An Indoor Positioning System for Way-Finding inside Buildings

Mid Report

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Introduction

1. Objectives
2. Outcome

Objectives

- Develop an indoor positioning smartphone application utilizing Inertial Measurement Unit (IMU) and employing one or more technologies such as Wi-Fi, Bluetooth Low Energy (BLE) that can localize the smartphone in 3D space with respect to a given map.
- Apply the system to Bren Hall so a user can find her way around inside the building.

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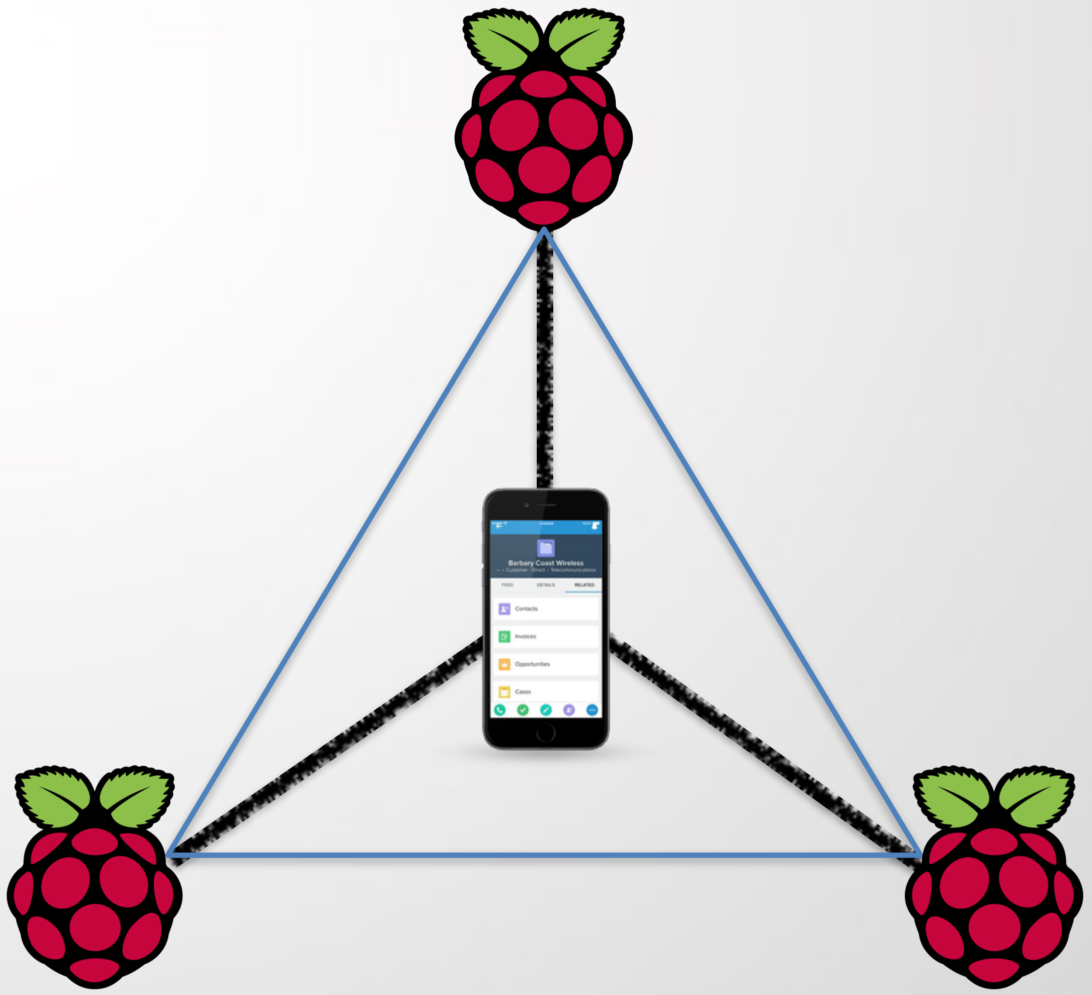
Introduction

1. Objectives
2. Outcome

Objectives



Introduction

1. Objectives

2. Outcome

System Algorithm for Indoor Positioning

RSSI signal reception

↓

Our formula

↓

Triangulation

↓

Kalman Filter

↓

The final x,y coordinates

Introduction

1. **Objectives**
2. **Outcome**

Expected Outcome

- We will learn how to access sensor data, work with BLE or other communication devices, use sensor fusion and Kalman filter techniques to develop a robust system that handles uncertainties in sensor data.
- Indoor GPS is an active area with many applications.

