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Remote Object Tracking with Efficient Localization Using RSSI

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ABSTRACT: Localization is a important method in wireless sensor network (WSN).Global Positioning system receiver has high cost and include more number of sensor nodes while using this Localization concept. For indoor localization RSSI (Received Signal Strength Indicator) concept used to find out the unknown node depend up on the received signal strength. Three sensor nodes are used for this object tracking application these nodes are also\ called as anchor nodes or beacons. Direction of arrival (DOA) and Time of arrival (TOA) value are the important parameters in Localization. Finally the depend up on the corrected value of RSSI distance will be calculated. The proposed algorithm is ML-DONL (Maximum likelihood based Distributed optimization for Node Localization) used to improve the accuracy of the node localization and also eliminate the positional errors.

KEYWORDS: RSSI, Wireless sensor network (WSN), DOA (Direction of Arrival), ML-DONL algorithm.

I. INTRODUCTION

Wireless sensor network used in this project to transfer the information. This method used Localization concept for tracking process and also monitoring purpose. It does not need any specific knowledge about sensor nodes who are situated inwireless sensor network because it only depends up on the signal strength received from each nodes in the WSN captured by RSSI.In GPS localization used costly component for outdoor localization.RSSI is used for indoor Localization. Sensor nodes are used acoustic sensors and inertial sensor to estimate the position of the object when it is in motion condition.TDOA (Time Difference Of arrival) and TOA (Time of arrival) are important parameters to estimate the position of the object.

Some other method like relative localization method is also used to find out the unknown sensor node position in wireless sensor network [8]-[10].Maximum likelihoodestimation is used in this relative localization method.in our project we used ML-DONL(Maximum likelihood based Distribution Optimization for node localization) algorithm is used to find out the position when they are distributed in wireless sensor network(WSN). ML estimator used mapping algorithm to estimate the node position depends up on the estimated range measured in different ways.

The indoor localization method used for many applications such as wireless acoustic sensor networks, object tracking and localization, Device free environment and so on. The sensor count and sampling rate is important one in this method. If the number of sensor nodes will be increased the accuracy is improved and positional errors also reduced. Prior synchronization is not necessary in this method and also reference node also no need.

II. PREVIOUS METHOD

In[1], a set of smartphones are connected in wireless sensor networks(WSN) for indoor localization application such as indoor positioning system[5], pedestrian tracking, smart cities, teleconference system, speech enhancement system using external microphones(ex. Hearing aids) and so on. Multi-lateration and multi-angulation techniques are used to findout the position of the unknown sensor nodes. It does not need any reference node to find out the distance between the unknown sensor nodes so it is known as blind node localization.

Bluetooth, WIFI and GSM modules are available in commercial smartphones are used for localization in WSN by using RSS and RF signal to calculate the node position. Due to the multipath propagation and dynamic environment RF-based indoor localization yield low accuracy. These drawbacks could be overcome by using data fusion techniques.

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The information are combined which is comes from any sensors: RF, acoustic signal, inertial sensors, image/video and so on [6],[7].

In [4] it gives the node information in the form of image but it is not gives the information about the position of the node. So the blind node localization algorithm is proposed to find out the position of the node.In [1] this algorithm proposed to find out the position of the object. A set of smartphones are connected in WSN, each smart phone consists of two microphones also containing inertial and acoustic sensors. This algorithm no needs any reference node and synchronization. But this proposed approach has some limitations in hardware.

