Algorithms for Indoor Localization on WLAN Networks Applications

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Abstract— A locating system for indoors has been tried to develop by using WLAN systems (protocol number: IEEE 802.11). Wireless modems using IEEE 802.11 protocol installed all around 4 corners of corridor were used as RF transmitters as well as laptop computer was used as RF receiver. A computer software generated by EMUMAM software group was used in order to calculate RSS, and 672 different measurement data were collected. Each location measurement was repeated by 7 times. 100% location success rate is achieved within the ±10% deviation and ±5% deviation in exact location is achieved with 75% success.

1. INTRODUCTION

Increased popularity of locating technologies requires that development of a proper indoor propagation model is essential for obtaining precise indoor location. Use of a proper model is not only required for indoor localization but also Body Area Network (BAN) systems and personal tracking systems in in forest areas [1–3].

This paper proposes algorithms for location applications for indoor scenarios over Wireless Local Area Networks (WLAN). We compare the use of radio frequency (RF) power levels based on ray-tracing as detection methods to estimate the localization of a set of mobile station using the fingerprint technique. Wi-Fi (802.11x) and Wi-Max (802.16x) standards play an important role in applications of high frequencies techniques for locations as a detection method. The proposed algorithm computes the Euclidean distance between the samples of signals received from each known source position and radio-map obtained using EMUMAM's simulation tool. The Euclidean distance has been compared with others similarity distance measures. Experimental results show that more precision can be obtained at same level instead of different floor location of transmitter and receiver. An effect of increasing the number of transmitters has also been investigated and compared. Proposed algorithm allows to obtain very precise indoor localization over WLAN networks. WiFi systems using IEEE 802.11 procols have been used for generating indoor locating algorithms that they use RSS measurements [4, 5].

2. INDOOR PATH LOSS MODEL

Friis uqaution is basically used for calculating path loss between tranciever couples operating line-of-sight, and let us to calculate distance between those couples. Instead varying indoor propagation models are valid in the literature [6–8], very common model used for indoor path calculation using Radio Signal Strength (RSS) is given in Equation (1).

$$P\left(d\right) = P\left(d_0\right) - 10 \times n \times \log\left(\frac{d}{d_0}\right) + \zeta \tag{1}$$

where $P(d)$is the signal strength obtained by the receiver at a distance of d and $P(d_0)$ is the received signal strength at 1 m distance (means referance signal) both in dBm, n is the path loss index for indoors, and ζ is the random variable describing shadowing factor [6, 9].

3. DERIVATION OF n AND MEASUREMENT CAMPAIGN

At first glance, it seems that it had better to use values of n given in the literature rather than calculating new one; however, n value is a value strictly depend on interested campaign. Figure 1 gives measurement campaign, and there are 6 WiFi transmitters located around the corridor which are shown as red stars. Given corridor is 7.2 m wide and 50 m length, and measurement points are aligned by 60 cm apart from each other that we determine 120 different locations. It has to be noted that each transmitter has its own "n" value that is going to be used in path loss.

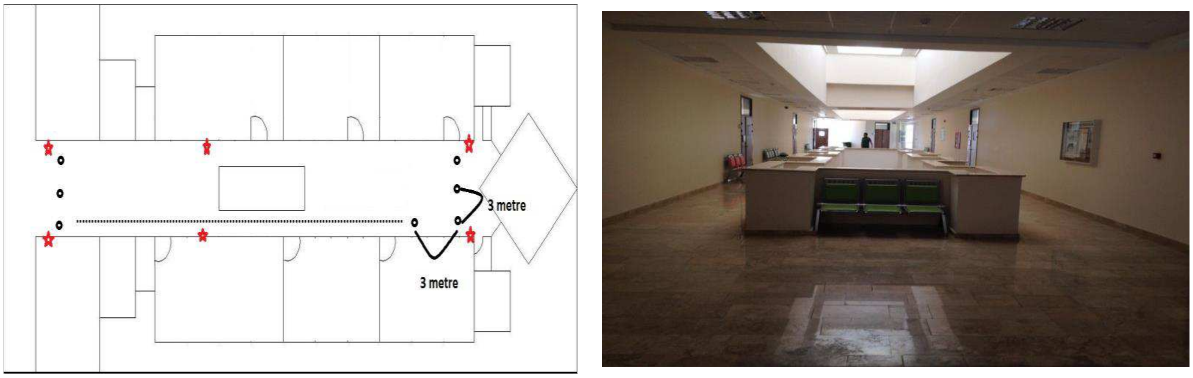

Figure 1: Second floor of engineering faculty.