Description

1. BLE
2. Devices
3. Measurement
4. Output

BLE (Bluetooth Low Energy)

- Bluetooth Low Energy takes the same Bluetooth technology used in our cars and mobile devices and allows it to constantly run and collect data use very little energy.

Description

1. BLE
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BLE vs. Bluetooth

- Bluetooth can handle a lot of data. But consumes battery life quickly and costs a lot more.
- BLE is used for applications that do not need to exchange large amounts of data, and can therefore run on battery power for years at a cheaper cost.

Bluetooth® SMART vs. Bluetooth

Description

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Devices (Raspberry Pi)

- Raspberry Pi 3 1 GM RAM
- We need 3 Raspberry Pi
- Role : AP
- Send a RSSI Signal

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Devices (Raspberry Pi)

- Raspberry Pi 3 1 GM RAM
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- Role : AP
- Send a RSSI Signal

Recieved Signal Strength Indicator(RSSI) is a measurement of the power present in a received radio signal

Description

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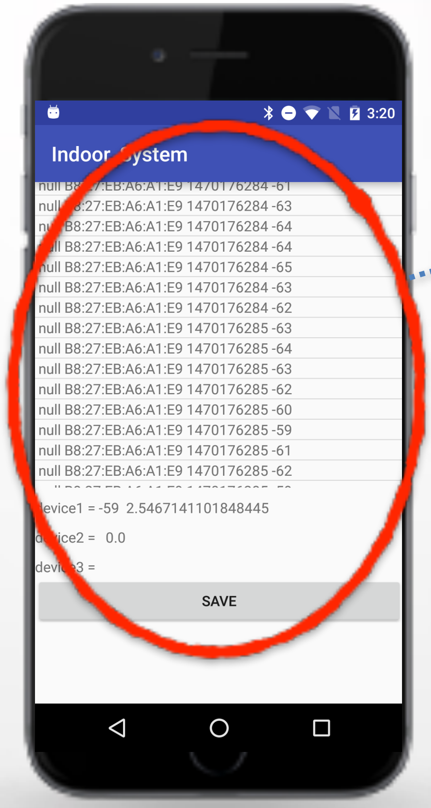
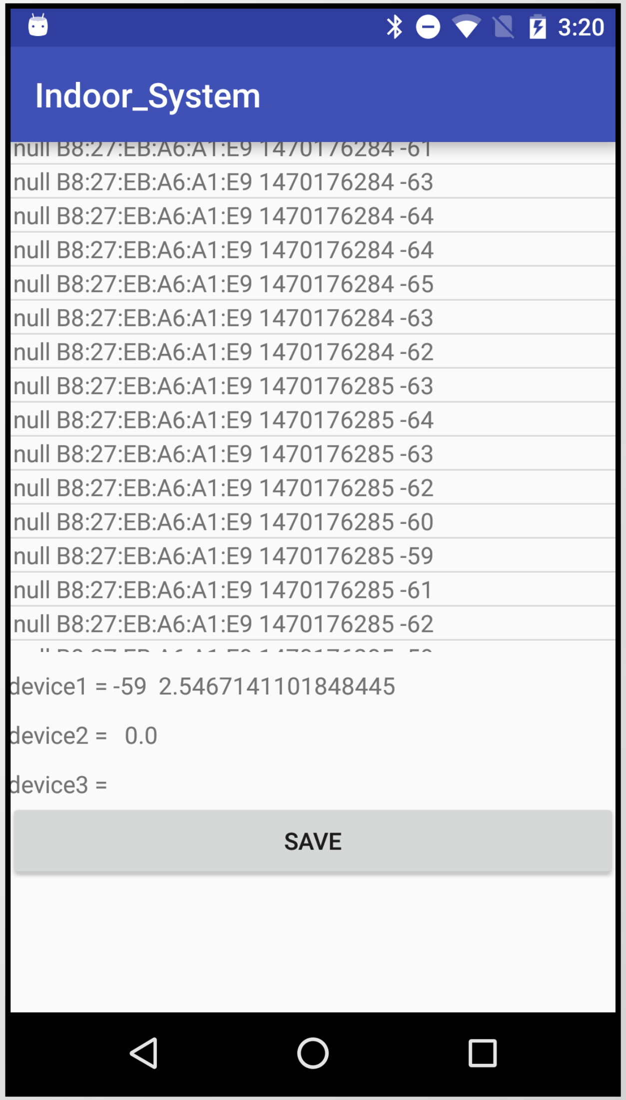
Devices (Mobile Device)