In [3], indoor localization is performed by RF signal processing. The node distance will be calculated using MEMS(Micro Electro Mechanical system).It contain many features like embedded devices are small, data processing operation, and communicate with all other nodes to find out the short distance. It includes some spatial diversity technique like multipath fading to find out the accurate location of the node. The range estimation diagram is below:

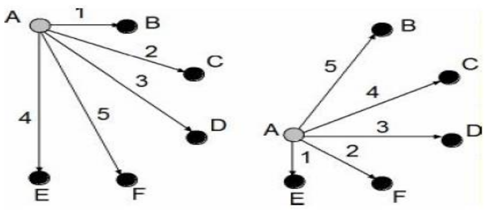

Fig: 1 RF Based indoor localization

In [3], localization is performed using TDOA (Time difference of arrival) method. In [1], TDOA method is used to find out the position of the smart phones, because the processing time of every smart phones are different so this method gives accurate result without considering the processing time. The distance between receiver and particular smartphones are estimated using coordinates that equation is below:

$$R_i = |\vec{M}_i - \vec{S}_0| = \sqrt{(x_i - x_0)^2 + (y_i - y_0)^2}.$$

And also in air the speed of the sound is calculated using below formula:

$$C_{air} = 331.5\,\text{m/s}\sqrt{1 + \frac{\vartheta}{273.15°C}}.$$

In Adhoc broadcasting WSN contain j nodes so the signal received from the different nodes in different angles.

1) Two Microphones: m1 j (t) (back microphone originally intended noise reduction) and m2 j (t) (front microphone).
2) 3-D Accelerometer: **a**j (t) = [ax j (t), ayj (t), azj (t)] [m/s2].
3) 3-D Magnetometer: **b**j (t) = [bx j (t), byj (t), bzj (t)] [μT].

The below diagram explains the distance estimation from different angle from the two microphones and the speaker. The objective of the localization is to find out the Euclidian distance and also orientation of the J nodes in the network

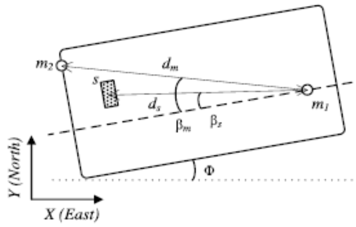

Fig: 3.2 Node Configuration: dm and Bm are the distance and the angle between the two microphones, respectively and ds and Bm are the distance and the angle between the back microphone and the speaker.

. The position matrices are below: **M**1 =[**m**1x ,**m**1y], **M**2 [**m**2x ,**m**2y], and **P** = [**p**x , **p**y] containing the 2-D Cartesian coordinates of the back microphone, the front microphone, and the speaker, respectively, for J nodes

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(i.e., **m**1x = [xm11, . . . , xm1J]T , **m**1y = [ym11, . . . , ym1J]T ,**m**2x = [xm21, . . . , xm2J]T , **m**2y = [ym21, . . . , ym2J]T , **p**x=[x p1, . . . , x pJ]T , **p**y= [yp1, . . . , ypJ]T).

$$\mathbf{M}_2 = \mathbf{M}_1 + \begin{pmatrix} d_{m1}\cos(\phi_1+\beta_{m1}) & d_{m1}\sin(\phi_1+\beta_{m1}) \\ \vdots & \vdots \\ d_{mJ}\cos(\phi_J+\beta_{mJ}) & d_{mJ}\sin(\phi_J+\beta_{mJ}) \end{pmatrix} \quad (1)$$

$$\mathbf{P} = \mathbf{M}_1 + \begin{pmatrix} d_{s1}\cos(\phi_j+\beta_{s1}) & d_{s1}\sin(\phi_j+\beta_{s1}) \\ \vdots & \vdots \\ d_{sJ}\cos(\phi_j+\beta_{sJ}) & d_{sJ}\sin(\phi_j+\beta_{sJ}) \end{pmatrix}. \quad (2)$$

The localization problem is reduced by estimating 2D coordinates using this matrix P=[px,py].

III. PROPSED METHOD

In proposed method, the sensor node positions are calculated simultaneously using location estimator. In [3] ,RSS signal of wifi estimates the node location accurately but the signal strength is poor[1].it will be performed using acoustic signal measurement in the form of RF signal. Maximum likelihood estimator based tailored algorithm used to estimate the position simultaneously. We used another optimization algorithm that is ML-DONL (Maximum likelihood based Distributed algorithm for node localization). The main two steps in this algorithm is Distributed ML estimator solve DOA uncertainty problem. Node optimization procedure is same as all nodes but each node initial condition is different.another step is centralized used to choose best solution derived from the previous step. The below block digram explains the overall simulation process of the work.

