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Received signal strength based indoor positioning algorithm using advanced clustering and kernel ridge regression

Key words: Indoor positioning; Received signal strength (RSS) fingerprint; Kernel ridge regression; Cluster matching; Advanced clustering

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Motivation

1. Recent advances in information technology have made it practical and accessible to provide indoor positioning services to consumers. Achieving a satisfactory positioning accuracy in a complicated indoor environment for these services has become an attractive research topic.

2. Fingerprint localizations based on the received signal strength (RSS) have been extensively studied in recent years for their advantages of high flexibility, low cost, and no additional hardware.

3. Robust and adaptive models that could accurately describe the relationship between the positions and RSSs are developed.

Main idea

1. An advanced clustering (AC) strategy is used during the offline phase to reduce the maximum positioning error and to solve the problem that RSS signals with similar features may have disparate geographic locations.

2. Kernel-based methods have been used within the scope of a cluster for fast and accurate localization during the online phase.

Method

1. AC strategy is based on the K-medoids clustering algorithm using additional reference points that are geographically located at the outer cluster boundary to enrich the data of each cluster.

2. Both the Euclidean distance of RSSs and the Hamming distance of the coverage vectors between the observations and training records are explored for cluster matching.

3. Kernel-based ridge regression (KRR) is used to define the positioning function between RSSs and positions.

Method

Proposed indoor positioning algorithm

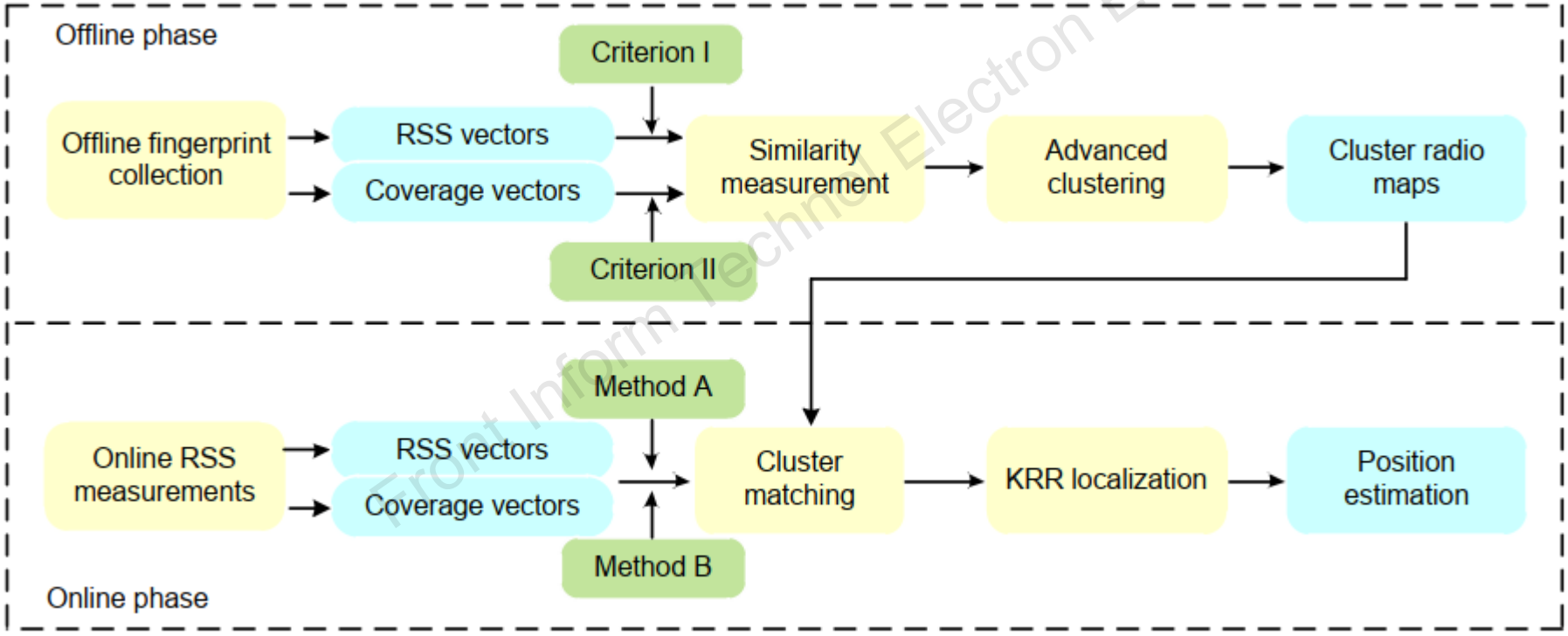


Fig. 1 The proposed indoor positioning algorithm

Major results

Layouts of two typical experimental sites

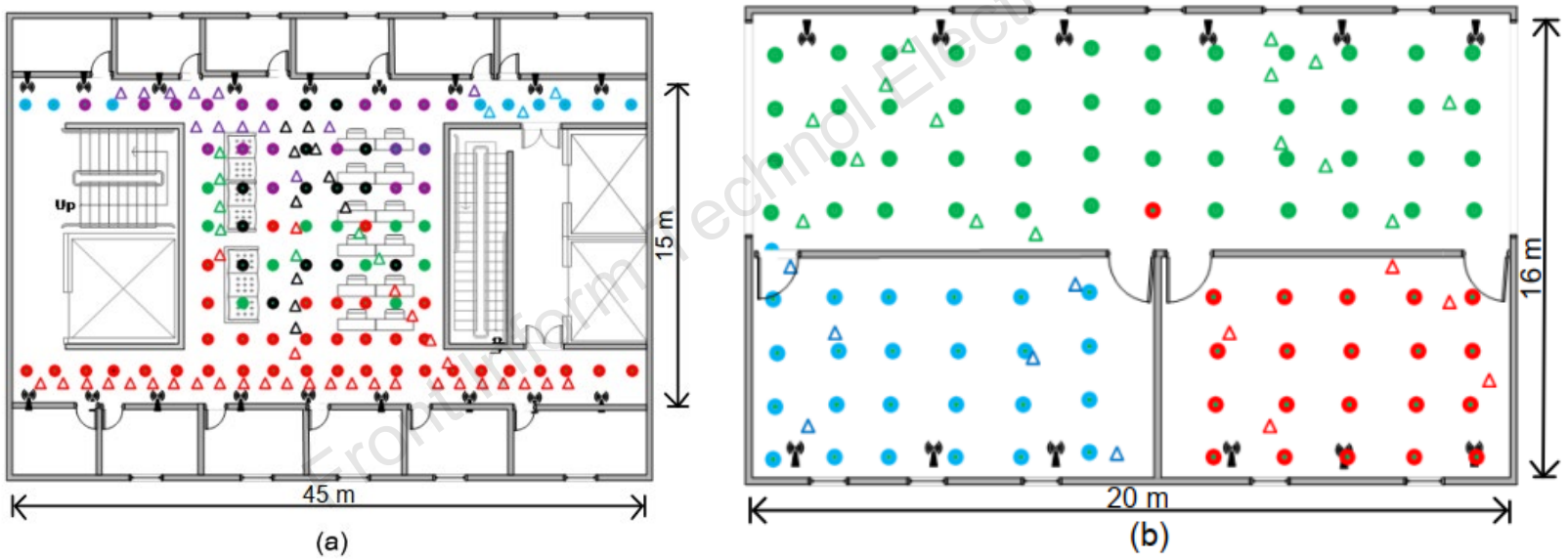
