Infra WIFI Indoor localization: Multiverse with 0 speed

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CONTENTS

1. Motivation and Previous Work

2. System Overview

3. Implementation and Experiments

4. Evaluation

5. Conclusion

Introduction

Introduction

There has been a long and rich history of **WiFi-based indoor localization** research.
Each works have trade-off. So, to reduce limitation and increase advantage, Many studies have used various combinations.

- Client-base Localization
- Server-base Localization
- Fingerprint Localization
- Model-base Localization
- Etc.

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2018, Experiences & Challenges with Server-Side WiFi Indoor Localization Using Existing Infrastructure

Introduction

Introduction

Client-base Localization

Client-base methods tend to have the highest accuracy. Users can actively send out RF(Radio-Frequency) signal to locate them when they want to.
But, It have to install specific programs to a user's device or modify OS.

Server-base Localization

Server-base methods tend to have more inaccuracy then client-base. But, It don't need to modify user's devices.
The system can only 'see' sended unmodified signal. So, It works with passive way.

Introduction

Introduction

Fingerprint Localization

Fingerprint methods is pre-mapping the real space and specific data(ex: RF-signal). And matching the map and a newly accepted signal data to find where the signal located.
This way is easy to integrate compared with model-base. But, It need to pre-mapping before process.

Model-base Localization

Model-base method analyzes signals that are complex parameters and based on them, perform localization.
This method analyzes a signal that combines the time the signal reaches, the strength of the signal, and so on in many ways to derive a general result.
This way is hard to implement. Because constructing model and analyzing signal is too complex.

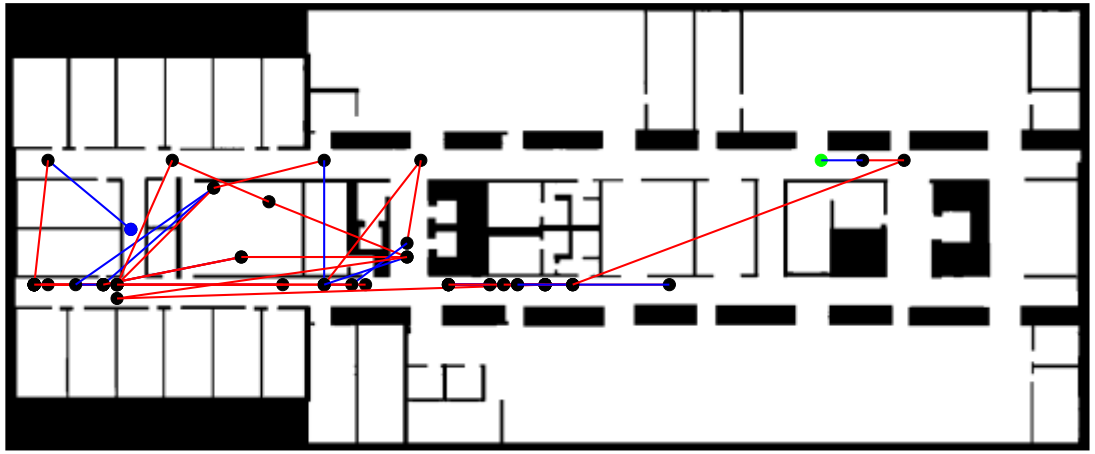
Multiverse trajectory trace

Introduction

In previous work, it choose ‘server-base localization’ and ‘fingerprint localization’. Also, it implement new idea concept which is ‘Multiverse trajectory trace’.

Server-base Localization

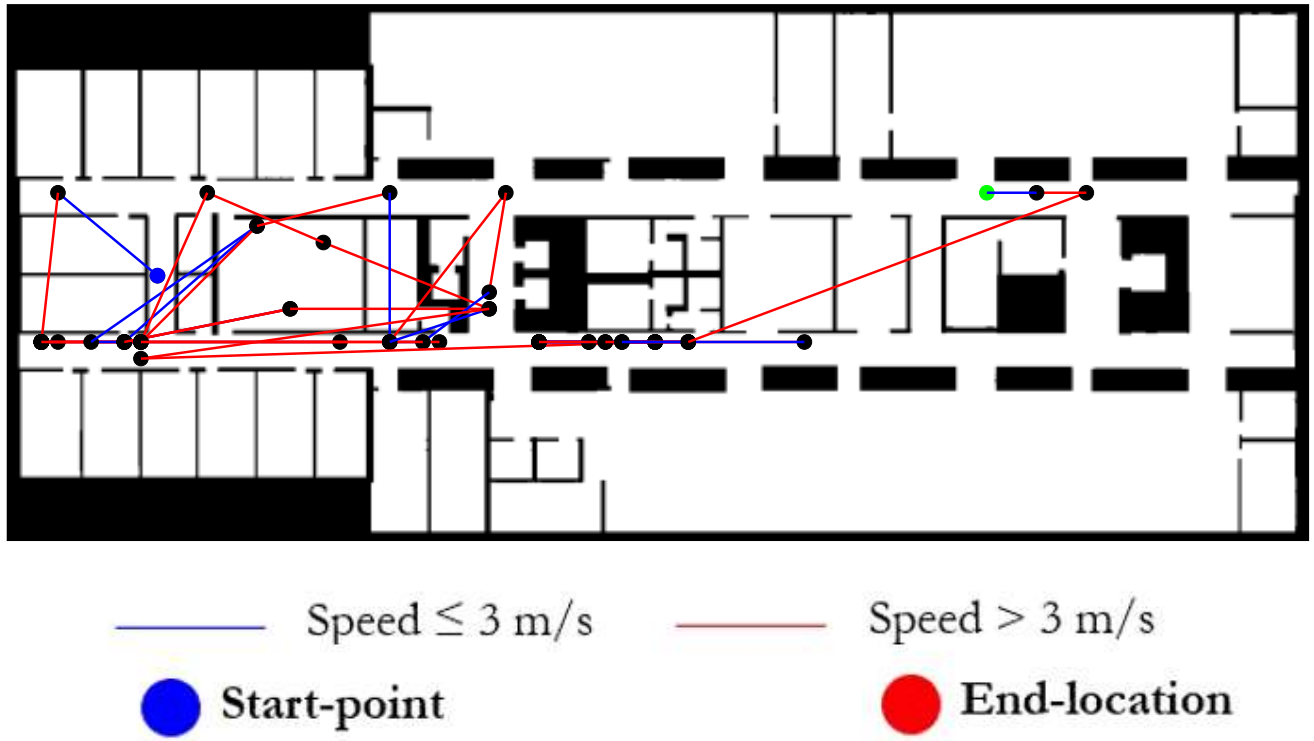
Fingerprint Localization



Multiverse trajectory trace

Introduction

The work adopt human walking pattern by trajectory trace. Which is connecting all points of probable location to the true location. And discard impossible trajectory.