Description

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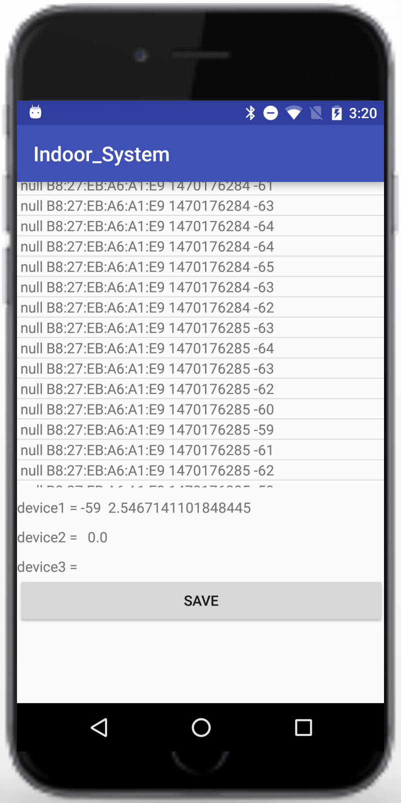
Devices (Mobile Device)



- Nexus 5
- Android 6.0.1
- Role : Terminal
- Receive a RSSI Signal
- Calculate the Distance

Description

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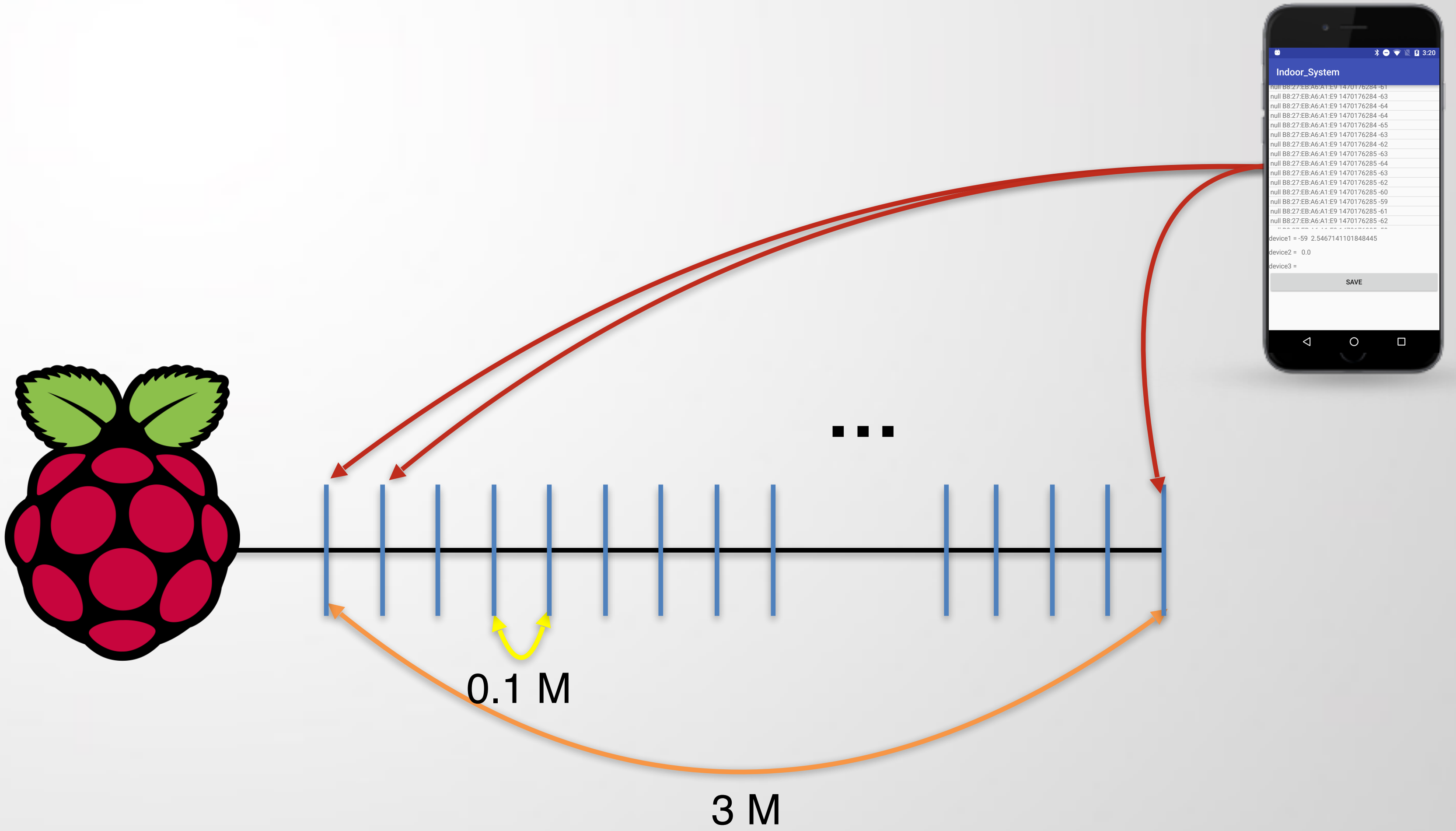
Measurement