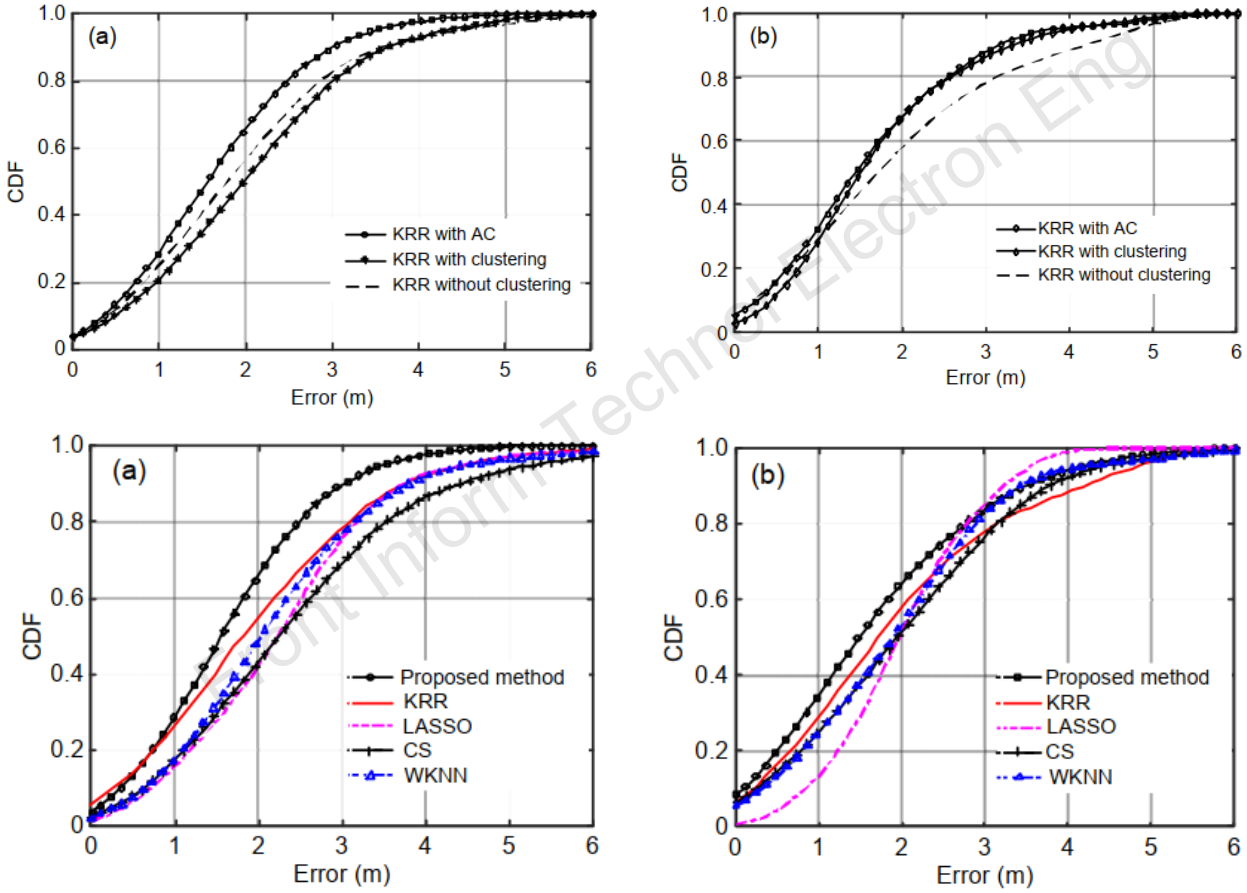


Fig. 2 Layouts of the experimental sites: (a) LA; (b) LB
Each dot denotes one RP, and different colors for the RPs indicate different clusters. Each triangle represents the location of each online test point with the corresponding cluster.

Major results (Cont'd)



CDF of the positioning error for proposed algorithm and others: (a) LA ; (b) LB

Conclusions

1. A new algorithm based on kernel ridge regression with advanced clustering for RSS fingerprint positioning in indoor environment is proposed and evaluated.

2. The approximate localization based on cluster matching significantly reduces the computational complexity of the KRR based localization algorithm and improves the positioning accuracy.

3. The parameters in the proposed algorithm are consistent between different clusters in a single environment, which makes KRR easy to implement and requires no additional memory space for storing the cluster parameters.

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