A Comparison between Vector Algorithm and CRSS Algorithm for Indoor Localization

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Keywords: Indoor localization. CRSS, RSS.

Abstract

In this paper a comparison between two indoor localization algorithms using received signal strength is utilized the vector algorithm and the Comparative Received Signal Strength algorithm. The comparison considered the effect of the radio map resolution, the number of access points, and the operating frequency on the accuracy of the localization process. The experiments were carried out using ray tracing software, measured values and MATLAB.

1 Introduction

Indoor localization has become one of the most attractive areas in the research nowadays. The concept of location based services has many applications like business initiative as enquiry and information services and mobile marketing, and for Public Initiatives which include enhanced emergency services.

2 Received Signal Strength

The idea behind localization using RSS is to establish a one to one relationship between the target location and its received signal strength .The major principle for the received signal strength is that as the distance between the target node and transmitter increases, the signal becomes weaker.RSS localization systems excel in short range distances. Moreover, RSS is sensitive to shadowing, low signal to noise ratio (SNR), and non-line of sight propagation. The shadowing and reflection is normally represented by a log normal random variable [1].

3 RSS Comprehensive

The idea behind localization using RSS Comprehensive is to establish a one to one relationship between the unknown and the known received signal strength. The entries of this matrix are determined by the comparisons between the RSS values as in Equation 1 [2]:

$$c_{ij}(x,y) = \begin{cases} 1 & R_i > R_j \\ -1 & R_i < R_j \\ 0 & R_i = R_j \end{cases} \qquad (1)$$

Where $c_{ij}(x,y)$ is the entry of the matrix at row i and column j , R_i is the RSS reading from Access Point i at the location (x,y) and (x,y) is the location for the mobile which considered to be unknown.

4 Angle of Arrival (AOA)

Angle of arrival (AOA) method makes use of incident angles of WLAN signal to a WLAN enabled receiver and the intersection of angle direction lines to estimate the position. AOA assumes the mobile device can detect the incident angle of WLAN signal or know the direction of access point that broadcast the WLAN signal. AOA requires at least two access points from two different locations; the position of the user can be estimated at the intersection of the lines of bearing from the two access points.

Assuming the distances between the access points and user location to be $d_1, d_2, and\ d_3$, where d_0 the initial received signal strength at the reference distance is. We can calculate the distance $d_1, d_2, and\ d_3$ as follows:

$$d_n = (\,{d_0}^2 * \frac{P_0}{P_n})^{.5} \qquad (2)$$

Initially, d_0 is the initial received signal strength at the reference distance of d_0.
We can use the triangulation approach with AOA to estimate the position of user. After calculating the distance, we find the angle θ_1, $\theta_2\ and\ \theta_3$ between the user position and APs, and then we are able to calculate the possible position matrix of the user as follows:

$$\begin{pmatrix} x_1' & y_1' \\ x_2' & y_2' \\ x_3' & y_3' \end{pmatrix} = \begin{pmatrix} x_1 + d_1\cos\theta_1 & y_1 + d_1\sin\theta_1 \\ x_2 + d_2\cos\theta_2 & y_2 + d_2\sin\theta_2 \\ x_3 + d_3\cos\theta_3 & y_3 + d_3\sin\theta_3 \end{pmatrix} \qquad (3)$$

Averaging the value of position matrix, we can estimate the user position as follows:

$$x = \frac{x_1' + x_2' + x_3'}{3} \qquad (4)$$
$$y = \frac{y_1' + y_2' + y_3'}{3}$$

5 The Model

The actual environment, for the measurements and analysis of the MIMO systems was a lab, at the An Najah National University. The materials of the walls, doors, ceiling, ground and windows were physically verified in order to have an approximation of the widths of each element as shown in Figure 1.