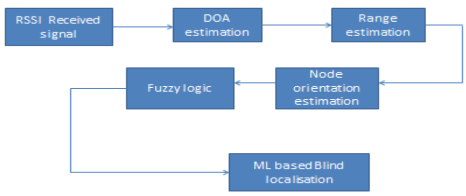

Fig: Block diagram of overall simulation process

Implementation procedure:

1. Broadcast system is enabled, but all information exchanged between nodes will travel through the master node.
2. Master node sends a request for acoustic transmission to the other nodes in the network and starts to record.
3. Receive the request for transmission and their position in the acoustic transmission queue.
4. DOA estimation of node, range estimation of node and orientation estimation of node.
5. The master node broadcasts a request to start the distributed step of the localization algorithm ML-DONL. When the nodes finish their optimization procedure, they send the results to the master node.
6. The master node selects the best solution, in terms of ML, among the J solutions obtained in the distributed step of ML-DONL and executes the second step of ML-DONL (localization).

Algorithm for blind node localization in a WSN

The belowalgorithm chart explains the optimization accuracy result improved from the first step of localization process.ML estimator is a main concept used to find out the best solution when all sensor nodes are distributed in WSN. This algorithm also used for android devices are connected in star network.

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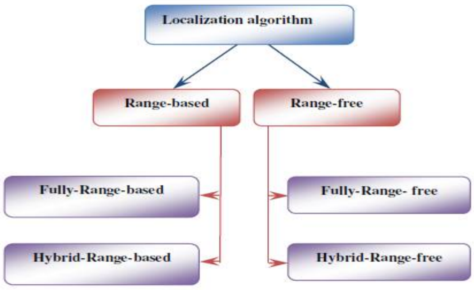

fig:Blind node localization flow chart Problem formulation and identification: Direction of arrival estimation:

Locating the source(loud speaker) as in the array's far field, the wave front coming from different nodes from different angles like αjk corresponding with the DOA, as shown in fig 3 two signal arriving time difference is expressed as τ jk= ds j cos(αjk)/c, where c is the speed of sound. DOA estimation is same as the TDOA estimation in the far field case.

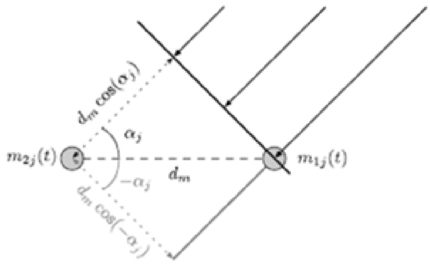

Fig:3 Illustration of the DOA estimation from two microphones m1j(t) and m2j(t) (jth node)the source sk is located in the far-field.

in 2-D case, a TDOA estimate τ jkhas two potential DOAs, αjkand –αjk.

$$\gamma_{jk} = \phi_j + \beta_{mj} \pm \alpha_{jk}.$$

Next range could be estimated depend up on that corresponding DOA measurement. In[2] DRR(Direct-to-Reverberant energy Ratio) is used to calculate the source distance depend up on that below equation

$$\mathrm{DRR} = E_D/(E_T - E_D)$$

ML estimator for node localization:

The goal of the process is used to find out the position matrix **P** = [**p**x ,**p**y] it is based on the standard deviation error as σr(j, k) and σγ (j, k). Each polar measurement (azimuth and distance pair) is converted into a measurement vector in Cartesian coordinates **d**jk= (v jk,wjk), where v jk= r jk· cos(γ jk) and wjk= r jk· sin(γ jk), with r jk≥ 0 and γjk∈ [−π, π] for all j and k from 1 to J . Let us consider the joint probability density function (pdf) of the measurements in Cartesian coordinates as a multivariate normal distribution, given by

$$f_{jk}(\mathbf{P}) = \frac{1}{2\pi |\mathbf{C}_{jk}|^{\frac{1}{2}}} e^{\left(-\frac{1}{2}(\mathbf{p}_j - \mathbf{p}_k - \mathbf{d}_{jk})\mathbf{C}_{jk}^{-1}(\mathbf{p}_j - \mathbf{p}_k - \mathbf{d}_{jk})^T\right)}$$

