Enhancing Multi-Floor Indoor Localization Accuracy Using Fingerprint-Based Dynamic *k*-NN Approach

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Overview

- Why multi-floor indoor localization?
- Our three innovations
- From scans to position
- Dataset
- Amplified voting scheme
- Dynamic valid-neighbor selection
- Accuracy & error improvements
- What comes next?

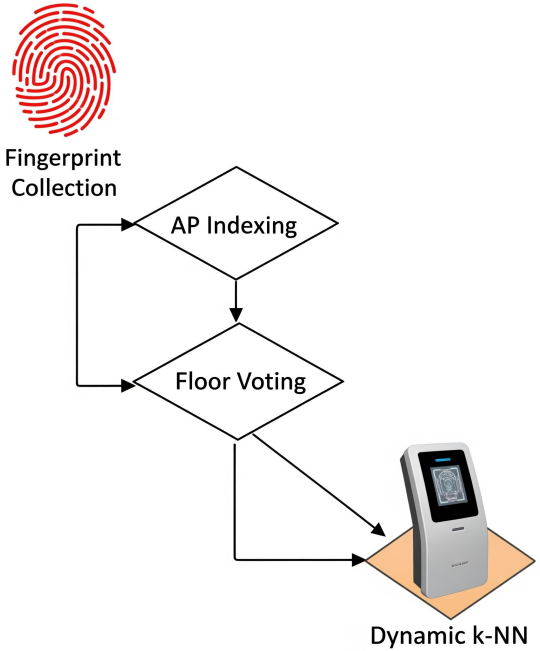
Why Multi-Floor Indoor Localization?

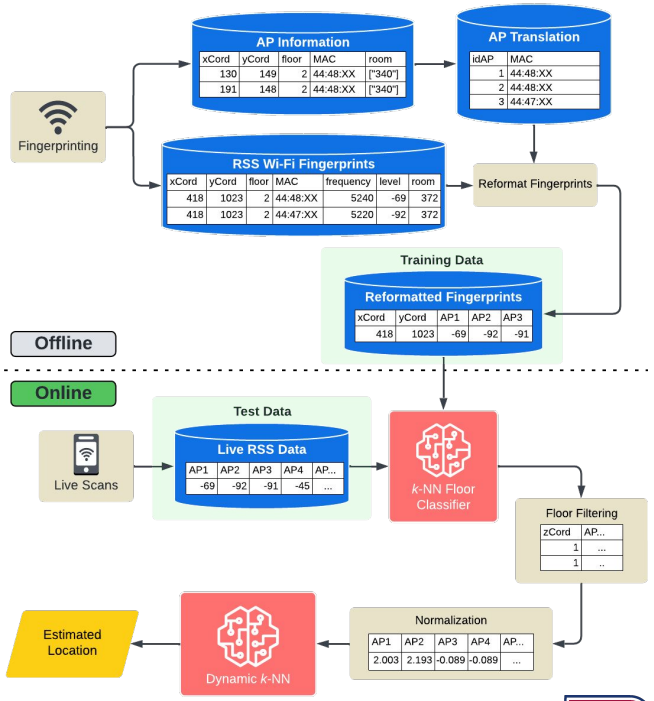
- GPS blackout indoors → need for Wi-Fi fingerprinting
- **Applications**: smart buildings, emergency response
- **Challenge**: floor misclassification + variable fingerprint density

Our Three Innovations

- **Amplified voting** for perfect floor classification
- **Dynamic *k*-NN** to adapt neighbor count per query
- **Floor-Specific Preprocessing** (filter + normalization)

