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One Step towards Finding AOA/TOA for Mobile Location

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Abstract

Due to development of technology mobile devices are becomes more common, to satisfy increasing demand of mobile communication more accurate calculations are required. In mobile communication angle of arrival and time of arrival plays important role for determining the actual position of the mobile nodes. In this paper we propose, design and implement an extension over calculating AOA using "HYBRID TOA/AOA SCHEME". Here we derive a new hybrid approach to find the AOA and TOA for mobile location estimation based on their previous calculations. Additionally we provide comparative study between newly designed and previously given technique.

Keywords

AOA, TOA, mobile location, performance

1. Introduction

Wireless communications refers to the transfer of information between two or more points that are not physically connected. Distances can be short, such as a few meters, or as far as thousands or even millions of kilometers. It contains various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones and wireless networking.

Angle of arrival estimation is a method for defining the path of transmission of a radio-frequency wave occurrence on an antenna array, this governs the direction by measuring the Time Difference of Arrival at different elements of the array -- from these delays the AoA can be calculated. Commonly this TDOA measurement is made through calculating the difference in received phase at each element in the antenna array.

Due to study and small literature survey we found that there are a lot of work are proposed and already done for wireless location systems. Various technologies, methods and algorithms are proposed and implemented in the past few years. A large variety of wireless location estimation techniques include angle of arrival (AOA), signal strength (SS), time of arrival (TOA) and time difference of arrival (TDOA). The signal-strength scheme uses a known model to describe the path loss attenuation with distance. The TDOA scheme measures the time difference between the radio signals. The angle-based schemes require a minimum of two BSs to determine the MS location, while the time-based schemes require at least three BSs. However, the time-based schemes generally provide better positioning accuracy than angle-based schemes.[1] MS location estimation's accuracy is depends on the propagation conditions of the wireless channels.

To improve the accuracy for the location estimation, it is required to get the idea from more than method or schemes and combine them. A hybrid TDOA/AOA location algorithm gives much better location accuracy for wideband code division multiple access systems [2]. In this paper we applied the hybrid geometrical positioning schemes to estimate MS location. [1]

In this paper we are going to work for estimate the MS location more accurately with the geographical scheme proposed in [1]. And define a new way calculation with the help of previously developed technique of location estimation.

2. Background

In the previously defined technique of MS location estimation the TOA measurements from seven BSs and the AOA information at the serving BS is used to give a location estimate of the MS, as shown in Fig. 1. Let ti denote the propagation time from the MS to BS ,i and the coordinates for BS i are given by (Xi ,Yi), i=1,2,3…….7 . The distances between BS I and the MS can be expressed as

$$r_i = c \cdot t_i = \sqrt{(x - X_i)^2 + (y - Y_i)^2}$$

where (x, y) is the MS location and c is the propagation speed of the signals. In Fig. 1 θ is the measured AOA from the serving BS with respect to a reference direction (x-axis) and defined as:[1]

$$\theta = \tan^{-1}(\frac{y}{x})$$

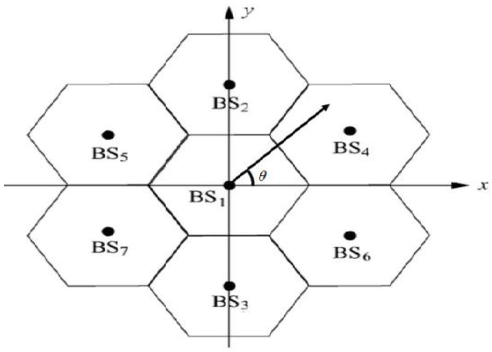


Fig 1: Geometric layout of the seven circles and a line

A. Proposed scheme

To implement and verify our derived scheme first we implement the previously developed location estimation scheme and after that we introduce our estimation technique. The first here we describe the adopted previous technique.

HYBRID TOA/AOA SCHEME: this scheme is proposed and verified using the author of [1]. We use this primary concept for calculation and propose new one.

TOA at any BS form a circle which is centered at the BS. Thus the MS location is defined by the crossing points of the circles from various TOA quantities. In the same way, a single AOA measurement makes the MS beside a line. Each of the following equations describes a circle for TOA, a line for AOA, as shown in Fig. 1.