To evaluate proposed node localization algorithm database creation is necessary.it includes 300 sceneries to process the signals. The acoustic scenarios include both reverberation and background noise. Reverberation is controlled by the absorption coefficient of the walls. The background noise is additive white noise that covers the entire frequency range and it is controlled by the signal-to-noise ratio (SNR). Each scenario has ten similar nodes and they have been generated varying the next parameters: room dimensions from 6 to 12 m in length/width and 2 to 3 m in height, absorption coefficient from 0.5 to 1, SNR from 5 to 20 dB, and node positions and node orientations. All

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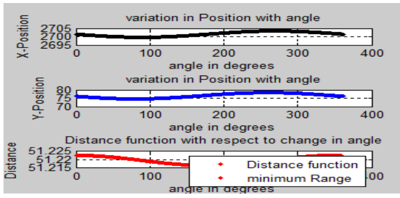
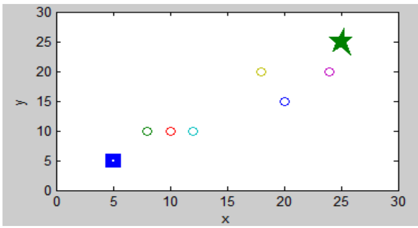
parameters are selected at random for each scenario. The RT60 has a mean value of 0.332 s and a standard deviation of 0.053 s. The positions of the nodes are restricted as if they were laying on a table with dimensions 5×2 m (a standard conference table). The minimum distance between nodes is 15 cm. The selected nodes are BQ Aquaris 4 smartphones, whose physical characteristics are the following:
dm= 0.106 m, ds = 0.096 m, βm = 9.3°, and βs = 5.9°. The sampling rate is 44.1 kHz.

IV SIMULATION RESULTS

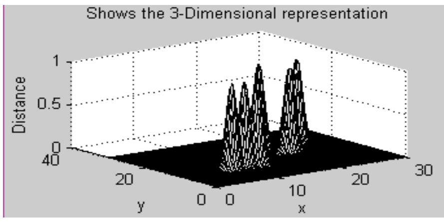
The following result were obtained by simulating the program to detect the object depend up on the signal strength received by PIC microcontroller with RSSI module which is send by the node located nearer to the object. Step by step evolution process is below:



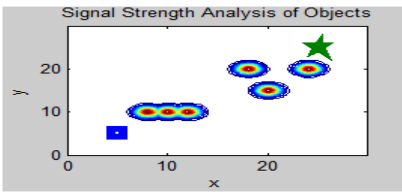
Variation in position with angel



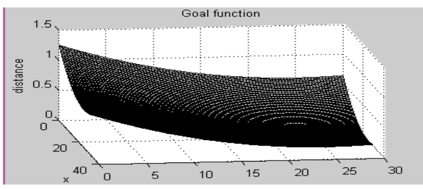
Location of anchor nodes



Sensor node 3-D object representation



Signal analysis of object



Goal function

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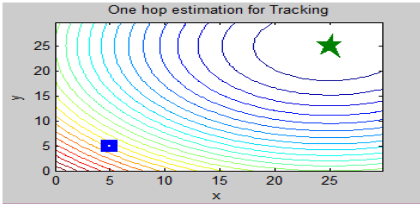
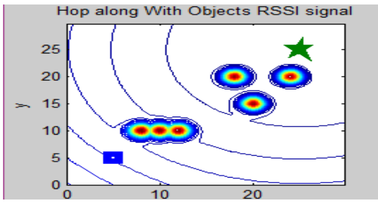
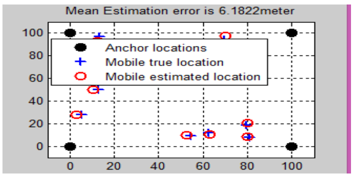