Description

1. BLE
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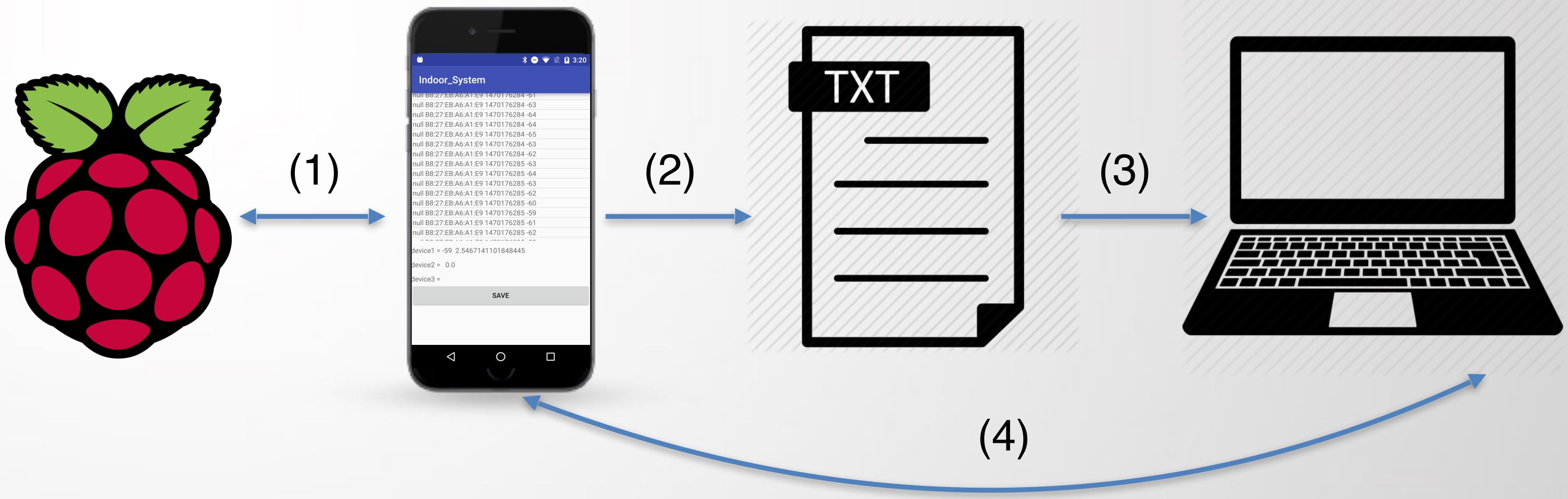
3. Measurement
4. Output