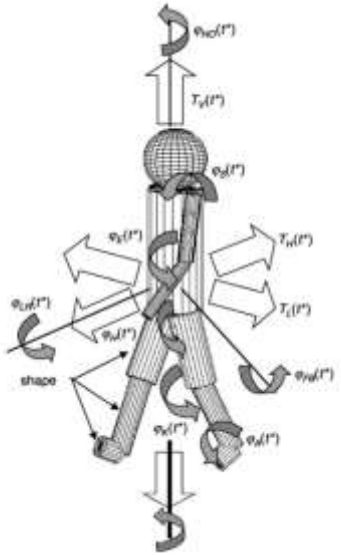


Limitation

Introduction

The Multiverse is attractive approach which makes more accuracy then old works.
But, it has limitation which assume that human's walking speed is consistent with all trajectory path.

In real world, human can stop at some point and walking again.
So, I try to improve this Multiverse algorithm with 0 speed.



van Dorp, Ph, and F. C. A. Groen., "Human walking estimation with radar." IEE Proceedings-Radar, Sonar and Navigation, 150.5, pp. 356-365., 2003.

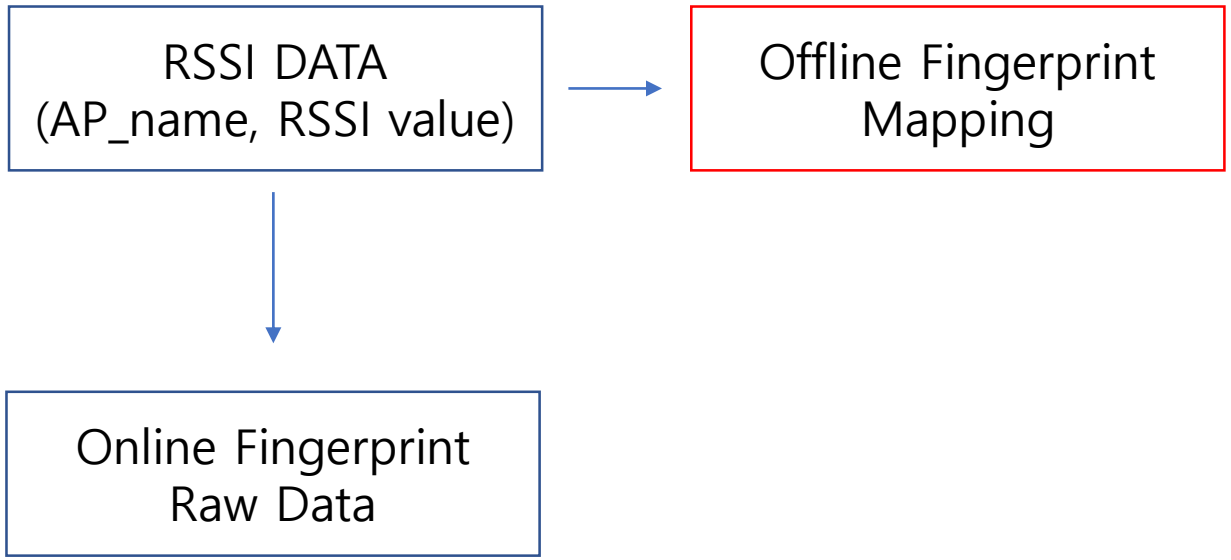
System Overview

Introduction

RSSI DATA
(AP_name, RSSI value)

