Efficient Design of Scalable Indoor Positioning System based on Wi-Fi Fingerprinting

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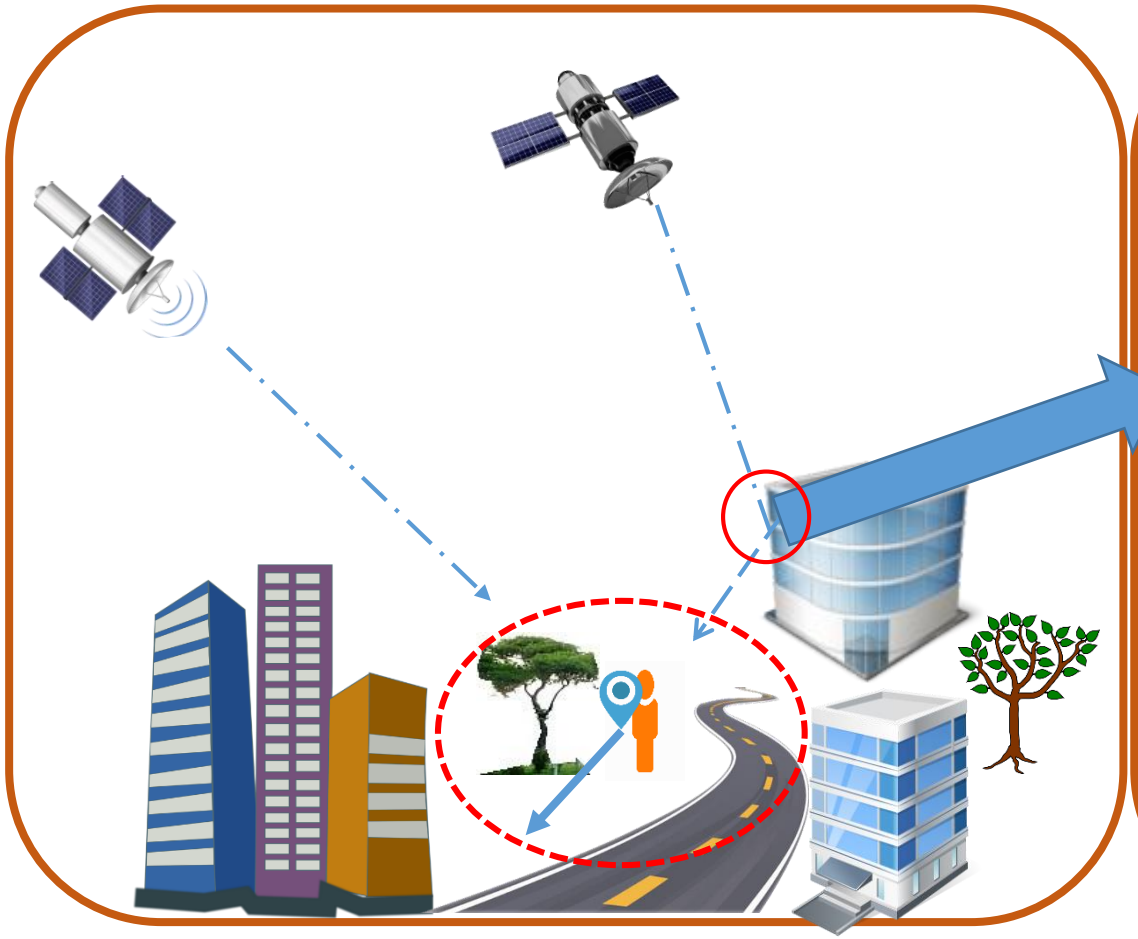
Contents

Indoor Positioning System (IPS)



Wi-Fi Fingerprinting Technique

Offline Phase

- Select Reference Point (RP) in area of interest
- Record fingerprint/RSS at each RP
- Upload the fingerprints to the positioning server