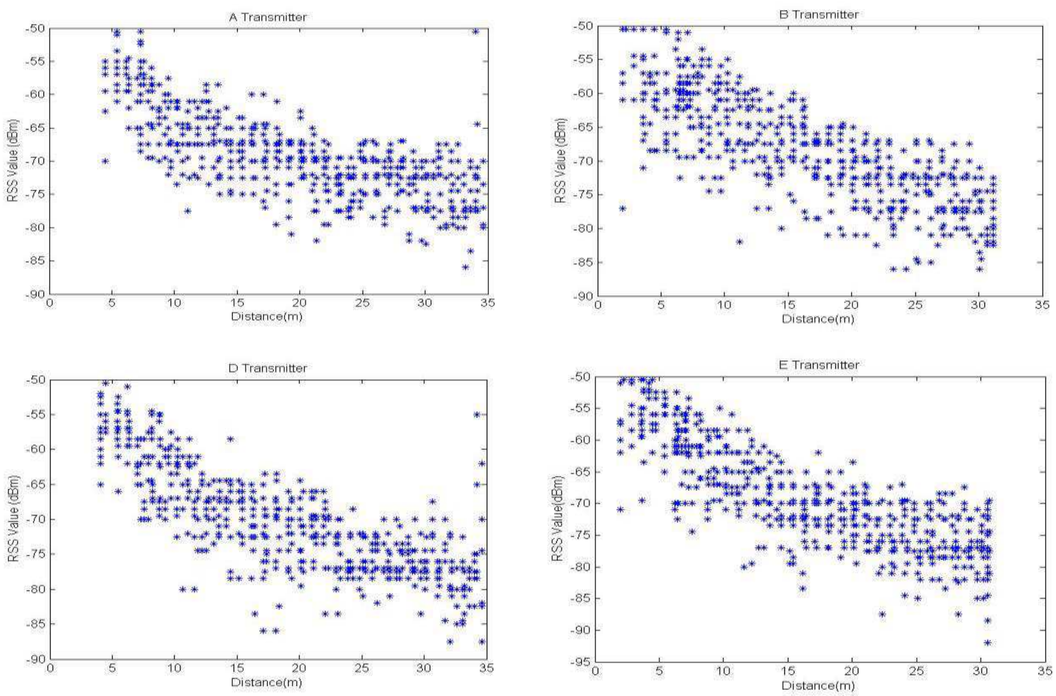

Figure 2: Obtained RSS values related to 4 different WiFi transmitters.

4. RESULTS AND CONCLUSIONS

Figure 2 shows measured RSS values at pre-determined locations which are used for calculating "n" values of each transmitter. Since the path loss equation is basically given by Eq. (2a) in draft, logarithmic form of n is given by Eq. (2b).

$$path\ loss \propto \left(\frac{d}{d_0}\right)^{-n} \tag{2a}$$

$$n = 10\log_{10}(d/d_0) \tag{2b}$$

For those given locations calculated "n" values are calculated as shown in Figure 3.

Figure 4 shows predicted locations and real measured locations. As easily seen from the figures that 100% location success rate is achieved within the ±10% deviation and ±5% deviation in exact location is achieved with 75% success.

Predicted results at initial step of current project shows that very preceise indoor location estimation has been achived in case of small distance between Rx and Tx. 100% location success rate is achieved within the ±10% deviation and ±5% deviation in exact location is achieved with 75% success rate.

The Smart Locater a software which is currently being developed in our group will have a