Measurement

Description

1. BLE
2. Devices
3. **Measurement**
4. Output

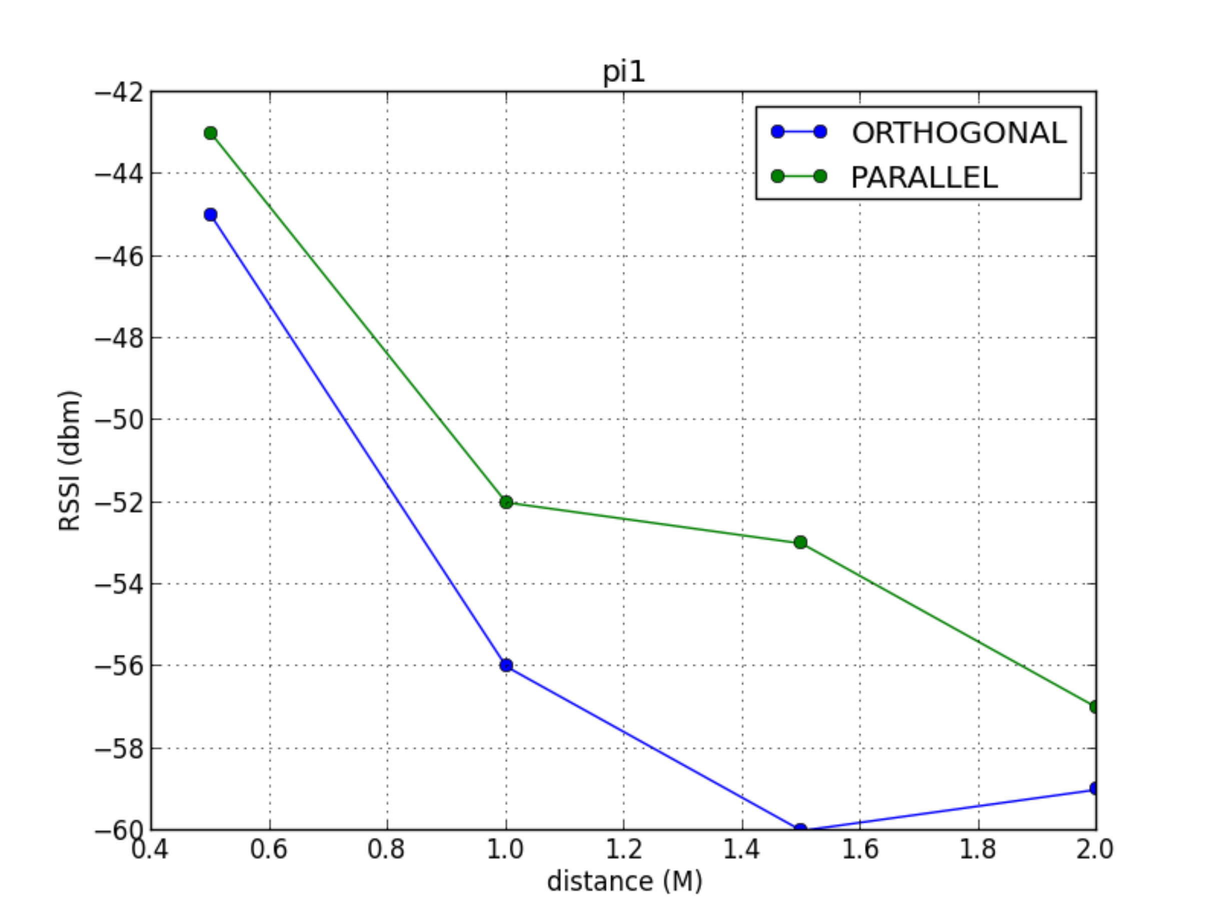
Measurement



(1)Information interchange
(2)Collecting data in text file format
(3)Analyzing the data
(4)Updating the Application