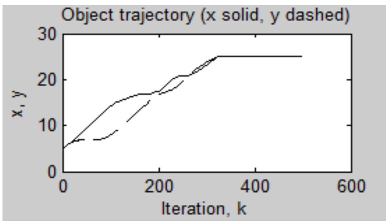
One hop estimation for tracking



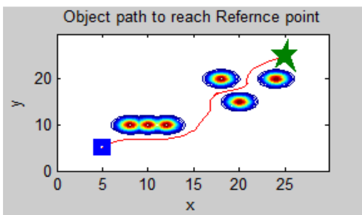
Hop along with object RSSI signal



Mean estimation error



Object trajectory(x solid dashed)



Object path to reach reference point

V. CONCLUSION

In this paper RSSI concept is used to track the object in wireless sensor network (WSN). In previous concept GPS is used only for outdoor object tracking process. But this RSSI concept especially used for indoor object tracking with accurate node localization by receiving the signal strength from different nodes using ML-DONL(Maximum likelihood based distributed optimization for node localization) algorithm and also it does not need prior synchronization and reference node.

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REFERENCES

[1] D. Ayllón, H. Sánchez-Hevia, R. Gil-Pita, and M. Rosa-Zurera, "Indoor blind localization of smartphones by means of sensor data fusion," in *Proc. IEEE Sensors Appl. Symp.*, Apr. 2015, pp. 1–6.

[2] Y.-C. Lu and M. Cooke, "Binaural estimation of sound source distance via the direct-to-reverberant energy ratio for static and moving sources," *IEEE Trans. Audio, Speech, Lang. Process.*, vol. 18, no. 7, pp. 1793–1805, Sep. 2010.

[3]P.Bahland V.N. Padmanaban, "RADAR: An in-buliding RF-based user location and tracking system."In *proc. 19th Annu.JointConf. IEEE Comput. Commun. Soc*., vol. 2. Mar. 2000, pp- 775-784.

[4] M. Werner, M. Kessel, and C. Marouane, "Indoor Positioning using smartphone camera," in *Proc. Int.Conf. Indoor Positioning Indoor Navigat.*, Sep, 2011, pp. 1-6.

[5] Y. Gu, A. Lo. And I. Niemegeers, "A survey of indoor positioning systems for wireless personal networks."*IEEE Commun. Surveys Tuts.*, vol. 11 no. 1, pp.13-32, Mar. 2009.

[6] S. Ladstaetter, P. Luley, A. Almer, and L. Paletta, "Multisensor data fusion for high accuracy positioning on mobile phones," in *Proc. 12th Int. Conf. Human Comput. Interact. Mobile Devices Services*, Sep. 2010.pp. 395-396.

[7] M. Klepel et al., "OLS: Opportunistic Localization system for smart phones devices." In *Proc. 1st ACM WorkshopNetw., Syst., Appl. Mobile Handhelds*, Sep. 2009, pp. 79-80.

[8] C. Savarese, J. M. Rabaey, and J. Beutel. "Locating in distributed ad-hoc wireless sensor networks," in Proc. IEEE Int. Conf. Acoust., Speech Signal Process., vol. May 2001,pp.2037-2040.

[9] A.Savvides, C.-C.Han,andM.B.Strivastava, "Dynamic fine-grained localizationinad-hocnetworksofsensors,"in*Proc.7thAnnu.Int.Conf.Mobile Comput. Netw.*,Jul.2001,pp.166–179.

[10] F.Mondinelli and Z.M.Kovacs-Vajna, "Self localizing sensor network architectures," *IEEE Trans. Instrum. Meas.*,vol.53,no.2, pp.277–283, Apr.2004.