In this method TOA circles and the AOA line is used to find all possible intersection to find the location of the MS. e true values due to the excess path length. The true MS location must lie in the region of overlap of the circles. The intersections that are within this are defined as feasible intersections. Thus this will be defined as

$$(x - X_i)^2 + (y - Y_i)^2 \leq r_i^2$$

The most direct method of approximating the MS location is use this feasible intersections of the circles and the line. However, not all the feasible intersections provide information of the same value for location estimation. In order to achieve high accuracy of MS location with less effort, several better methods which previously have proposed and one of them which is used is given as.

2.1 Distance-Weighted Method*:*

The method to estimate the X, Y location is described below.

1. Find all feasible intersection of circles
2. MS location (Xn, Yn) can be found by averaging all feasible intersection where

$$\bar{x}_N = \frac{1}{N}\sum_{i=1}^{N} x_i \quad \text{and} \quad \bar{y}_N = \frac{1}{N}\sum_{i=1}^{N} y_i$$

3. Calculate the distance di between each remaining feasible intersection (Xi, Yi) and the average location (Xn, Yn)

$$d_i = \sqrt{(x_i - \bar{x}_N)^2 + (y_i - \bar{y}_N)^2}, \ 1 \leq i \leq N$$

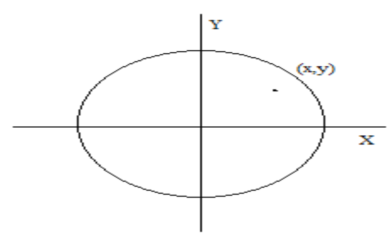
4. Set the weight for the ith remaining feasible intersection to $(d_i^{\,2})^{-1}$. Then the MS location (Xd, Yd) is determined by.

$$x_d = \frac{\sum_{i=1}^{N}\left(d_i^{\,2}\right)^{-1} \cdot x_i}{\sum_{i=1}^{N}\left(d_i^{\,2}\right)^{-1}} \quad \text{and} \quad y_d = \frac{\sum_{i=1}^{N}\left(d_i^{\,2}\right)^{-1} \cdot y_i}{\sum_{i=1}^{N}\left(d_i^{\,2}\right)^{-1}}$$

2.2 New Proposed Scheme

As the above algorithm works in the same way and system we derive a new calculation for estimating the MS location the algorithm steps are given as.

1. Find all feasible intersection of circles
2. Let us suppose the coordinate of position of MS in a particular time (Xp, Yp) than we know that a circle in trigonometry can be known as 2л, the respective average of these coordinates can be found using



Xp = ∑ Xi cos 2л Xp

Yp= ∑ Yi sin 2л Xp

3. Calculate the distance between each remaining feasible intersection (Xi, Yi) and average of (Xp, Yp)

$$d_i = \sqrt{(x_i - \bar{x}_N)^2 + (y_i - \bar{y}_N)^2},\ 1 \le i \le N$$

4. Get the exact position of the coordinate we know the exact position of coordinate is find between the 1<= I <= N and Di2. Then the MS location (Xd, Yd) is determined By

Xd= ∑ Di2(cos2л Xp + sin2лXp).Xi/ Di2(cos2л Xp + sin2лXp)

Yd= ∑ Di2(cos2л Yp + sin2лYp).Xi/ Di2(cos2л Yp + sin2лYp)

3. Simulation Setup

To evaluate the actual outcome of the designed system and previously proposed system we simulate the complete scenario of the simulation using NS2 and TCL script. The simulation environment is given in the below given table.

Table 1: simulation environment

antenna model	Omni Antenna
Dimension	750 X 550
radio-propagation	Two Ray Ground
Channel Type	Wireless Channel
No of Mobile Nodes	20
routing protocol	AODV
time of simulation	10.0

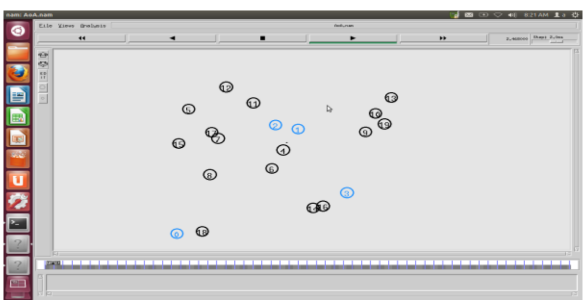


Fig 2: simulation screen

After implementation of simulation script with 20 mobile nodes looks like the above given fig-2

The basic steps of creating and simulating the complete simulation for AOA estimation the execution of the complete implementation is taken place in the below given steps.

