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# Device Self-Calibration using Signal Strength Histograms

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## ABSTRACT

Traditionally, positioning with WiFi Received Signal Strength (RSS) fingerprints involves the laborious task of collecting a radiomap with a reference mobile device. Acceptable accuracy can be guaranteed only in case the user carries the same device, while positioning with different devices requires a *calibration* step to make the new devices' RSS values compatible with the existing radiomap.

In the literature, a linear relation between the RSS values reported by heterogeneous devices has been observed experimentally, leading to data fitting approaches where the user has to collect a series of RSS measurements at several *known* locations (i.e. the user has to be familiar with the area). Subsequently, the parameters are estimated through standard least squares fitting. Device calibration with RSS data recorded at *unknown* locations is feasible, but computationally expensive methods are required to obtain the linear fitting parameters. More importantly, both approaches imply a considerable data collection effort by the user prior to positioning.

We propose a novel device self-calibration method that uses histograms of RSS values. First, we use the existing radiomap to obtain the RSS histogram of the reference device. Subsequently, when the user enters a building and starts positioning, the observed RSS values are recorded simultaneously in the background in order to create and update the histogram of the user device. Then, we use the RSS values that correspond to the $10^{th}$, $20^{th}$, …, $90^{th}$ percentiles of the empirical cumulative distribution function to fit a linear mapping between the user and reference devices.

The proposed method is simple, yet very effective and does not require any user intervention, unlike the existing RSS data fitting approaches. Moreover, our calibration method is running concurrently with positioning, while the user walks freely inside the area of interest. Experimental results with five smartphones in a real indoor environment indicate that soon after positioning is initiated the user device has been automatically calibrated and the positioning system delivers accuracy as good as in the case of using a radiomap that is created from data collected with the same device.

**KEYWORDS**: Indoor positioning, WiFi, Fingerprinting, Device calibration, Signal strength histograms.