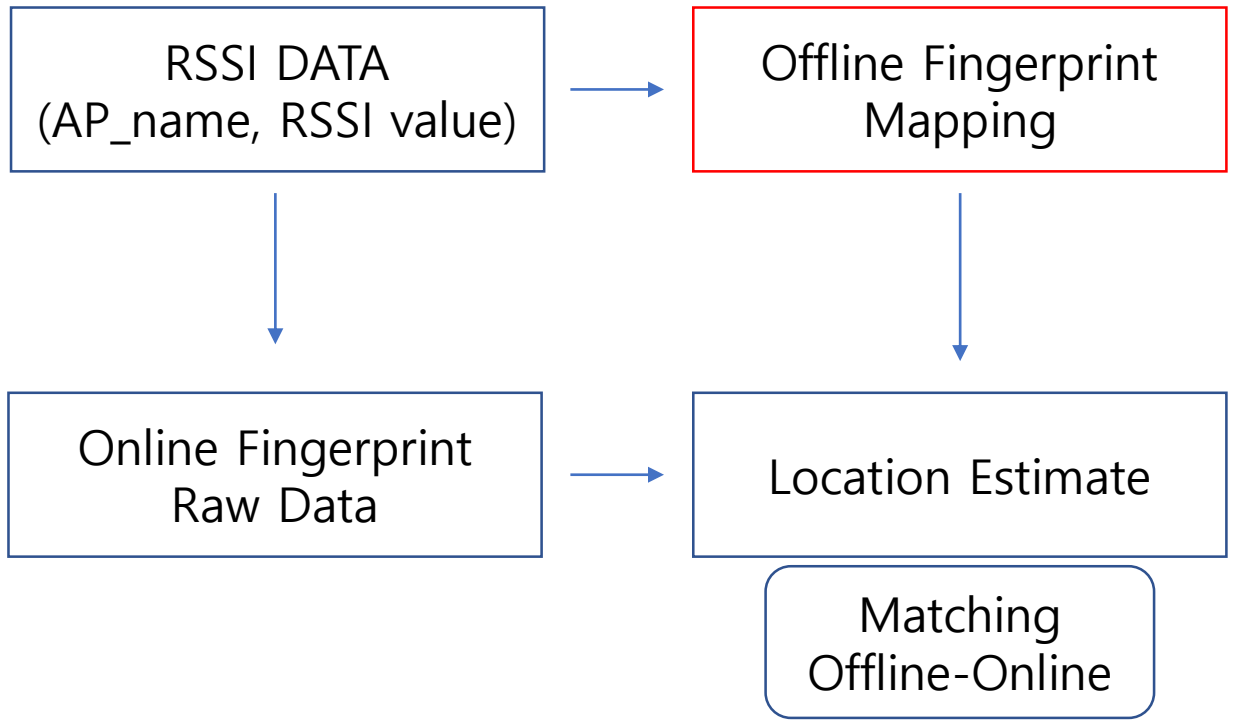
System Overview

Introduction



System Overview

Introduction



System Overview

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