2012 International Conference on Indoor Positioning and Indoor Navigation, 13-15th November 2012

Statistical Path Loss Parameter Estimation and Positioning Using RSS Measurements in Indoor Wireless Networks

Henri Nurminen, Philipp Müller, Simo Ali-Löytty and Robert Piché
Department of Mathematics
Tampere University of Technology
Tampere, Finland
{henri.nurminen, philipp.muller, simo.ali-loytty, robert.piche}@tut.fi

Jukka Talvitie, Elena-Simona Lohan and Markku Renfors
Department of Communications Engineering
Tampere University of Technology
Tampere, Finland
{jukka.talvitie, elena-simona.lohan, markku.renfors}@tut.fi

ABSTRACT

Each access point (AP) of a wireless network has specific signal transmission and attenuation characteristics that are not known but have to be estimated using pre-collected data. Statistical uncertainty is unavoidably present in the result of the estimation process, and it is mathematically challenging to take this uncertainty into account within logarithmic measurement models.

A simple statistical path loss model is used to model signal propagation in space. A Bayesian method with uninformative prior is presented for estimating the parameters of the chosen model for an AP using pre-collected learning data. The number of required path loss parameters is kept small in order to relax the computational complexity and the amount of information required in the positioning phase. As a built-in property, the presented method returns uncertainty estimates for estimated parameter values.

Furthermore, this article shows the influence of path loss parameter distributions on the positioning results. Three positioning methods are presented: grid method which achieves arbitrary model accuracy, Monte Carlo -based Metropolis–Hastings sampler and computationally lighter Gauss–Newton method. For each of these, two versions are implemented: one is the conventional method in which the path loss parameter estimates are assumed accurate, and the other assumes the parameters to follow specified prior distributions.

The methods are tested using real WLAN data that is collected at the university campus. All the measurements are made indoors, where satellite-based positioning is unavailable. The tests indicate that the new methods outperform the conventional methods especially in the consistency of error estimates. Taking the uncertainties into account may be computationally demanding, but the Gauss–Newton optimization method regularized by a prior distribution is shown to provide a satisfactory approximation with computational load that is reasonable for many real-time solutions.

KEYWORDS: indoor positioning, RSS, WLAN, path loss model