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Target Tracking using RSSI In WSN

[1] Anuradha R.Lohar [2] S.A.Khandekar
[1] Student [2] Assistant Professor
[1][2] Department of Electronics Engineering
MIT AOE, Alandi

Abstract:-- **In many wireless sensor network applications like target tracking recovery operation, catastrophic management, & environmental monitoring the position estimation is a crucial element. When talking about the success of localization technique the localization accuracy is the most important factor to be considered. The RSSI range based localization algorithms is simple and cost effective localization technique that relies on measuring the received signal strength indicator (RSSI) for distance estimation. This paper present research & development of tracking system using RSSI, KF & UKF.The proposed system is an efficient solution for tracking the object**

Keywords:— **RSSI, Kalman Filter, Unscented Kalman Filter.**

I. INTRODUCTION

Wireless sensor networks (WSNs) have evolved into the apotheosis of pervasive technology, because they are constructing many activities in our society. WSNs have an infinite cluster of promising applications in both military and civilian applications, containing land-minedetection, battlefield surveillance, target tracking, environmentalmonitoring, wildfire detection, and traffic regulation. The strength of sensor location is the common component included in all of these critical applications. The important function of a WSN is to detect and report events which can be consciously incorporate and known. In addition to this, in any WSN, for understanding the application circumstance, the location information of nodes plays an important role. Mainly there are the three apparent benefits of knowing the location facts of sensor node. First, to recognize the location of occurrence of significance, the location information is essential. For example, the locationof a criminal, the location of a fire, or the location of enemy tanks in a battlefieldis of detracting significance for arranging recovery and respite contingents. Second, location directory services which support the doctor with the knowledge of neighbouring medical equipment and personnel in a smart hospital, target-tracking applications for locating residue in detritus, or enemy tanks in a battlefield, these all are some numerous application services which facilitates the location awareness. Third, geographical routing network coverage checking , and location-based information querying these are the some system functionalities in which the location awareness can help. Therefore, with these benefits and much additional, it is but natural for location informed sensor devices to become the defacto standard in WSNs in all application domains that provide location-based service.[1]

There is one solution for this, is to equip each sensor with GPS receiver which provides the exact location of sensor to which it equipped. But this is not possible from economic point of view as very large no of sensors are used and manual configuration is too bulky and therefore not practical. Hence, localization in sensor network is very dispute. In past, abundant protocols have been designed to facilitate the location analysis mechanism in WSNs to be self-governing and able to operate separately of GPS and other manual techniques. The important mark of location analysis has been a group of attribute nodes calls as beacon nodes, which have been mentioned to by some analyst as anchor, locator, or seed nodes. These anchor nodes perceive their location, either through a GPS receiver or through manual configuration, which they transfer to other sensor nodes. With the help of this position of anchor nodes, sensor node estimates their position utilizing different methods. Hence, It is important that malignant anchor nodes be obviated from giving wrong position information after all sensor nodes totally depend on the information given to them for c estimating their position.There are three vitalelements correlate with localization: energy efficiency, accuracy, and security.

II. RELATED WORK

Currently, various localization methods for WSNs have been given. These localization algorithms divided into two types: range-based and range-free schemes .Range-based schemes are commonly attached bysupplementary sensor hardware which measures the distances or angles of the signals being transmitted between the nodes such as Time of Arrival (TOA) [2], Time Difference of Arrival (TDOA) [3], and Received Signal Strength Indicator (RSSI) [4]. Thedefects are easier to be interfered by multipath, fading, and noise and an extra hardware is essential.

On the other hand, range-free schemes avert expensive hardware by applying inter-node communication and the sensing range of the node to evaluate the location of the sensor nodes such as Centroid [5] and DV-HOP [6]. Few area-based localization schemes are advanced to confine the available region for a sensor node. These waysusually require a huge amount of fixed anchor points include a huge computation for attaining greater accuracy. In addition to this,huge communication betweenadjacent sensor nodes create ahuge traffic load. A huge range of WSN-based position and tracking systems have been studied and noticed [7,8,9]. In this paper focus is on RSSI based localization systems.

