# Wireless LAN based Indoor Positioning using Radio-Signal Strength Distribution Modeling

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## ABSTRACT

Aiming to solve one of the serious problems of radio-signal strength (RSS) indoor positioning (namely, fluctuation of RSS values due to reflective waves), a novel indoor-positioning method based on RSS distribution modeling (called "RSS distribution modeling using the mirror-image method," RDMMI), was developed. To evaluate this method, we constructed an indoor positioning system using widely-used wireless LAN devices (Wi-Fi access points). In this system, a position of a smartphone is estimated using RSS of beacon signal from access points which are installed in a positioning field.

With RDMMI, a RSS distribution is modelled for each access point as a sum of a direct wave and reflective waves caused by walls and obstacles. Model parameters are a source position of direct wave and imaginary source positions of reflective waves. The model parameters are estimated by maximum-likelihood method using training data which are measured in the positioning field. With this model, an unknown position is determined as a position (x,y,z) with the highest posterior probability $P(x,y,z|R,\Theta)$, where R is RSS from all the access points.

In an indoor positioning field (about 350 square meters), 17 Wi-Fi access points are installed. In this field, a training data set (143 data) and a test data set (27 data) are measured. Using these data sets, the RDMMI and two conventional methods (the nearest-neighbor method and the trilateration method) are evaluated. As a result, average errors are 3.4 m for the RDMMI, 3.7 m for the nearest-neighbor method, and 5.8 m for the trilateration method. The RDMMI improved the conventional methods by 0.3 and 2.4 m. Moreover, average positioning error with a small set of training data was evaluated. Even in this case, the RDMMI achieved higher positioning accuracy than conventional methods.

**KEYWORDS**: indoor positioning, wireless LAN, radio-signal strength distribution modeling, reflective wave, maximum-likelihood method