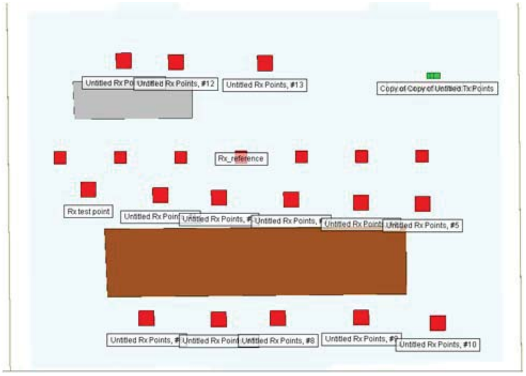

Figure 1: Lab Plan Simulated Model including the transmitter and the receivers

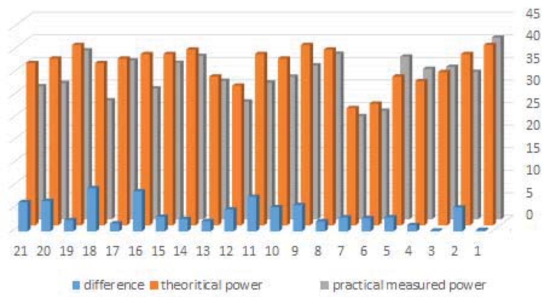

Figure 2: Measured and simulated RSSI.

The simulation was performed Wireless Insite Software through 3D Shoot and Bouncing Ray (3D SBR) technique, which allowed evaluation of the paths launched from the transmitter. The measurement campaign was developed to evaluate the field strength distribution using one laptop and two MIMO 2×3 systems The waveform type used for the simulations was a Gaussian waveform of 2410 MHz frequency with 23 MHz bandwidth. The antenna type implemented were linear dipoles, vertically polarized with a 6 cm length

5 Simulations and Result

Figure 2 show the comparison of the received signal strength measured per receiver location and the simulation of the 3D RSSI Scenario results. The simulated results are an average of the received signal obtained for the maximum and minimum transmission power of the antennas.
The RSS method was used to determine which point in the Lab is the closest to the test point by comparing the difference in the RSS readings, also the CRSS algorithm was used to make the same comparison.

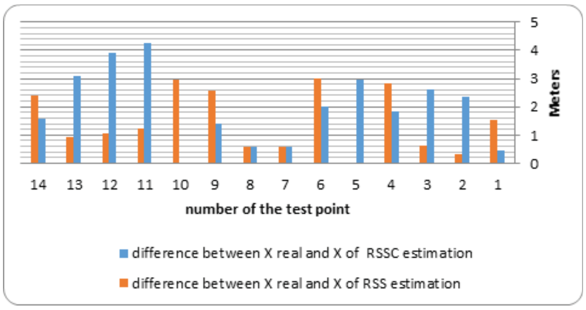

Figure 3: error in meters using the RSSI and CRSS algorithms

Figure 3 shows the x-axis error in meters using the RSSI and CRSS algorithms based on the measured data.

Then we used the results for the closest point obtained by the CRSS algorithm the x and the y location of the test point using the AOA algorithm.
Figures 4 and 5 shows the estimated and real vales for x and y, also the error was calculated and shown.

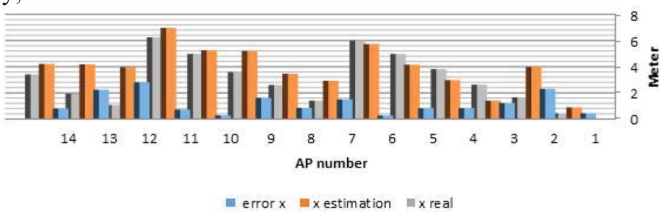

Figure 4: Comparison between the real and estimated values of x

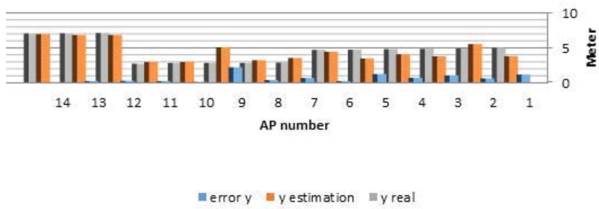

Figure 5: Comparison between the real and estimated values of y.

Reference:

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