However WSNs were not planned for the objective of localization applications, calculating the RSSI values for each transmitted message may give localization information of mobile targets. The work given in [10] contains a RSSI based localization system through IEEE 802.15.4 protocol standard at 2.4 GHz. The system was expanded for inventory andposition of moving assets in an indoor office building. Cortina is a distributed real-time position systemplanned to track assets or people moving indoors, through using theRSSI measurements from nearby sensor nodes [11]. A fingerprinting indoor positioning system using the RSSI of a ZigBee WSNs and IEEE 802.15.4 WSNs presented in [12]. A hybrid localization system based on RSSI using divide-and conquersstrategy presented in [13].

III. METHODOLOGY

Signal strength can be calculated at receiver when it receives the packet transferred from transmitter. RSSI is a unit less metric used to estimate the power of the received radio signal that are equipped with an on board transceiver. The RSSI is an analogous indicator and the more the value of the RSSI, the stronger is the signal. The calculated value provided by the module may not be accurately the received power in dBm. Yet, received signal strength indicator (RSSI) is used to give the condition of received power level.This can be simply converted to a received power by applying offset to calibrate to the correct level.

$$RSSI = -(10*n*\log10(d) + A)$$

Where

n: path loss exponent (constant & environment dependant)

d : distance at which RSSI is to be found out

A: RSSI at 1 meter distance

RSSI is the unit less metric used to measure the power of the received radio signal, It is represented by one byte integer and can assume any value in range 0 to 255.Nowdays, most of the trans receiver are equipped with a circuitry that measures RSSI.In this work we use C8051F930 WSN node that are equipped with on board RF-SI4461 transreceiver.

The Target coordinates using pure RSSI are given as follows

```
A = X1^2 + Y1^2 - d1_est^2;
B = X2^2 + Y2^2 - d2_est^2;
C = X3^2 + Y3^2 - d3_est^2;
X32 = (X3 - X2);
Y32 = (Y3 - Y2);
X21 = (X2 - X1);
Y21 = (Y2 - Y1);
X13 = (X1 - X3);
Y13 = (Y1 - Y3);
X_T = (A*Y32 + B*Y13 + C*Y21) / (2*( X1*Y32 + X2*Y13 + X3*Y21));
% X coordinante of target
Y_T = (A*X32 + B*X13 + C*X21) / (2*( Y1*X32 + Y2*X13 + Y3*X21));
% Y coordinante of target
```

Once we get estimated locations using RSSI, Now Next step is to use Kalman Filter or Extended Kalman filter to improve accuracy of estimation process, as RSSI values are generally fluctuating (corruption due to noise). These filters use system equation & observation equation.

X = A*X + B*U + [randn; randn; randn; randn];
…………………… system equation ……….(1)

Y = H*X_meas + [randn; randn; randn; randn];
…………………… observation equation…..(2)

Where X = [x; y; x_v; y_v]………state vector

X_meas = [x_rssi; y_rssi; x_v_calc; y_v_calc]……….observation vector

x & y : initial target coordinates x_v & y_v : initial velocities in x & y directions

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 12, December 2016

x_rssi & y_rssi: target coordinates obtained using RSSI
x_v_calc & y_v_calc: calculated velocities from x_rssi & y_rssi

- We have to use equation 1 & 2 for number of iterations to improve localization & tracking of target
- Find RMSE from estimated locations (using KF / UKF) & actual target locations

1. We will be implementing WSN nodes based on si lab RF chipset
2. Every node will be coin cell operated and will be having RF networking capabilities. On request every WSN node provides its RSSI. We will implement mesh of 8 nodes in first phase
3. A synch node will be connected to PC. And a MATLAB based UI will be used to access this WSN.
4. Using bacons and reference nodes we will map the mesh of 8 nodes to real world GPS coordinates with necessary offsets
5. Once mapping is done and UI is activated (just shown in movie battlefield), our WSN is ready for getting database of RSSI values relative to unknown node (foreign node)
6. We will move a foreign node with RF source in this WSN. Synch node will generate reading of RSSI every 100ms. All values will be stored in MATLAB database
7. Based on improved results we will compare accuracy of measured position with GPS

IV. RESULTS

In order to test the efficiency of proposed work in this paper three localization systems have been implemented. The first test the target location using RSSI system, in second the kalman filter is introduced along with RSSI to improve accuracy and finally in third for finding exact location the extended (Unscented KF) is combined with pure RSSI scheme.

In fig 1 the comparative study of all the algorithms ismapped. Here from graph it is clear that the location accuracy increases as the new algorithms are implemented. Fig 2,3,4,5 shows the error in respective algorithms with time. Fig 6 elaborates the non-linearity of RSSI with distance.