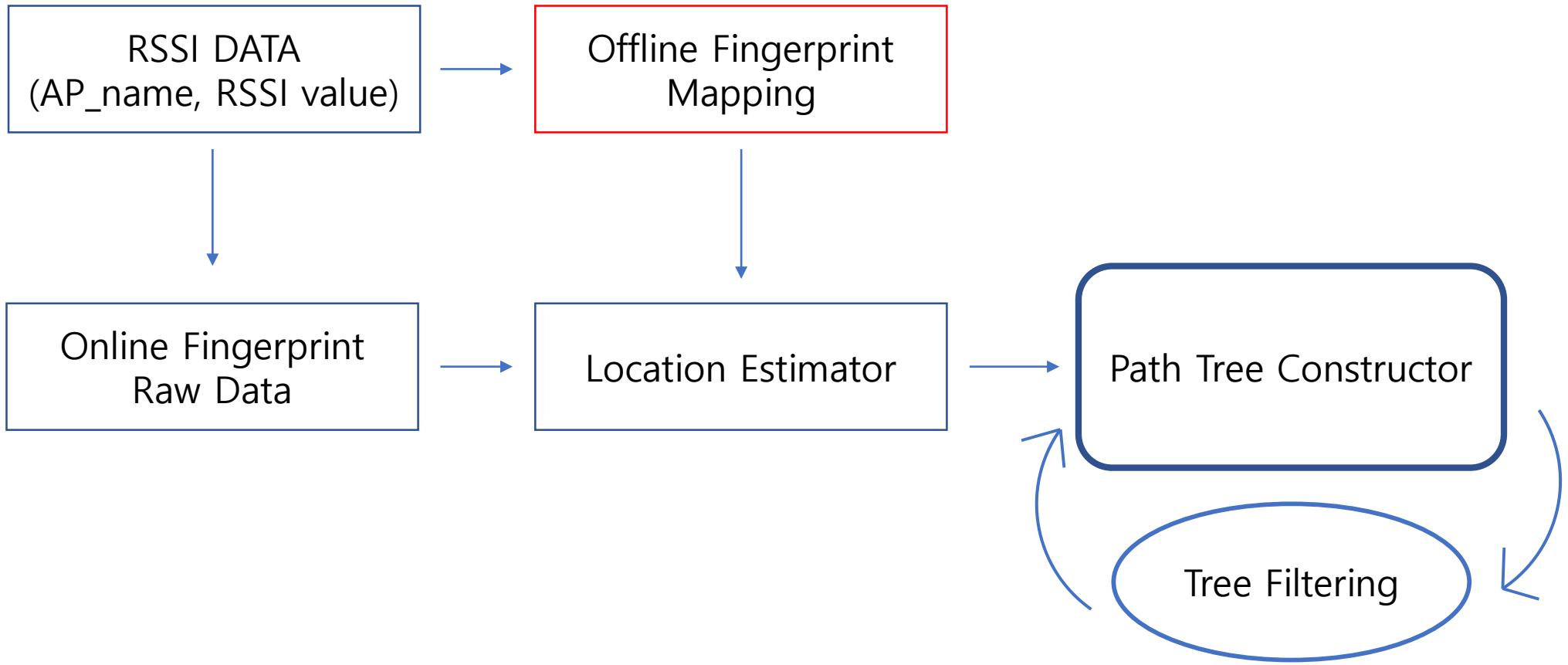
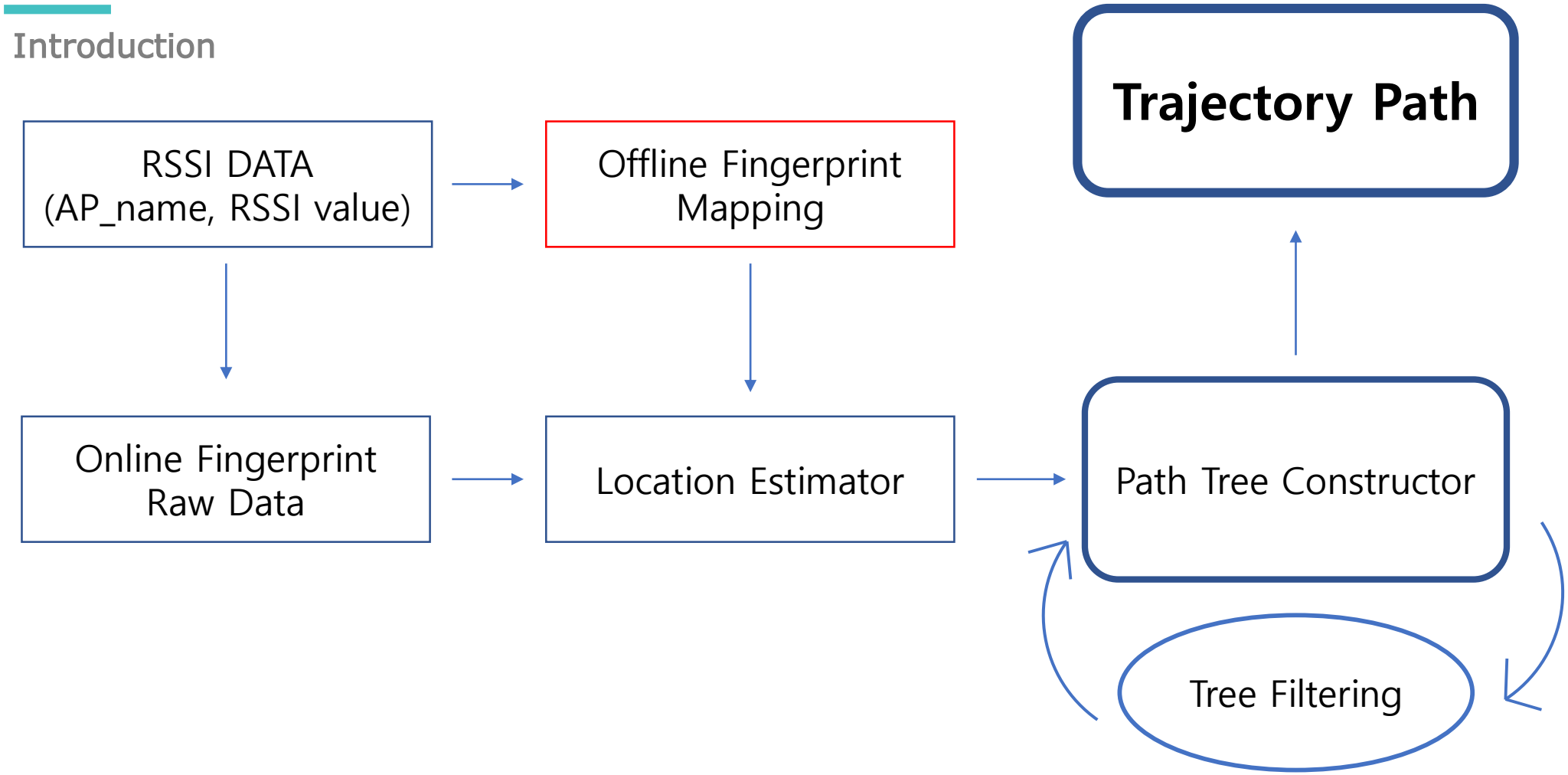
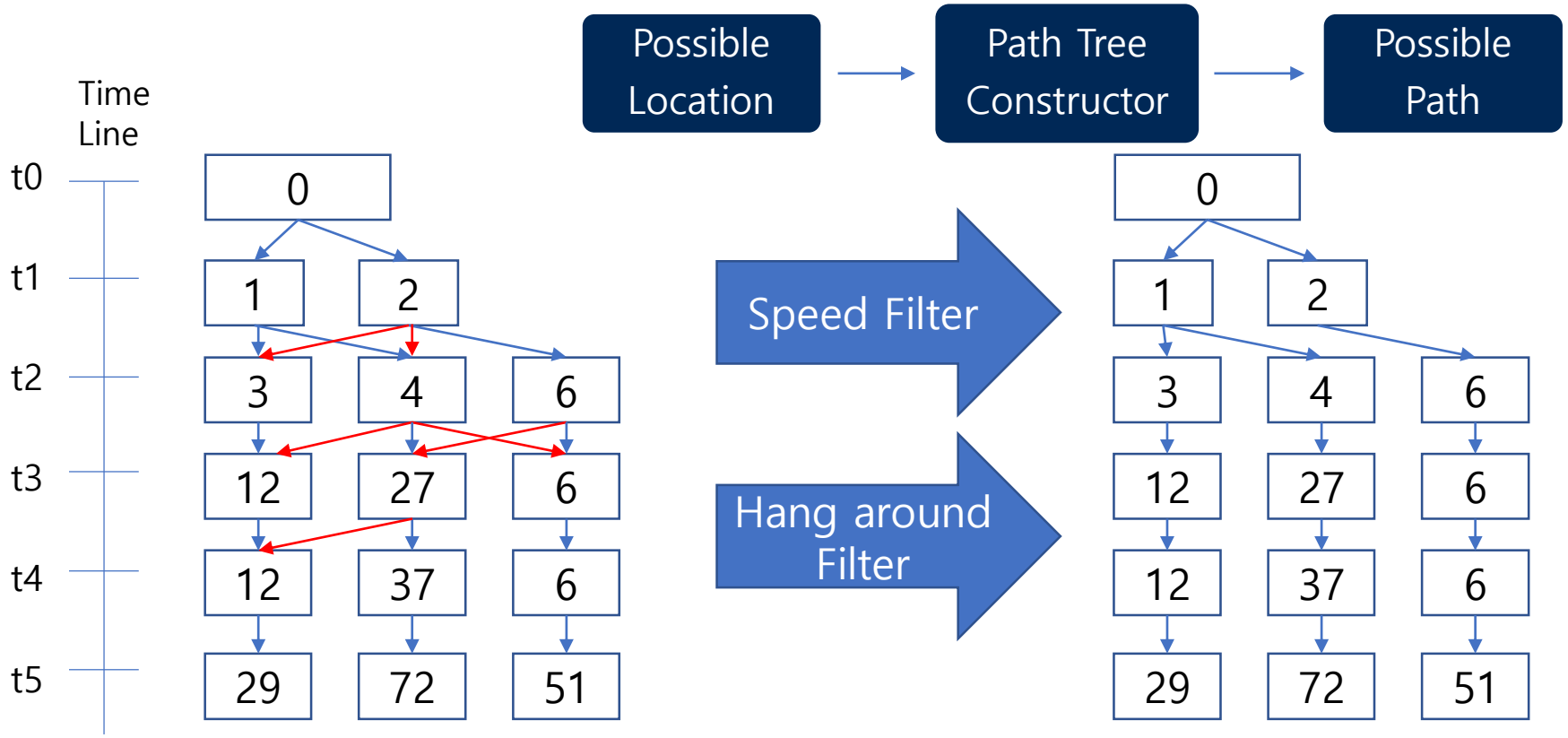