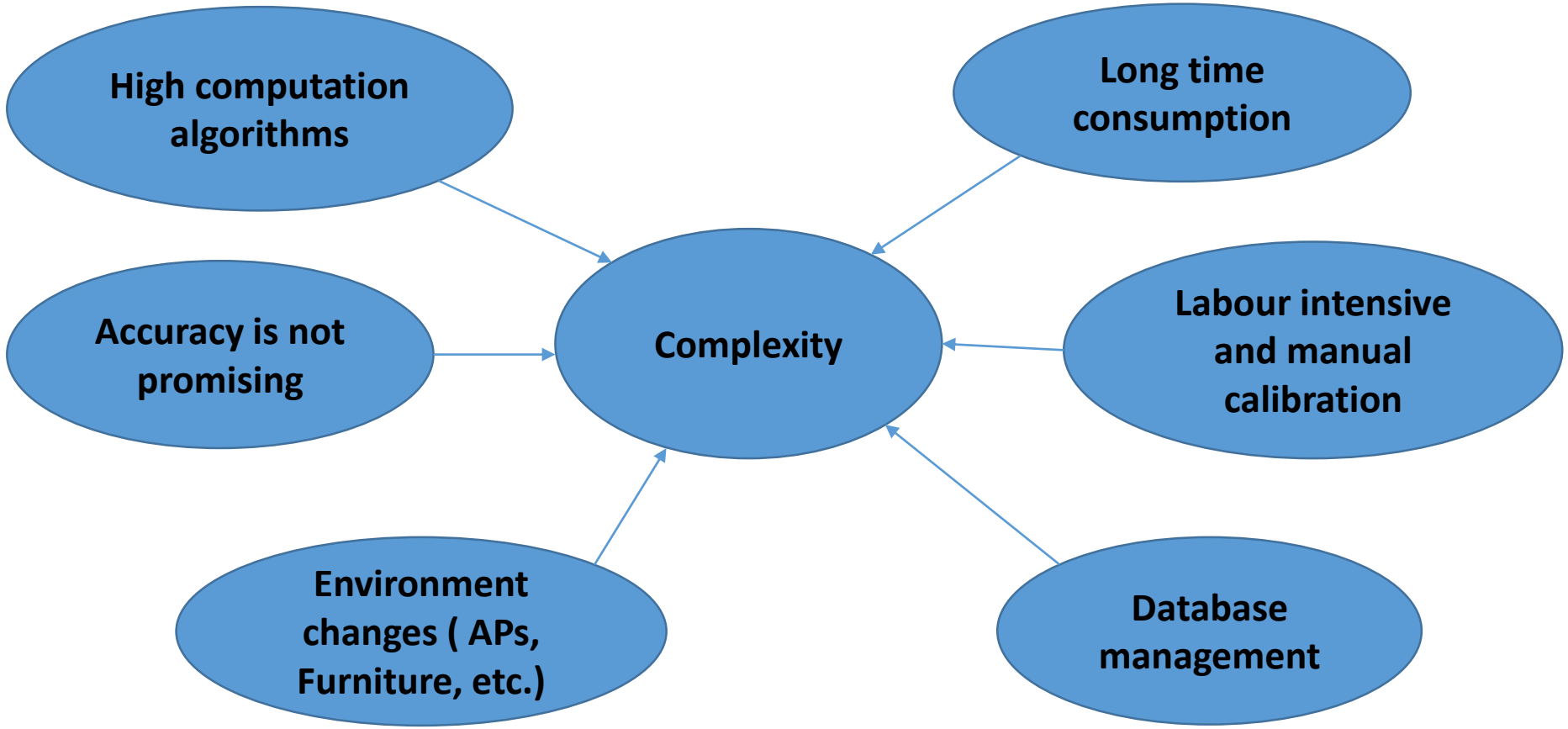
Positioning Server

- Store collected fingerprints in Database
- Execute matching algorithm
- Estimating the target position

Online Phase

- Mobile device sense RSS at RP
- The detected RSS at RP upload to positionig server
- Estimated positiong send back to the mobile device

1.1 Research Problem



1.2 Research Motivation and Objectives

To build cost-effective IPS by reducing the complexity of the IPS while maintaining efficiency and scalability.

Our objectives:

- Improve positioning accuracy and reduce the complexity of Algorithm calculations.
- Improve system scalability and reduce database-fingerprinting complexity.

1.3 Research Contribution

We expect this work makes three contributions:

- To simplify the Wi-Fi fingerprinting technique for indoor positioning.
- To propose an optimal IPS Wi-Fi fingerprinting system with acceptable accuracy and scalability.
- To identify Key Performance Indicators (KPI) for efficient design of IPS.