Fig 1: Target tracking based on RSSI

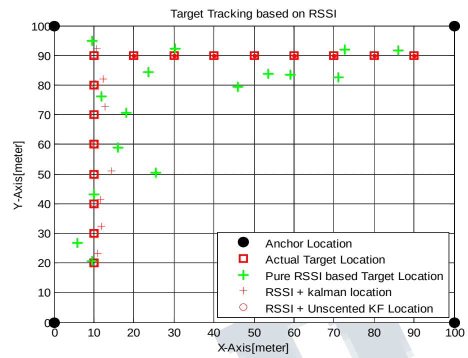

Fig 2: Error in X in UKF implementation

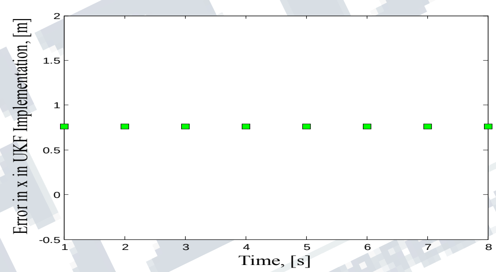

Fig 3: Errors in Y in UKF implementation

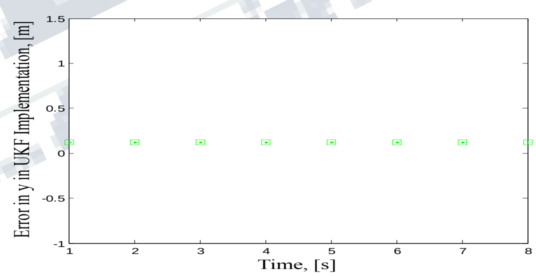

Fig 4: Errors in Y in KF implementation

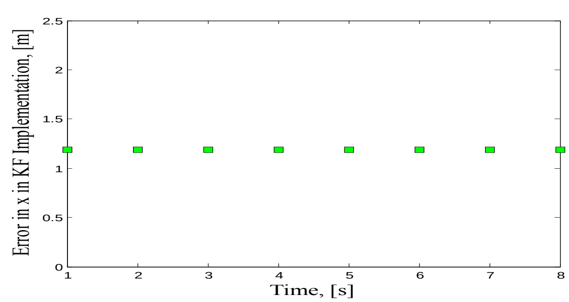

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Fig 5: Errors in Y in KF implementation

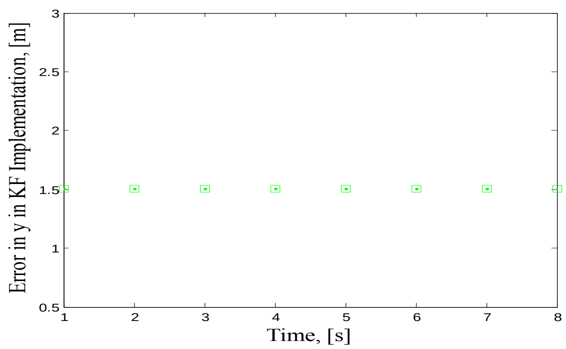
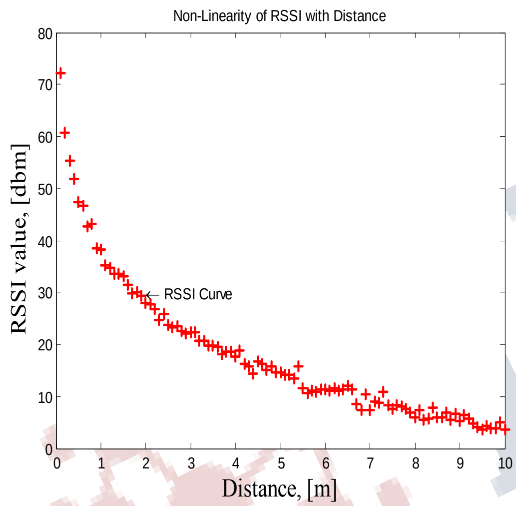


Fig 6: Non linearity of RSSI with distance



V. CONCLUSION

The objective of this work has been to show the accuracy of using RSSI measurements in estimating the relative position of sensor nodes in WSN.In this paper we proposed a RSSI+KF+UKF tracking system. The experimented result shows that the proposed algorithm in this paper raised the localization accuracy without increasing the complexity and cost.

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