From Scans to Position





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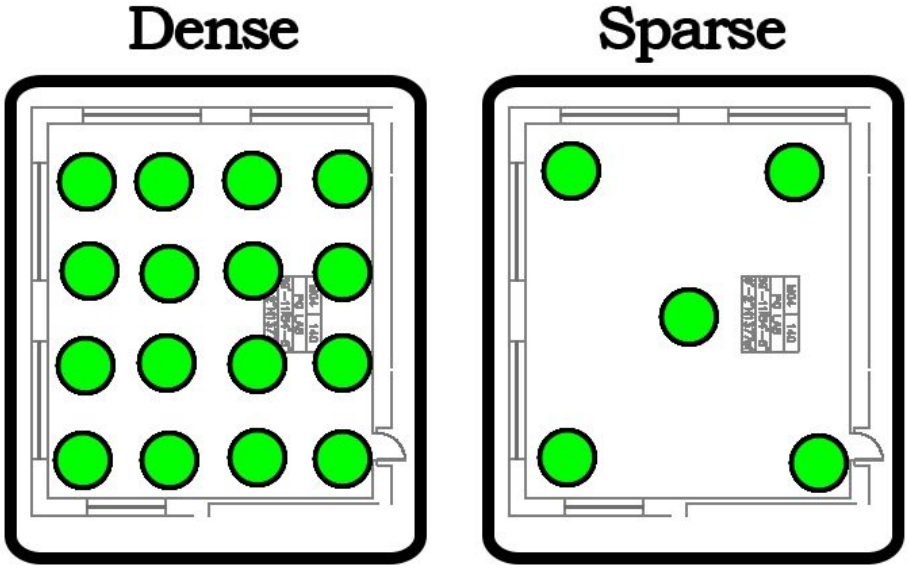
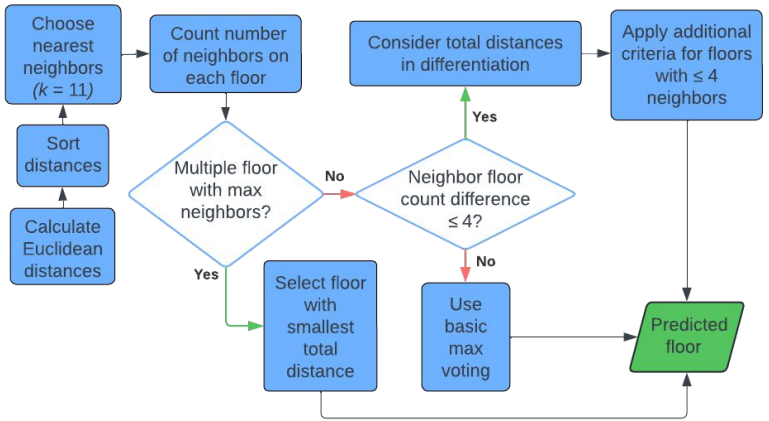
Dataset: Dense vs. Sparse



Floor	Dense Fingerprints	Sparse Fingerprints
#1	207	61
#2	277	98
#3	125	64
Total	609	223

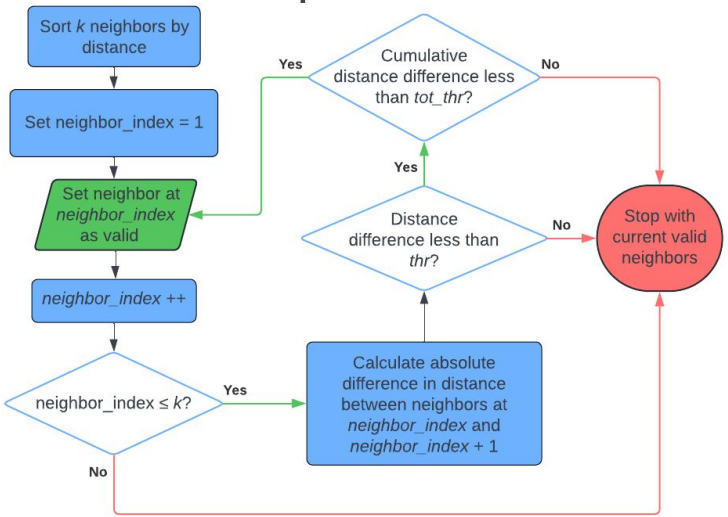
Amplified Voting Scheme

- Compute Euclidean distances → pick k = 11 neighbors
- Count votes by floor + sum distances
- Layered tie-break rules (vote diff threshold → distance sum → fallback)