System Overview

Introduction



Path Tree Constructor



Both Filter
Filtering impossible speed
And hang around behavior
fluctuating.

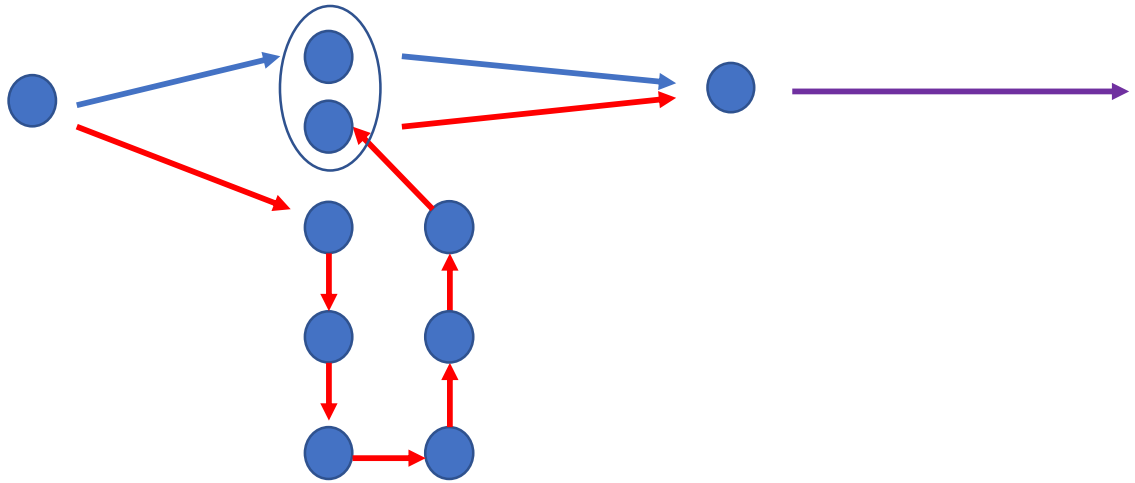
Previous work's Compressor
Can occurred removing stand
state position

Also, speed filter pass 0 speed
which can permit adding same
location and it has more
narrow speed allowed.

Comparing Compressor vs New Filtering

Path Tree Compressor	Number of Path	New Filtering

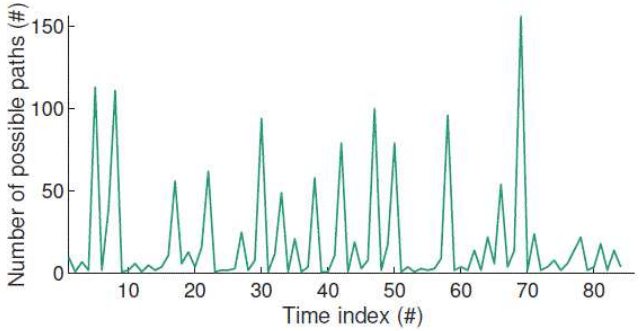
Previous work reduce a lot of path every 5sec.
This work with combine all adjacent node with one node.
It causes delete stand state. So, in new filtering didn't this step.



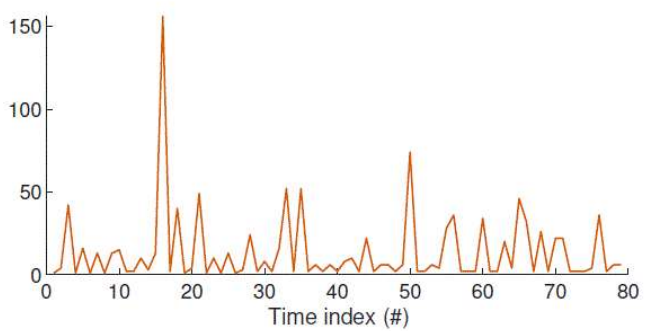
Stand with 6time path Non-stop walking path

