

# ***XJTLUIndoorLoc: A New Fingerprinting Database for Indoor Localization and Trajectory Estimation Based on Wi-Fi RSS and Geomagnetic Field***

Zhenghang (Klaus) Zhong

Email: zhenghang.zhong15@student.xjtlu.edu.cn



## Agenda

### Introduction

- Background
- Dataset Introduction
- Experiment Result

### Methodology

- WiFi & Geomagnetic Field Measurement
- Data Processing
- Training Model

### Result

- Database
- Training Result

### Conclusion

- Discussion
- Future Work

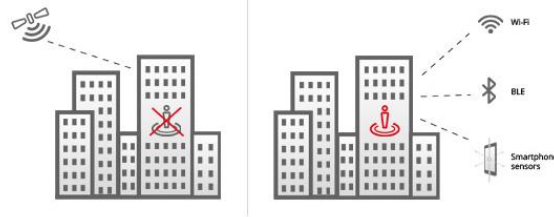


## Introduction

### Background

At indoor environment:

- I. Global positioning system (GPS) ❌
- II. Wi-Fi, geomagnetic field ✅



## Introduction

### Dataset Introduction

Popular databases:

- I. UJIIndoorLoc: WiFi fingerprinting, largest, first publicly-available. (933 reference points)
- II. UJIIndoor-Mag: based on magnetic field. (281 reference points)
- III. IPIN 2016: Wi-Fi fingerprinting, geomagnetic coordinates and Inertial measurement units (IMU) data. (325 reference points)

XJTLUIndoorLoc:

- I. RSS values, geomagnetic coordinates, IMUs (969 reference points,)

## Introduction

### Experiment Result

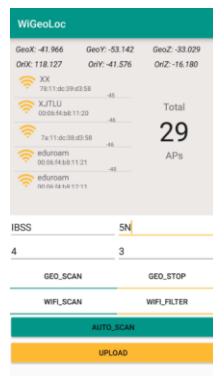
Ratio of Training data: 75% of total dataset (25,000 points)

Overall mean error: 0.75 m



## Methodology

### WiFi & Geomagnetic Field Measurement



APP: WiGeoLoc (Android)

Measure: Wi-Fi (RSS, mac address, time stamp, brands)

IMUs(Geomagnetic field intensity,

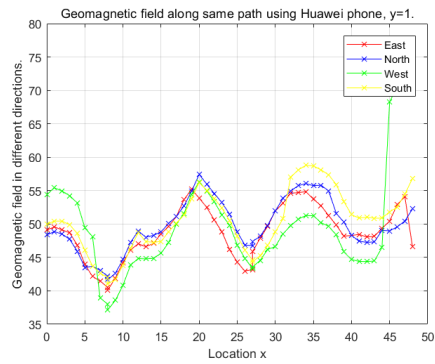
Acceleration, Orientation)

Optimization: Kalman Filter (KF)



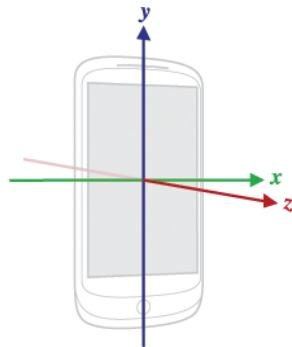
## Methodology

### WiFi & Geomagnetic Field Measurement



## Methodology

### WiFi & Geomagnetic Field Measurement



Euler Angles:

- X: Pitch
- Y: Roll
- Z: Yaw

Aim:

- Coordinate transformation

Methods:

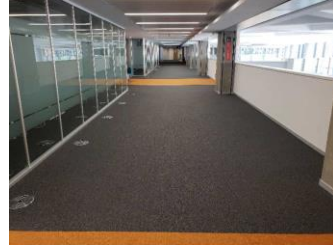
- Rotation Matrix
- Quaternion

## Methodology

### WiFi & Geomagnetic Field Measurement



5th floor, IBSS  
Space: 7.2m X 30m



4th floor, IBSS  
Space: 3.6m X 30m



## Methodology

### Data Processing – Data Interpolation

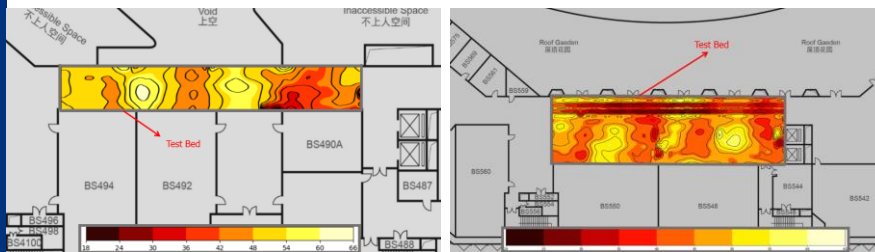
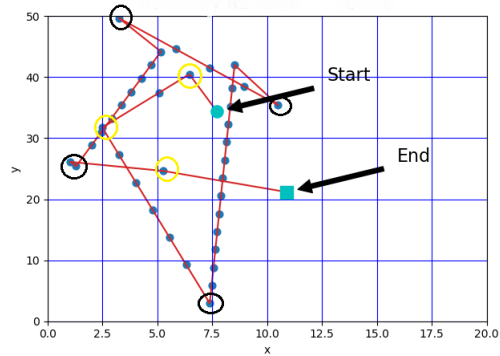


Fig. Geomagnetic field map of the fourth and the fifth floor in the IBSS Building at XJTU.



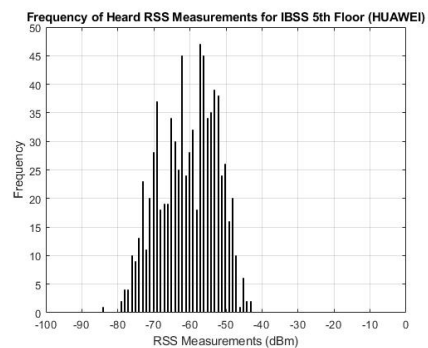
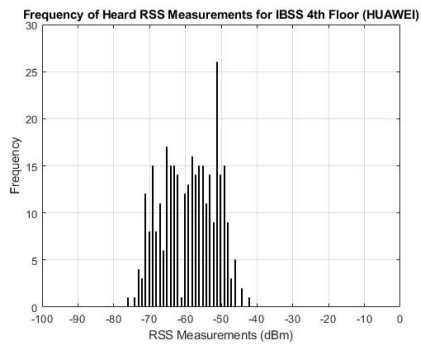
## Methodology

### Data Processing – Random Waypoint Model (RWM)



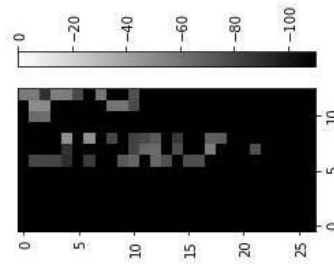
## Methodology

### Training Model --- Convolutional Neural Network (CNN)



## Methodology

Training Model --- Convolutional Neural Network (CNN)

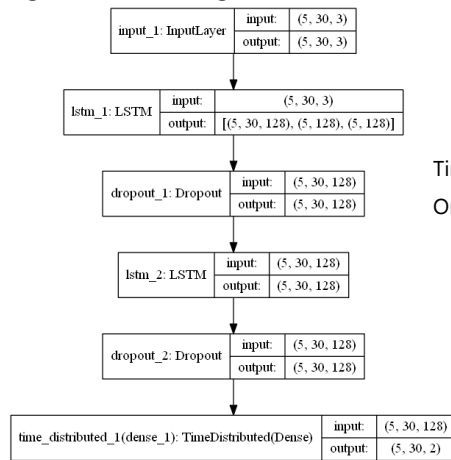


One reference point: Image input structure



## Methodology

Training Model --- Long Short Term memories (LSTM)



Time step: 30

One trace: 30 continuous points



## Results

### Database

TABLE I  
DATABASE STRUCTURE.

WAP000	...	WAP515	Loc_x	Loc_y	Floor	Building
-110	...	-110	0	0	5E	IBSS
-110	...	-110	1	0	5E	IBSS
-110	...	-110	2	0	5E	IBSS
-110	...	-110	3	0	5E	IBSS
-110	...	-110	4	0	5E	IBSS
-110	...	-110	5	0	5E	IBSS

TABLE II  
DATABASE CONTINUE FROM TABLE I.