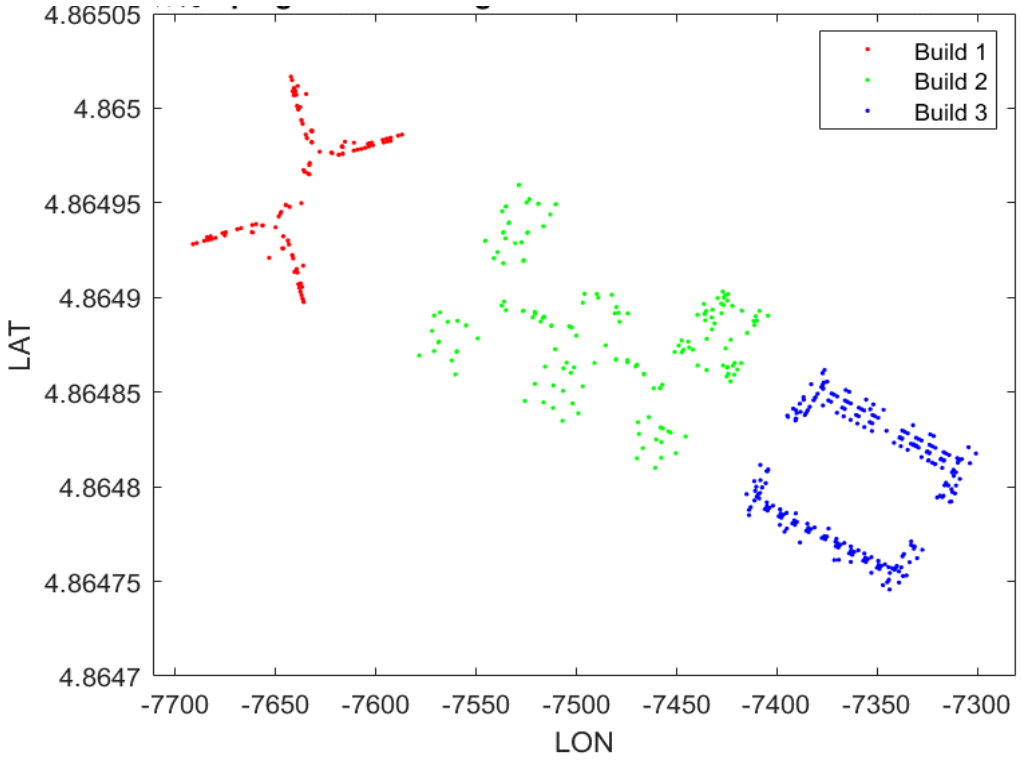
1.4 Research Proposed Plan

- Technology - Wi-Fi Fingerprint
- Environments – Indoor buildings with Wi-Fi infrastructure
- Applications: Locating people and objectives
- Methodology: Exploratory and Simulation based research
- Experiments: MATLAB and Public database (UJIIndoorLoc)

