$$

Put the value in equation (10) or take $\sum$ for new equation

$$\sum_{i=1}^{n}(1 - \tan \propto_i) . [X, Y]^r = \sum_{i=1}^{n}(x_i - y_i \tan \propto_i)$$

$$\sum_{i=1}^{n}(x_i - y_i \tan \propto_i) = \sum_{i=1}^{n}(1 - \tan \propto_i) . [X, Y]^r \quad (11)$$

$$obj_{fun} = \sum_{i=1}^{n} |(1 - \tan \propto_i) . [X, Y]^r (x_i - y_i \tan \propto_i)| \quad (12)$$

3. PROPOSED METHOD

The proposed system estimates the optimal location of node the existing anchor nodes by using TOA & AOA & finding the solution for both at the source.

3.1. Proposed Algorithm

Step 1: let in the present network, N- anchor nodes with their known location & all of them transmitting their location, data & power, if not them assumed that the nodes already have information.

Step 2: know the node the locate estimates the signal strength of the signal received from each anchor nodes with the help of TOA & with uses equation 2 to estimate the approximate distance from each of the anchor nodes.

Step 3: After estimates distance, it starts finding the angle of arrival for each nodes by either using array antenna process or by simple directional rotating antenna.

Step 4: after calculating the distance & angle the node uses the combination of TOA, &, AOA to find its coordinates, such as equation (13).

From equation (7) and (12)

$$obj_{fun} = \sum_{i=1}^{n} |\sqrt{(x - x_i)^2 + (y-y_i)^2} + E_{TOA,}i - r_{TOA,i}| + (1 - \tan \propto_i) [X, Y] - (x_i - y_i \tan \propto_i) \quad (13)$$

Step 5: It gives best fitting solution, if in feature same other method iteration used RSSI with TOA & AOA. Then it terminates & returns the solution otherwise it give best and or low error solution.

4. CONCLUSION

A new range-based localization algorithm has been presented which is based on the Genetic algorithm, in this paper, Localization based calculation which is in the meantime enhanced by the genetic algorithm to locate the ideal arrangement of the area of the sensor node utilizing some grapple or anchor nodes. Localization algorithm is utilized to appraise the position with the deliberate by TOA + AOA (T&AOA). The reproduction a result with diverse situation demonstrates that the present algorithm gives the most noteworthy precision with a base slip of 1% with is twice superior to the nearest competitor AOA. The outcome additionally shows that just three anchor node are adequate to give best estimation the further increment in stay node prompts increment in time yet does not improves accuracy. It gives best fitting solution, if in feature same other method an iteration used RSSI with TOA & AOA. Then it terminates & returns the solution otherwise it give best and minimal error solution.

REFERENCES

[1] Guangjie Han, Huihui Xu, Trung Q. Duong, Jinfang Jiang and Takahiro Hara "Localization algorithms of Wireless Sensor Networks: a survey", Telecommunication Systems Modeling, Analysis, Design and Management ISSN 1018-4864Telecommun System, DOI 10.1007/s11235-011-9564-7.

[2] Jagoe (2003), *Mobile Location Service: The Definitive Guide*, Upper Saddle River: Prentice-Hall.

[3] Ravindra. S and Jagadeesha S N, (2013), "A Nonlinear Approach for Time of Arrival Localization in Wireless Sensor Networks", 6th *IETE National Conference on RF and Wireless IConRFW-13*,Jawaharlal Nehru National College of Engineering, Shimoga, Karnataka, India 09-11-May, pp 35-40.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

[4] Yerriswamy. T and Jagadeesha S. N, (2011), "Fault Tolerant Matrix Pencil method for Direction of Arrival Estimation", *Signal & Image Processing: An International Journal*, Vol. 2, No. 3, pp. 42-46.
[5] The Federal Communications commission about "Emergency 911 wireless services", http://www.fcc.gov/pshs/services/911-services/enhanced911/Welcome.html
[6] Pawel Kulakowski, Javier Vales-Alonso, Esteban Egea-Lopez, Wieslaw Ludwin and Joan Garcia-Haro, (2010), "Angle of Arrival localization based on antenna arrays for wireless sensor networks", article in press, *Computers and Electrical Engineering Journal Elsevier*, doi:10.1016/j.compeleceng.2010.03.007
[7] Karl H, Willing A, (2005), *Protocols and architectures for wireless sensor networks*. John Wiley and Sons.
[8] Wang C, Xiao L. (2007), *Sensor localization under limited measurement capabilities*. IEEE Network,21:16–23.
[9] S. M. Kay, (1988), *Modern Spectral estimation: Theory and Application*. Englewood Cliffs, NJ:Prentice Hall.
[10] S. M. Kay, (1993), *Fundamentals of Statistical Signal Processing: Estimation Theory*, Prentice-Hall.
[11] Y. Huang and J. Benesty, Eds., (2004), Audio Signal Processing for Next Generation Multimedia Communication systems, Kluwer Academic Publishers.
[12] Balanis CA. Antenna theory: analysis and design. John Wiley and Sons; 1997.