

Human Activity Recognition

Weely Report 3 - Localization Algorithms

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Experiment Setup

Experiment

- Single AP: Asus RC68U
- Single RX: Small PC with Intel 5300 NIC
- Women(myself) standing in dotted positions
- $6 \times 9 = 54$ positions
- 40s per position, $100 \times 40 = 4000$ CSI samples.

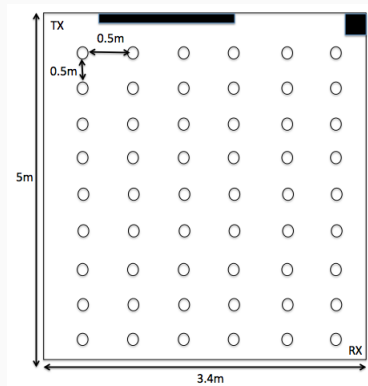


Figure 1: TX-RX Field With Human Standing in Dotted Positions

Data Analysis

Feature Extraction¹

Average on all antennas

$$H_{avg} = \sum_{m=1}^p \sum_{n=1}^q h_{mn}, H_{avg-amp} = |H_{avg}|, H_{avg-ph} = \angle H_{avg}$$

Compute difference among neighbor subcarriers

$$H_{amp_i} = |H_{avg-amp_i} - |H_{avg-amp_{i+1}}||, H_{ph_i} = \angle H_{avg-ph_i} - \angle H_{avg-ph_{i+1}}$$

Summation of all training samples

$$H_{amp-diff} = \sum_{i=1}^N H_{amp_i}, H_{ph-diff} = \sum_{i=1}^N H_{ph_i}$$

Fingerprint

$$H_{diff} = [H_{amp-diff}, H_{ph-diff}]$$

¹Chapre, Yogita, et al. "CSI-MIMO: Indoor Wi-Fi fingerprinting system." (LCN), 2014.

Bayes Rule

$$P(l_i | H_{test}) = \frac{P(l_i)P(H_{test} | l_i)}{P(H_{test})}$$

Compute prior probability on each training point

$$\rho_{H_{test} H_{train}} = \prod_{k=1}^K \frac{\text{cov}(H_{test}^k, H_{train}^k)}{\sigma_{H_{test}^k} \sigma_{H_{train}^k}}, \quad P(l_i) = \frac{\rho_{H_{test} H_{train}}}{\sum_{i=1}^L \rho_{H_{test} H_{train}}}$$

Maximum Likelihood Probability²

$$P(H_{e,k} | l_j) = \frac{1}{\sqrt{2\pi\Sigma_k}} \exp - \frac{(H_{e,k} - \bar{H}_{e,k})^T \Sigma_k^{-1} (H_{e,k} - \bar{H}_{e,k})}{2\sigma_{e,k}}$$

Post Probability

$$l = \sum_j^J P(l_j | H_e) l_j$$

²Xiao, Jiang, et al. "FIFS: Fine-grained indoor fingerprinting system." ICCCN, 2012.

Results

| Algorithm | Correctness | Ave Error(m) | Variation | Max Error(m) |
|-------------|-------------|--------------|-----------|--------------|
| KNN(K=1) | 22/54 | 0.89 | 1.096 | 4.03 |
| Naive Bayes | 43/54 | 0.27 | 0.46 | 3.54 |

Table 1: Classification Results