Output

- Correlation of RSSI Signal and Distance



Description

1. BLE
2. Devices
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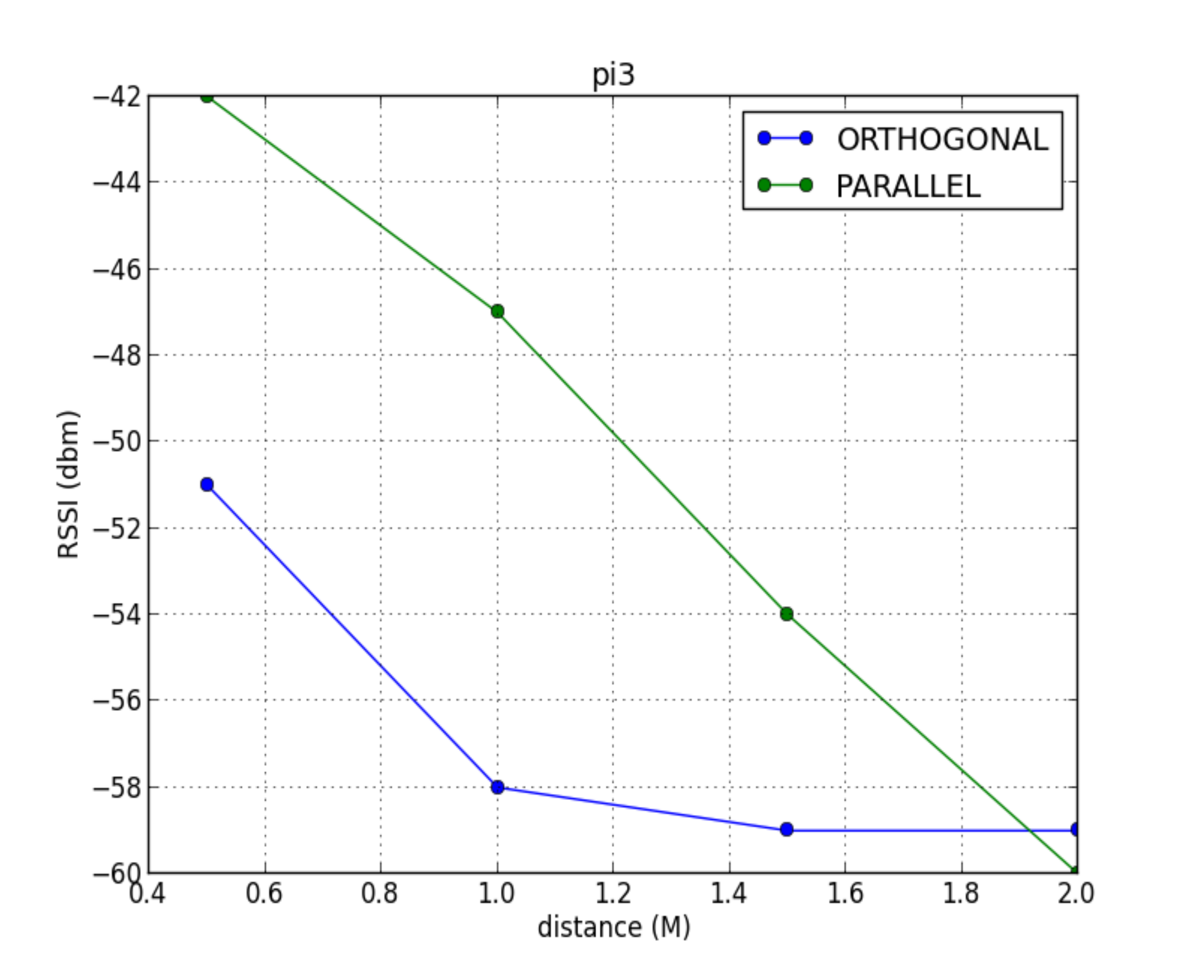
Description