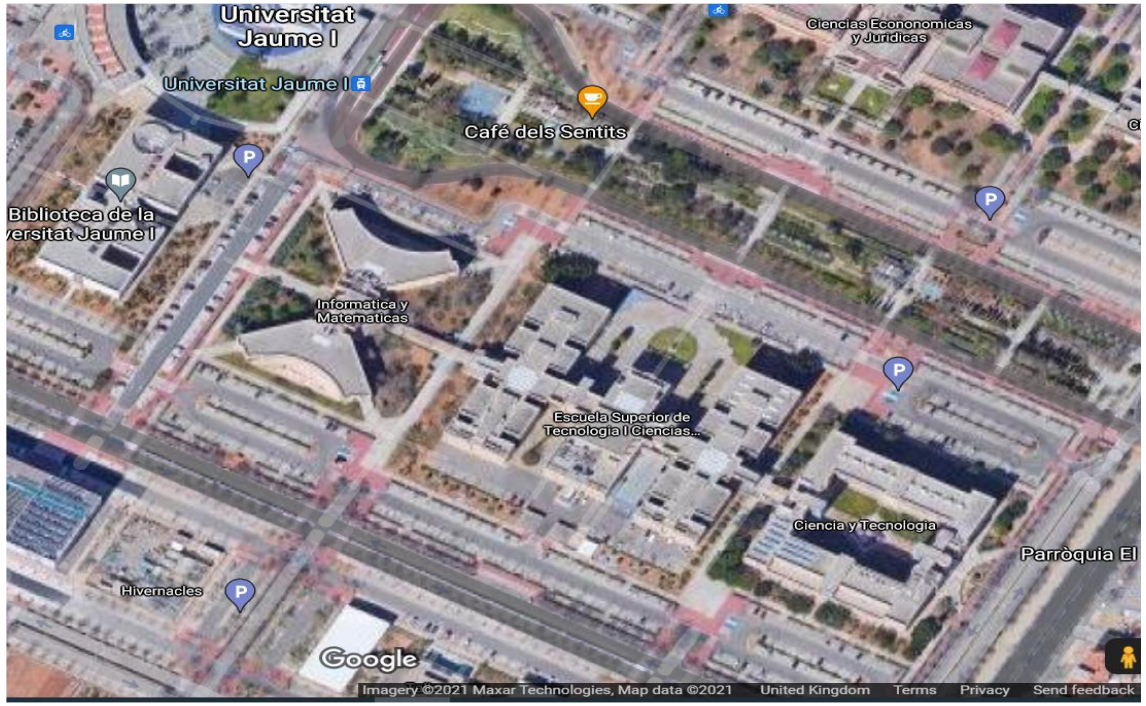
UJIIndoorLoc Database

- Built by Joaquín Torres-Sospedra et al. at Jaume I University campus, Spain.
- Area covered of 108,703m2, 3 buildings with 4 or 5 floors.
- 933 reference points (RPs) in the database.
- 19,938 sample points were obtained for training dataset.
- 1,111 sample points were obtained for validation dataset.
- In total 21,049 sample points.
- 520 different Wireless Access Points(WAPs) appeared in the database.
- Data collected by more than 20 users with 25 different mobile device models.