Comparing Compressor vs New Filtering

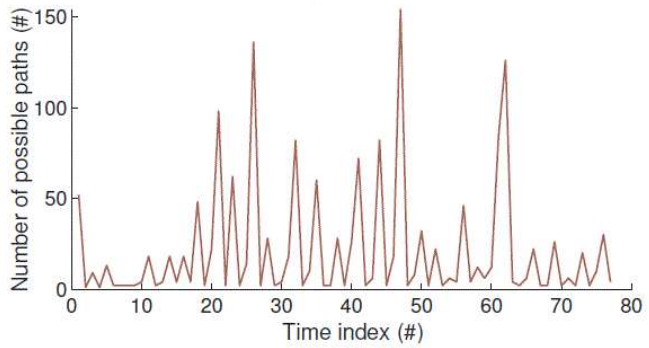
Path Tree Compressor



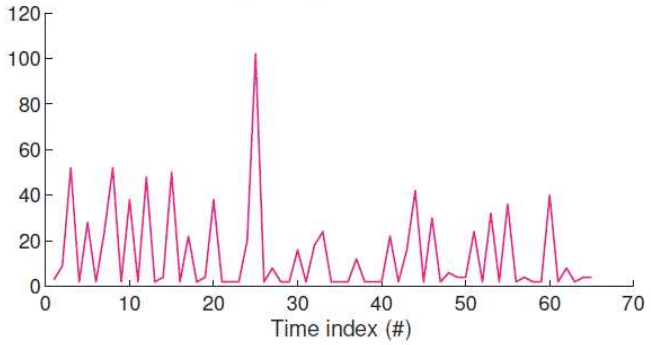
(a) Sample trace 1



(b) Sample trace 2



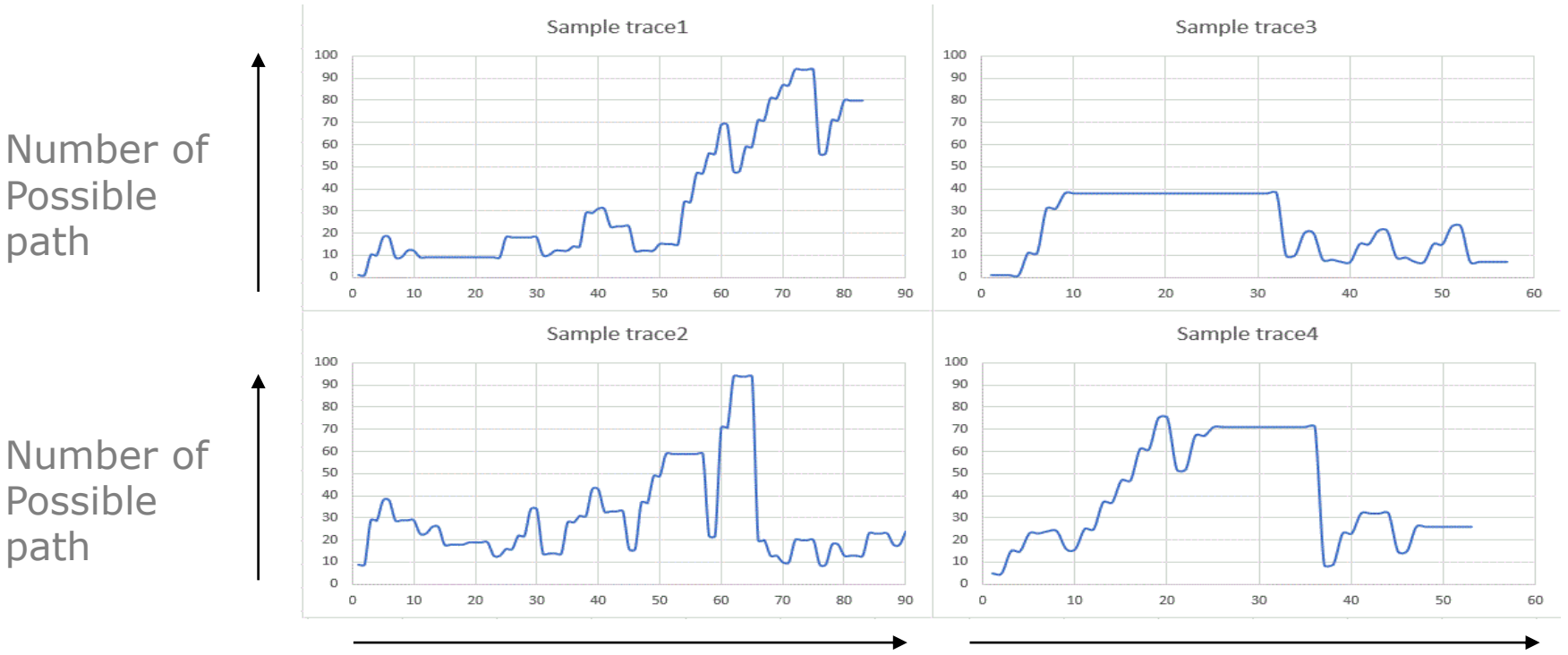
(c) Sample trace 3



(d) Sample trace 4

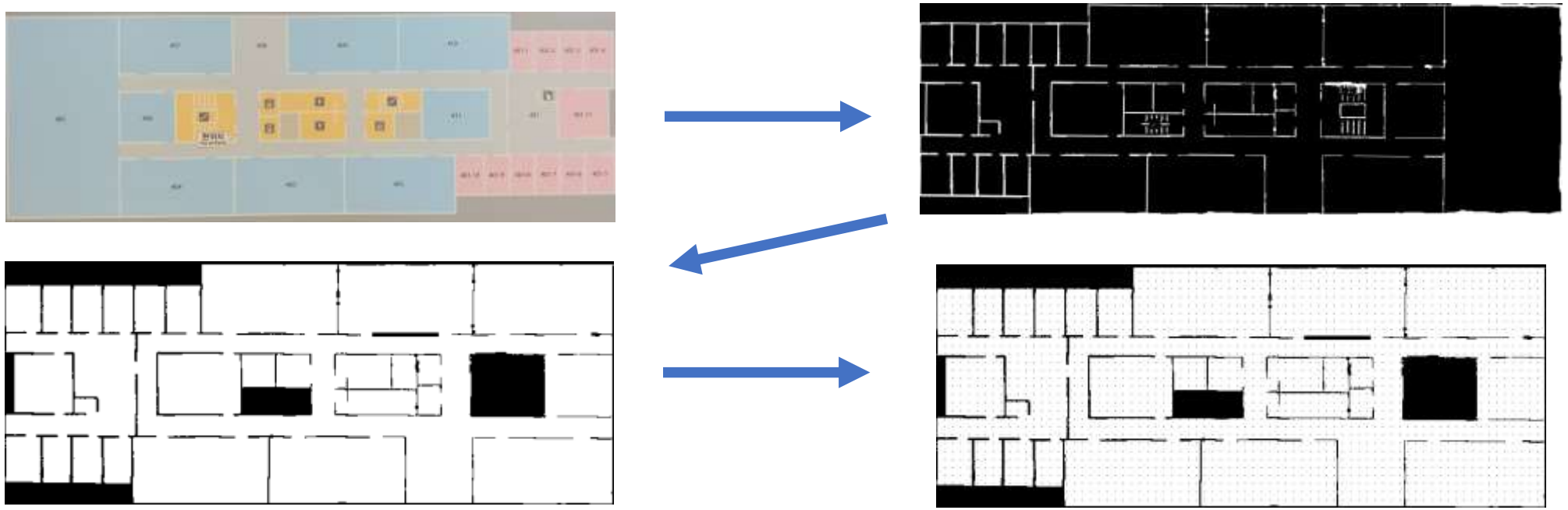
Comparing Compressor vs New Filtering

New Filtering



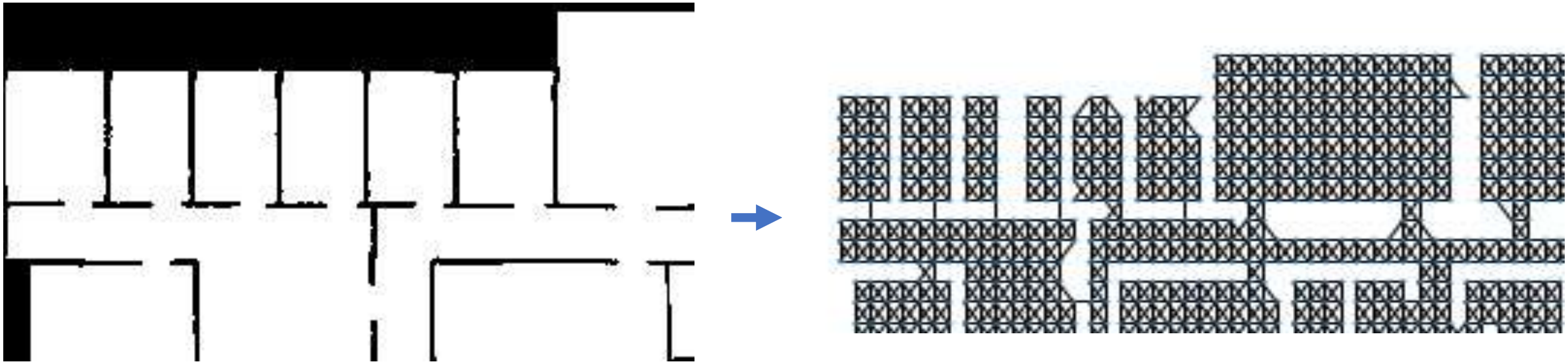
Map Processing Building 106 floor 4

In Fingerprinting base localization, Firstly, It have to need image map to fingerprinting.
By MATLAB function rgb2gray and im2bw, convert camera image to grayscale image and binarize image.
By python, flip the image bit and make image to node grid.