1. environment setup
2. Initialize Global Variables
3. set up topography object
4. configure node
5. Creating node objects
6. Provide initial location of mobile nodes
7. Setup traffic flow between nodes
8. Movement procedure
9. Implement Distance Weighted Method
10. Implement new model
11. Tell nodes when the simulation ends
12. End of simulation

4. Results

In this section of paper we provide the performance study of the model designed these performance parameters are based on the simulation and found results here we provide first 10 experiment resultant values. Here we estimate two performance parameters by which we define the performance of both systems. In our first table (table 2) we calculate the angle of arrival from base station to mobile station location and, for that purpose we estimate three different parameters first angle of arrival, secondly here we provide the geometric position of mobile location in X axis and as well as in Y axis.

Table 2: calculated angle by both methods

S. No.	Real Value	Distance weighted method	New proposed method
1	3.1206	3.3239	3.3900
2	1.7903	2.5138	2.8375
3	1.1947	1.0047	2.8118
4	1.0028	1.2097	1.0150
5	1.6297	2.9717	1.4491
6	1.8784	1.5553	2.0738
7	1.5568	1.1079	1.7692
8	1.7842	1.3074	1.1992
9	2.0936	2.7728	2.8922
10	2.7168	3.2316	2.4423

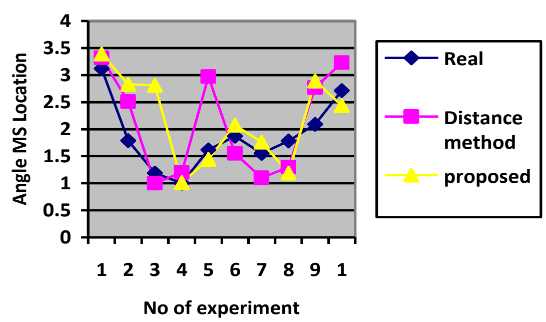


Table 3: shows X axis values

S. No.	Real values	Weighted method	Proposed method
1	571.165	373.511	481.279
2	430.2400	256.6857	399.8277
3	403.8451	370.896	420.478
4	394.3055	201.441	444.627
5	413.762	331.446	373.146
6	135.7305	209.3800	273.8823
7	549.974	430.903	496.072
8	356.702	250.605	297.611
9	104.1482	240.5464	257.7222
10	253.155	136.785	288.707

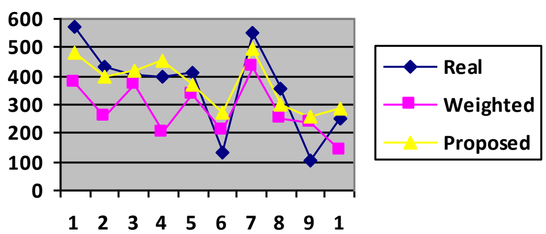


Table 4: shows Y axis values

S.no	Real values of Y	Weighted method	Proposed method
1	371.038	170.487	250.334
2	187.6984	149.5748	170.7280
3	78.241	41.423	58.143
4	86.0717	89.493	23.8949
5	20.052	79.299	15.8727
6	154.5095	132.9870	11.0789
7	336.62288	258.9900	212.1511
8	456.6289	367.6987	390.5120
9	183.511	203.600	153.757
10	147.258	295.909	112.983

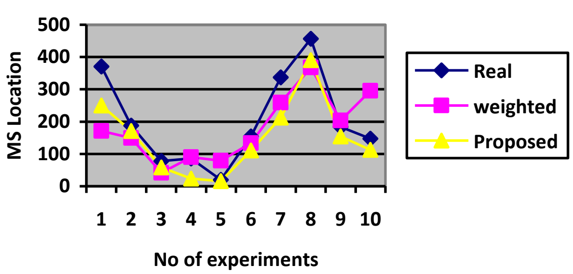


Table 2, 3 and 4 represents the real and calculated x, y coordinates by both previously proposed [1] and our derived method. After results analysis we found that that our proposed scheme provide much a near results from the previous hybrid method for estimating AOA.

5. Conclusions

The proposed scheme is based on trigonometric mathematical calculations and it is based on [1] configurations. In any circle the angle of any point can be estimated by some basic calculations. For proving our calculations we simulate the desistance weighted method and our proposed method after implementation we found that the proposed method provides better results than distance weighted method. But we found that not all the times both methods are provide good results some times DWM perform better, so the concluding results is that both methods are good for theoretical calculations but for achieving the better and adoptable method required to provide more efforts in the same direction. In future we make more efforts for gain the accurate results after modifying the proposed scheme so we get more accurate results all the time.

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