1. **BLE**
2. **Devices**
3. **Measurement**
4. **Output**

Output

- Correlation of RSSI Signal and Distance



Description

1. **BLE**
2. **Devices**
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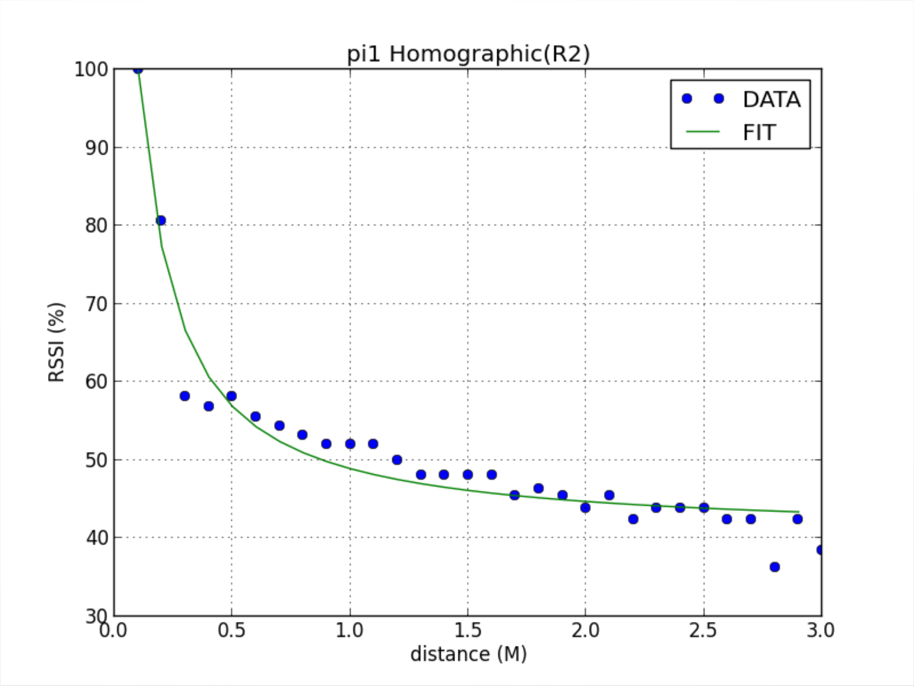
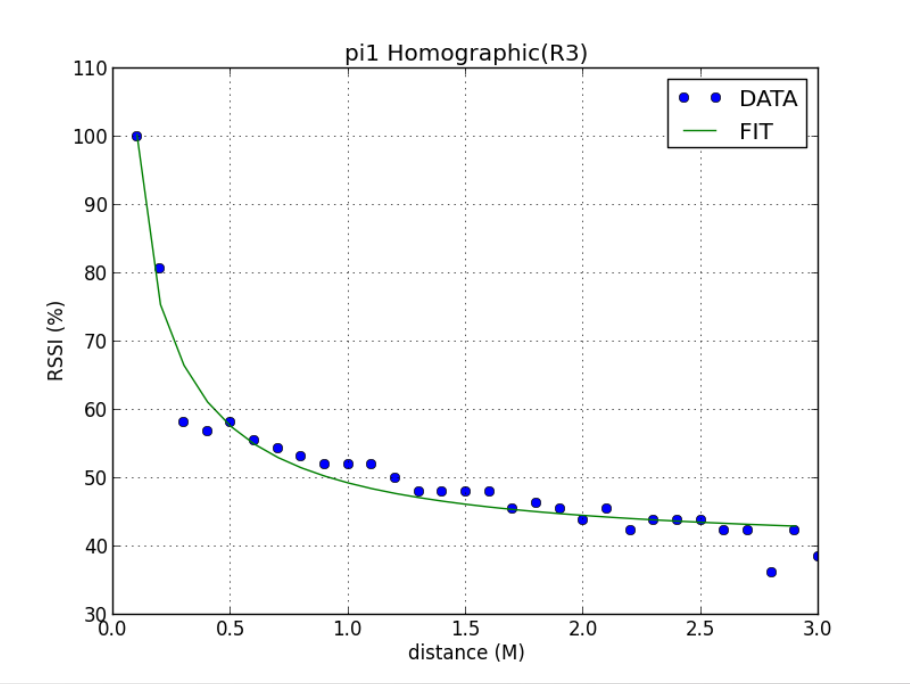
4. **Output**

Output

- Result of Curve Cutting





Draw a Graph by using LMS(Least Mean Square)

We concluded to use the homographic function(a(1/x^2)+b(1/x)+c)

Description

Output

- What is the LMS?

Least mean squares (LMS) algorithms are a class of adaptive filter used to mimic a desired filter by finding the filter coefficients that relate to producing the least mean squares of the error signal (difference between the desired and the actual signal).

