Monitoring Spot Configuration of RSS-based Factor Graph Geolocation Technique in Outdoor WSN Environments

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1 Introduction

This paper investigates the accuracy of received signal strength (RSS)-based factor graph (FG) geolocation technique in outdoor environment of wireless sensor networks (WSN). The current RSS-based FG geolocation technique is evaluated in small area of indoor environment with shadowing fading channel [1]. Therefore, this paper considers the path-loss fading channel by averaging RSS samples of each monitoring spot[1] and target, where the averaging is long enough to eliminate the shadowing and small-scale fading component of RSS. This paper shows the effect of the number and wide area of monitoring spot to the accuracy of RSS-based FG geolocation technique in outdoor environment.

2 Simulation

Area of investigation in this paper is $1,000 \times 1,000$ m^2. The square wide area of monitoring spot is evaluated from 100×100 m^2 until 800×800 m^2. The configuration of location in the simulation as follow, initial point of iteration is at $(0, 0)$ m, and three sensors location is at $(100, 0), (1100, 0), (600, -1000)$ m. Target location is randomly permuted 80×80 m^2 where the grid is every 10 m and $(600, -500)$ m is the center. The position of the sensor, target, and monitoring spots are shown in Figs. 1a and 1b.

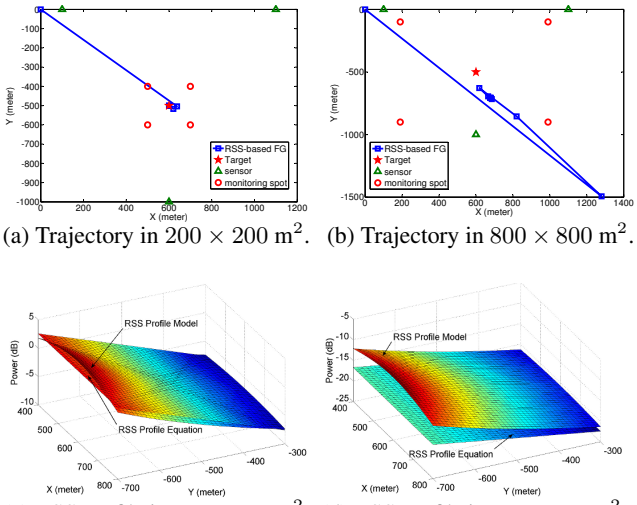
The exponential path-loss model P_L is expressed as $P_L(d) = 20 \log\left(\frac{4\pi d_0 f_c}{c}\right) + 10n \log\left(\frac{d}{d_0}\right)$, where frequency carrier f_c is 1 GHz, reference distance d_0 is 100 m, path-loss exponent n is 3 for urban area, and d is distance from sensor to target or monitoring spot. The RSS-based FG geolocation technique in this simulation is same as in [1]. The simulation is conducted in $10,000$ realizations, where each realization contains 10 iterations and 100 samples of RSS target. Each sample is from path-loss exponent (in watt), which is added zero-mean Gaussian noise as error measurement with σ_{RSS} is from $4 \cdot 10^{-6}$ until $13 \cdot 10^{-6}$ watt.

RSS-based FG geolocation technique employs the equation of linear plane derived in [1] as expressed as $a_x x + a_y y + a_p p = c$, where x and y is coordinate position, a_p is the RSS of target, and c is constant which we set 1. a_x, a_y, and a_p are the variable coefficients obtained by applying the leased square (LS) to the RSS monitoring spot. Therefore, the accuracy is depending on how the RSS profile of linear plane matches the actual RSS profile (RSS profile model).

3 Result

Fig. 1a shows the trajectory reaches the target position after several iterations in monitoring spot area 200×200 m^2 because the RSS profile of model and the RSS profile of the equation are almost fitted each other as shown in Fig. 1c. In other hand, Fig. 1b shows the trajectory can not reach the target position accurately after several iterations in monitoring spot area 800×800 m^2 because the RSS profile of model and the RSS profile of the equation are separated far away each other as shown in Fig. 1d.

[1] In this paper, monitoring spot is used instead of training point in [1] for better expression.



(a) Trajectory in 200×200 m^2. (b) Trajectory in 800×800 m^2.

(c) RSS profile in 200×200 m^2. (d) RSS profile in 800×800 m^2.

Fig. 1. RSS profile in sensor 3 and trajectory of RSS-based FG.

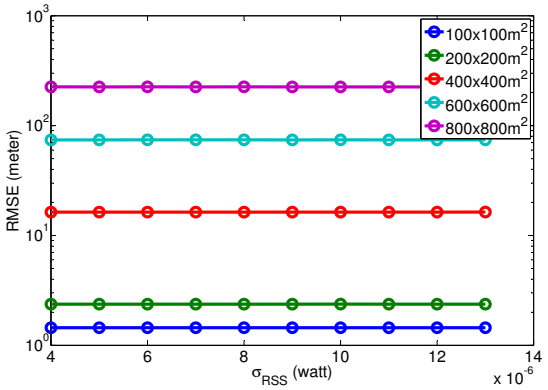


Fig. 2. RMSE vs. σ_{RSS} for each wide area of monitoring spot.

Fig. 2 shows that the accuracy increases when the area of monitoring spot is getting smaller. The accuracy of RSS-based FG geolocation technique is not depending the number of monitoring spot due to the LS property. If the monitoring spot number increases and spreads, then the accuracy is depending on how close the monitoring spot to the target.

4 Conclusion

The RSS-based FG geolocation technique is successfully evaluated in outdoor environment of WSN. The smaller area of monitoring spot around the target, the higher accuracy is obtained.

Reference

[1] C.-T. Huang, C.-H. Wu, Y.-N. Lee, and J.-T. Chen, "A novel indoor RSS-based position location algorithm using factor graphs," *IEEE Trans. on Wireless Comm.*, vol. 8, no. 6, pp. 3050–3058, June 2009.