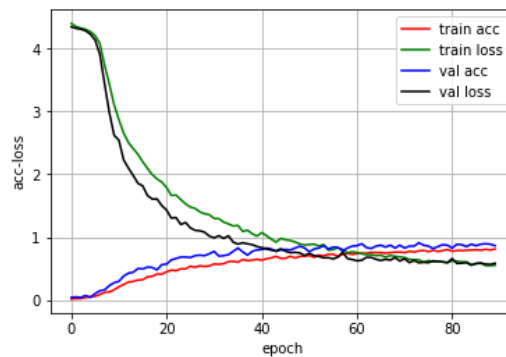
GeoX	GeoY	GeoZ	OriX	OriY	OriZ
-25.6125	-5.79286	-29.9464	97.59351	-4.38194	-2.16679
-25.2571	-5.475	-29.8786	97.82641	-3.71709	-1.29526
-22.099	-4.42014	-29.9931	100.7725	-0.04106	-1.98857
-23.4641	-5.41875	-28.0094	102.3195	-0.39816	-0.95255
-23.8958	-4.8006	-26.4107	101.139	-0.04733	-0.86068
-24.7422	-5.01172	-25.4219	101.2211	0.013164	-1.21606

Total reference points: 306 (4th) + 663(5th) = 969



## Results

### Training Result --- CNN





## Results

Training Result --- LSTM

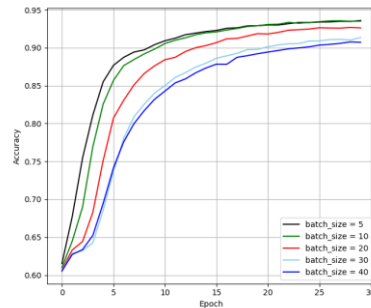
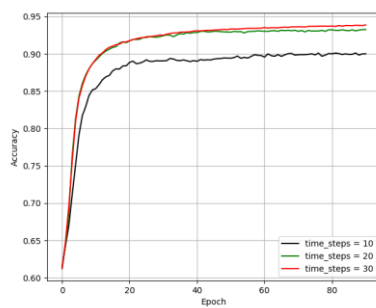
LSTM PARAMETER VALUES.

LSTM Parameter	Value
Ratio of Training Data to Overall Data	0.75
Number of Epochs	100
Batch Size	5
Time Steps	30
Hidden Nodes	128
Optimizer	ADAM [15]
Loss	Mean Squared Error (MSE)
Dropout Rate	0.2



## Results

Training Result



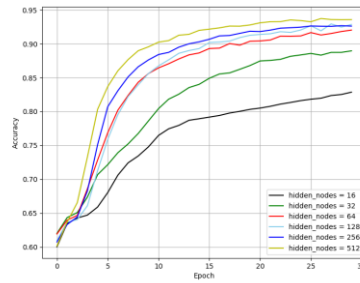
Localization accuracy of training data in terms of

Time steps & Batch size



## Results

### Training Result

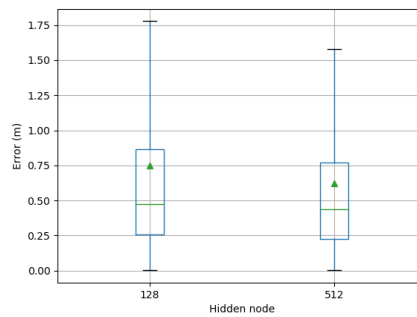


Localization accuracy of training data in terms of  
Hidden nodes



## Results

### Training Result

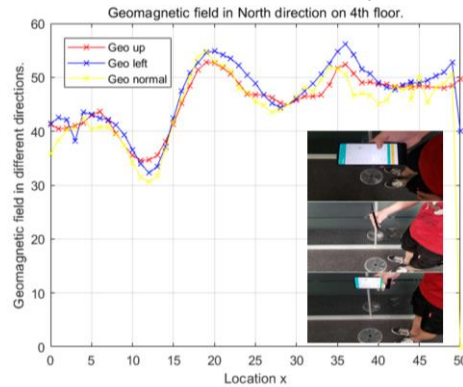


Localization error of validation data in terms of  
Hidden nodes



## Conclusion

### Discussion --- Measurement due to different postures



## Conclusion

### Discussion --- Future Work

- Combine RSS and Geomagnetic field
- Coordinate Transformation
- Bidirectional RNN
- Multi-floor & Multi-Building

# Acknowledgement

- 2018 SURF project members
  - Zhe Tang, Xiangxing Li, Tiancheng Yuan, Yang Yang, Meng Wei, Yuanyuan Zhang, Renzhi Sheng, Naomi Grant, Chongfeng Ling, Xintao Huan, Kyeong Soo Kim and Sanghyuk Lee
- Supports
  - XJTLU SURF programme (under Grant SURF-201830)
  - XJTLU Research Development Fund (under Grant RDF-16-02-39)
  - XJTLU Research Institute for Future Cities Research Leap
  - Grant Programme 2016-2017 (under Grant RIFC2018-3)
  - XJTLU Centre for Smart Grid and Information Convergence
  - XJTLU Campus Management Office (for the floor maps of IBSS building)



# Questions?



Thank You