Map Processing Building 106 floor 4

Firstly, Grid map converted as graph nodes.
Secondly, All node liked with adjacent nodes.
If there is wall then didn't linked.
This method can prevent checking impossible trajectories by only linking these nodes.



Android Application

In early exist research ‘1)’, Scan signal is the most suitable signal in WIFI indoor localization.
Because, The signal is the strongest signal and stable.
But, It makes hard to make fingerprint in real world.
Our device don’t send signal as we want.
So, I have to develop android application which send a scan signal manually.

1)Dheryta Jaisinghani, Rajesh Krishna Balan, Vinayak Naik, Archan Misra, Youngki Lee
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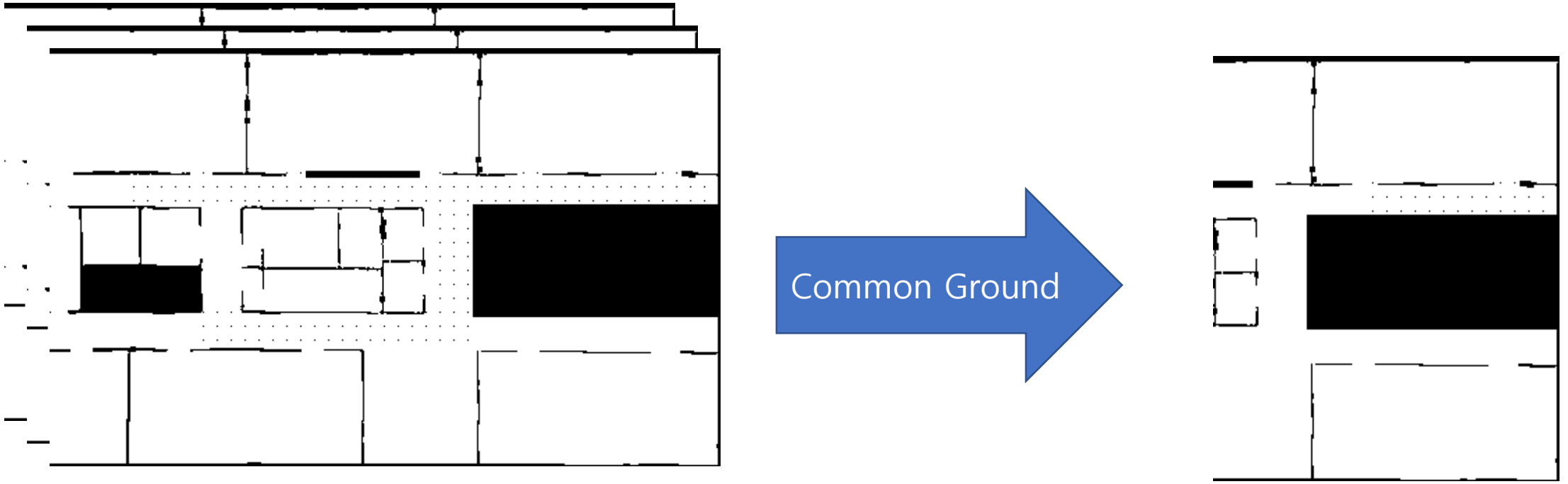
Possible Location Estimation

Find each ap's signal location. And find common ground points.
But this process need to discard less then -86 RSSI. '1)' in this paper if RSSI is less then -86 then it has high possibility to loss WIFI connection. So, I discard too weak RSSI.



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Result of Path

Walking path 1 and 2

Walking Standing
Combination path 1 and 2

Start Point End Point Estimated Path Ground Truth

0 Speed Result

Walking Standing
Combination path 1 and 2

Configure Standing position is almost same.
In above path, the matching with real and estimated path in standing point is perfectly matched.
In below path, the matching has only difference with 2sec's time reg.

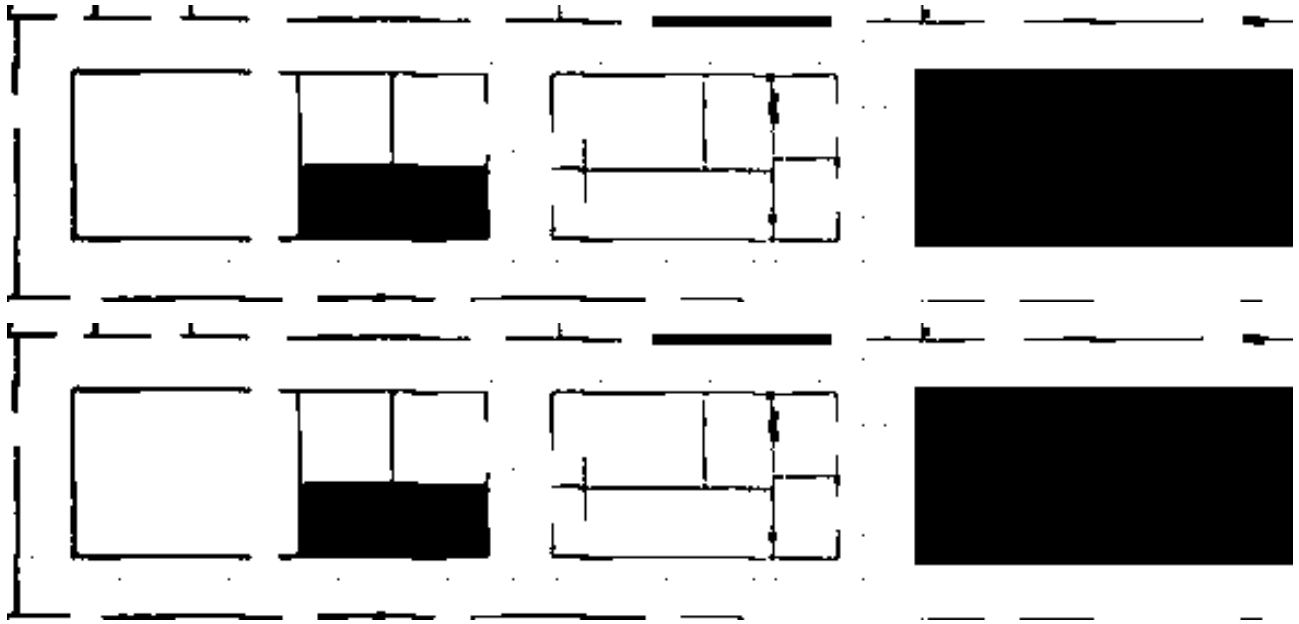
Start Point End Point Estimated Path Ground Truth