Dynamic Valid-Neighbor Selection

- Start with k = 5, then iteratively add neighbors whose gap < *thr* (4) & cumulative distance difference < *tot_thr* (20)
- Excludes outliers in sparse zones → tighter mean error



Accuracy & Error Improvements

Comparison of Accuracy and Misclassifications Across Sparse v. Dense Dataset on All Floors

Dataset	Simple		Amplified	
	Accuracy	# Misclass.	Accuracy	# Misclass.
Dense	0.998	1	1	0
Sparse	0.949	4	0.975	2

Accuracy & Error Improvements

Distance Error on Dense and Sparse Fingerprint Dataset Using

FIXED Number Neighbors in *k*-NN on Different Floors

Floor	Sparse error (m)	Dense error (m)
#1	3.24	1.74
#2	2.80	1.52
#3	3.42	1.86
Avg.	3.04	1.65

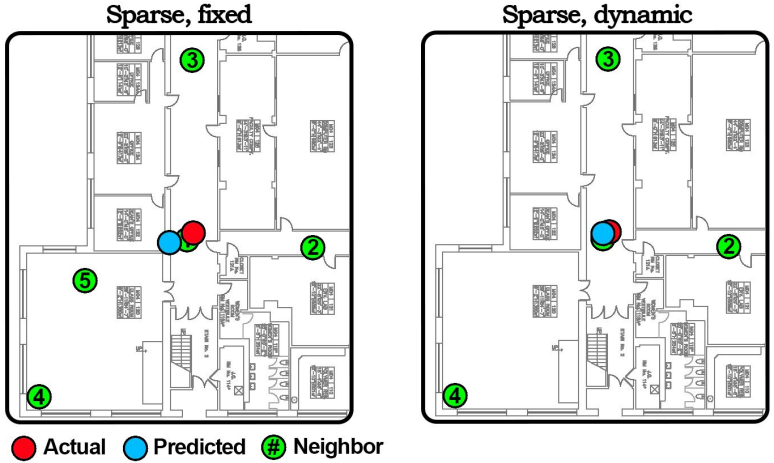
DYNAMIC Number Neighbors in *k*-NN on Different Floors

Floor	Sparse error (m)	Dense error (m)
#1	2.79	1.47
#2	2.93	1.47
#3	2.90	1.77
Avg.	2.87	1.53

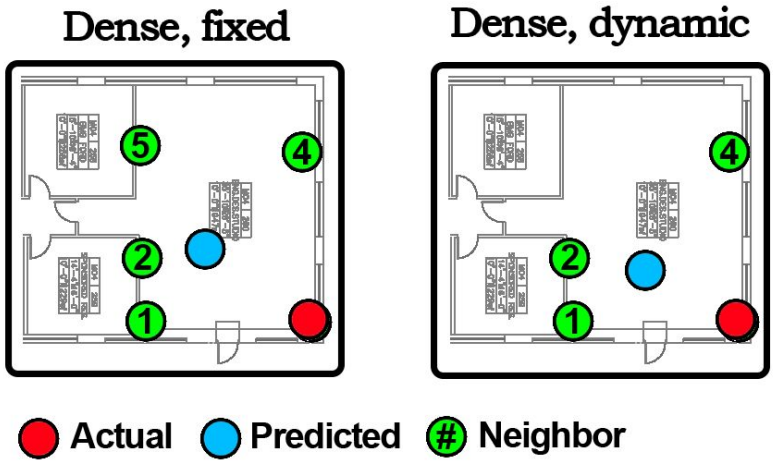
Accuracy & Error Improvements

Comparison of Fixed v. Dynamic Neighbor Selection in

SPARSE Fingerprinting Environment



DENSE Fingerprinting Environment



What Comes Next?

- Coverage of more buildings
- Hyperparameters: fixed thresholds (no sensitivity analysis)
- Runtime cost, device heterogeneity not addressed
- Sensor fusion

Thank you!
Questions?