UJIIndoorLoc Data Records and Location



2D plot for the dataset showing the vertical view of the three buildings

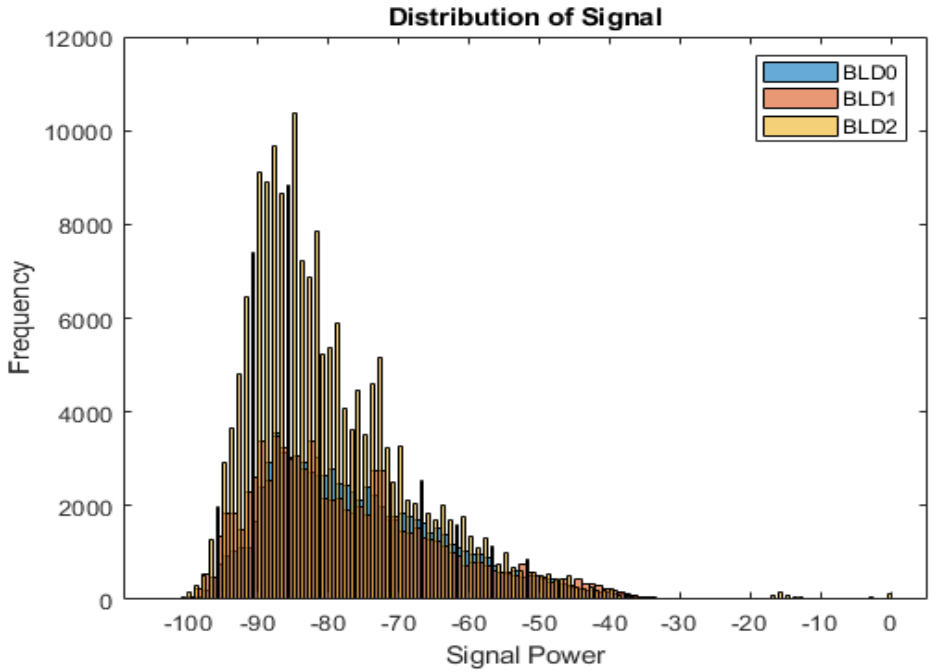


Jaume I University campus on Google Map

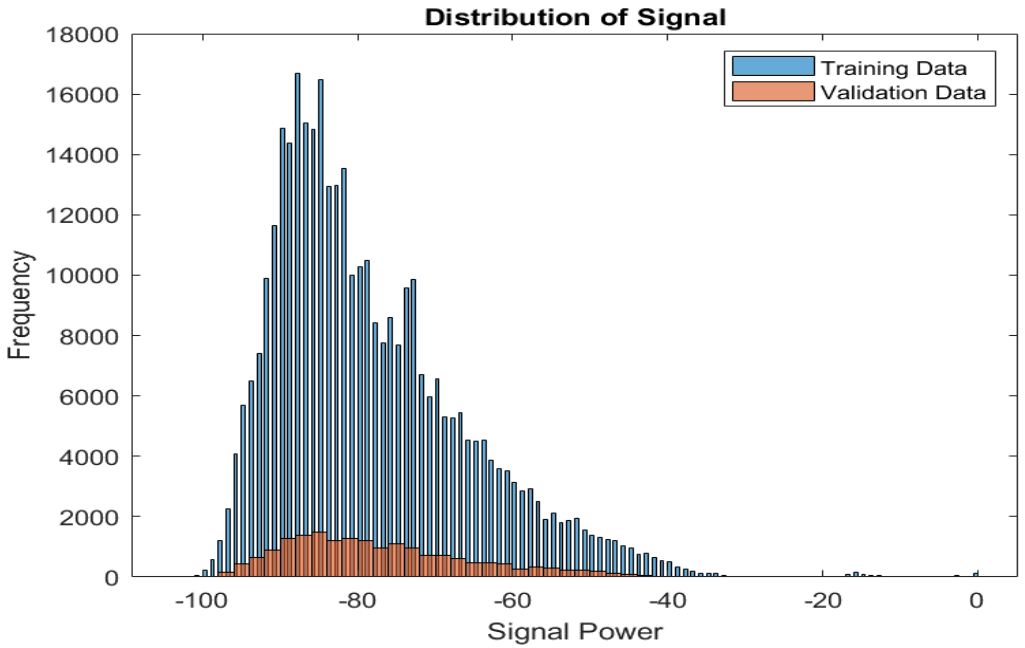
UJIIndoorLoc Database

An example of entry sample from UJIINdoorLoc dataset

[1]	...	[520]	[521]	[522]	[523]	[524]	[525]	[526]	[527]	[528]	[529]
WAP_{001}	...	WAP_{520}	Longitude	Latitude	Floor	BuildingID	SpaceID	Rel.Pos.	UserID	PhoneID	Time
-97	...	+100	-7594.7...	4864983.9...	3	0	111	2	11	13	1370340142



Distribution of Signals on Each Building



Distribution of signal in both the training dataset and validation dataset

2 Research Progress

- Testing KNN, WKNN and SVM algorithms on UJIIndoorLoc datasets.
- Further investigating KNN and WKNN algorithms
  - Data representations (*Positive, Exponential, Powered*)
  - Distance Functions (*Cityblock*, *Euclidean*, *Minkowski*, *Cosine* and *Correlation*)
  - K-value (1 to 50)
  - Distance Weight (*inverse distance* and *squared inverse distance)*
- Tuning WKNN with *Exponential data representation, Correlation distance, inverse weight, and k=26.*

2.1 Achieved Results

- Improving the positioning accuracy of Wi-Fi RSSI-based systems*.

*Our results are promising but the work is under submission in another conference.

2.2 Next work

Proposing and Testing Cloud-based IPS and analysis the system performance.

The design considers the deployment efficiency of Wi-Fi – Access Points (WAPs), fingerprint database, and Cloud management, and accordingly set the system requirements for optimal performance.

3 Related Works

Comparison of the existing systems in the literature for RSSI-based IPS.

System	Technique	Accuracy	Scalability	Complexity	Cost
RADAR [17]	RSSI	>2m	High	Low	Low
Horus [18]	RSSI	Avg. Error 0.6m	High	Low	Low
Ashami et al.[20]	RSSI	Avg. error 1.2m up to 98%	High	High	Low
DeepNar [22]	RSSI/trilateration	<1m and avg. error <0.75m	Low	High	High
Jin et al. [13]	RSSI	80% in 1.9m	High	Low	Low
Our study aims to	RSSI	Acceptable	High	Low	Low

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Thank you