0 Speed Result

This is the image of last candidate to select.
Most of data is same with small difference

Selecting Last Path

To select one last path, I used consistency of speed in multipath.
In previous work, Original Multiverse, it used speed consistency in path compressor step.
But it is not much affect to my paths. And it takes a lot of calculation.
So, I this concept to select Last Path.
Without this concept, the result is quit different through all paths.

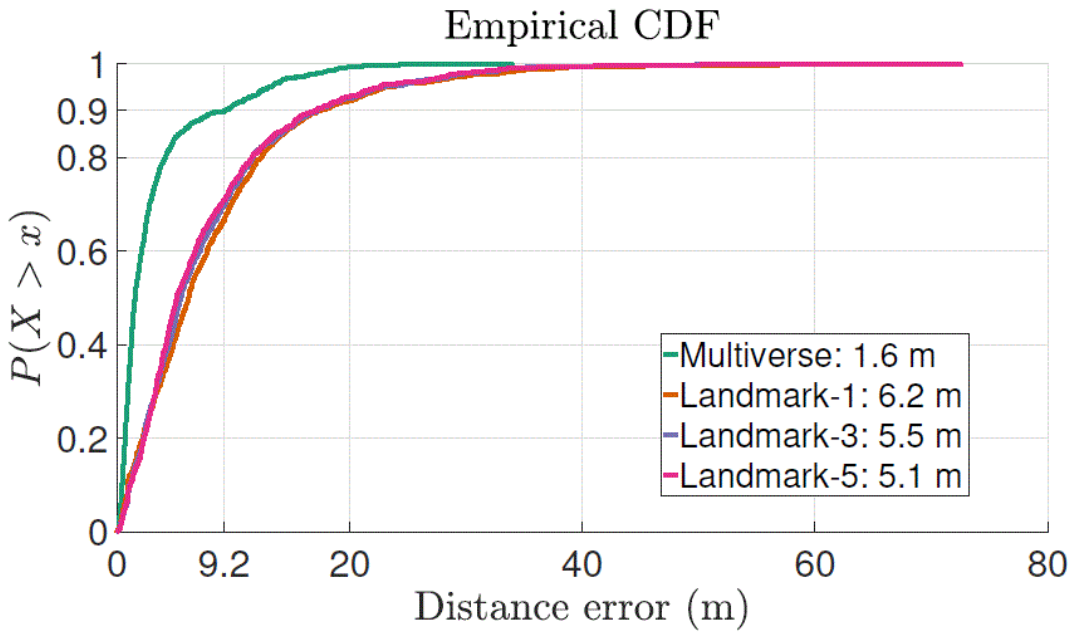


<- Most max standard deviation of node

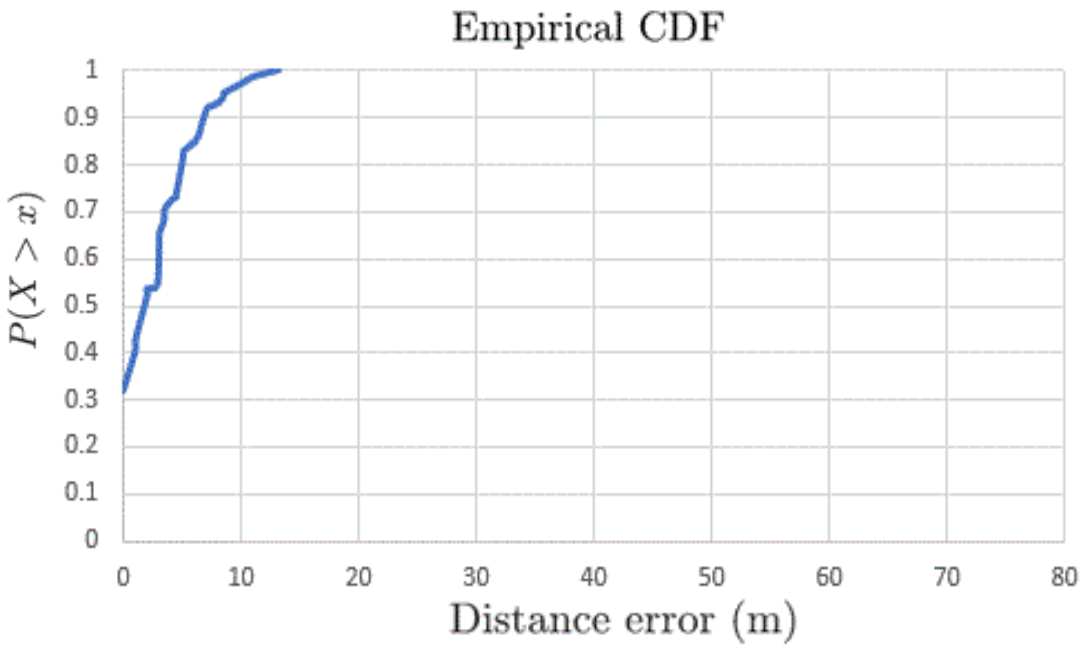
<- Most min standard deviation of node

CDF of Point wise difference

Original CDF of Point wise error



New CDF of Point wise error



Conclusion

The achieved mean accuracy [~ 1.6m]
Previous one's mean accuracy [~ 1.6m]
The achieved 90% accuracy [~ 6.8m]
Previous one's 90% accuracy [~ 9.2m]

The short 0speed is hard to figure out.

This experiment is assumed we know start point.
The heterogeneous device can bring different accuracy.