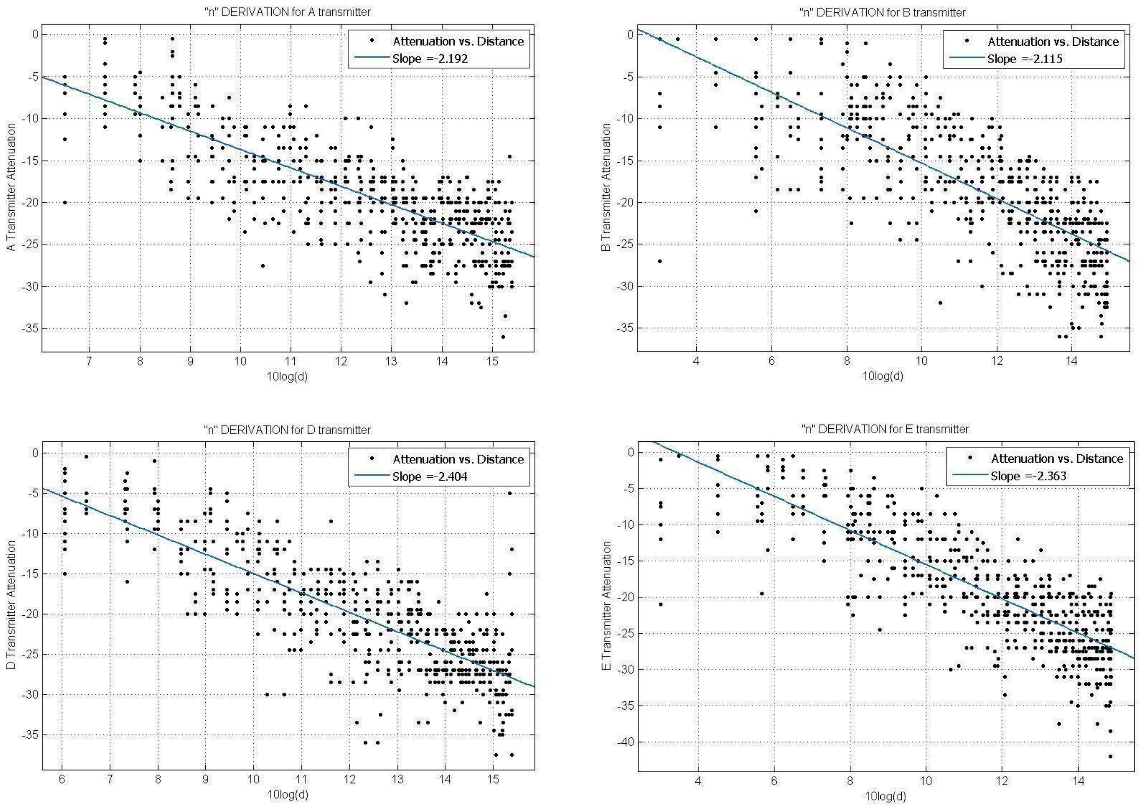

Figure 3: Calculated n values.

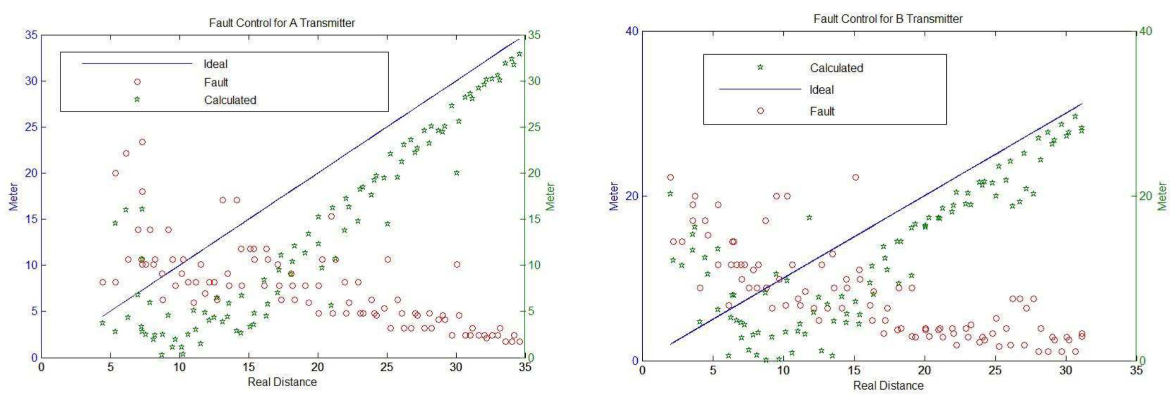

Figure 4: Measured and predicted distance.

capability to decide which "n" value need to be selected in a certain location will improve the system's preceise. Up to know, our group did not concenrate on location update time duration or locating speed of system, and this will be another subject that will be taken into accout in near future.

EMUMAM group is also working on ultrasonic and acustic indoor systems as well as high frequency indoor systems, and aimed to design hybrid indoor systems.

ACKNOWLEDGMENT

This project was granted by TÜBİAK 2209-A (PN: 1919B011303278) and Akdeniz University, Scientific Research Projects Supporting Unit (BAPYB).

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