Description

1. BLE
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Output

- Coefficient of the homographic function

- $A*(1/(x^2)) + B * (1/x) + C$

- A= -0.286, B=8.813, C= 40.389

Description

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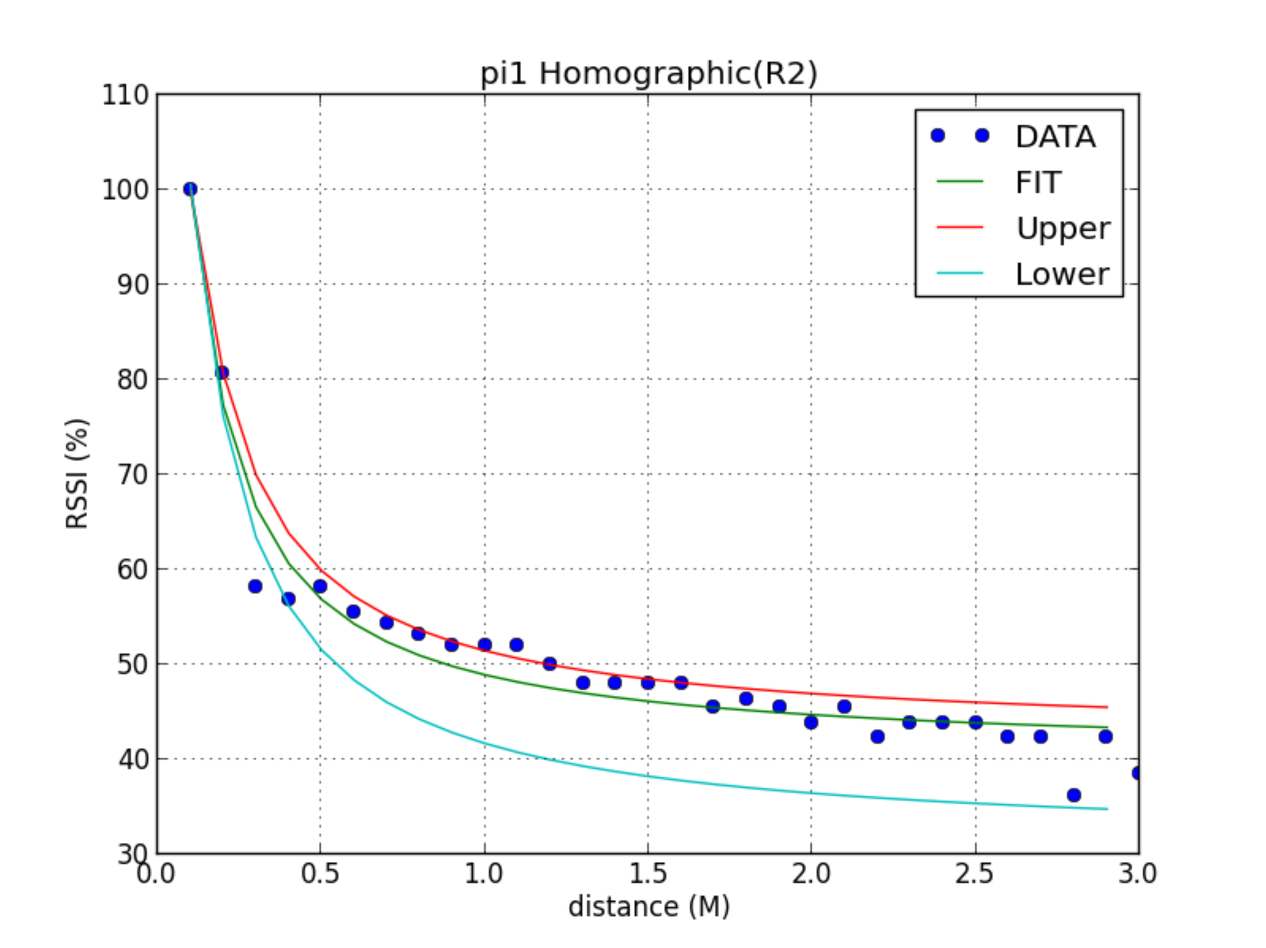
Output

- Add upper plot and lower plot for calculating weight



Description

1. **BLE**
2. **Devices**
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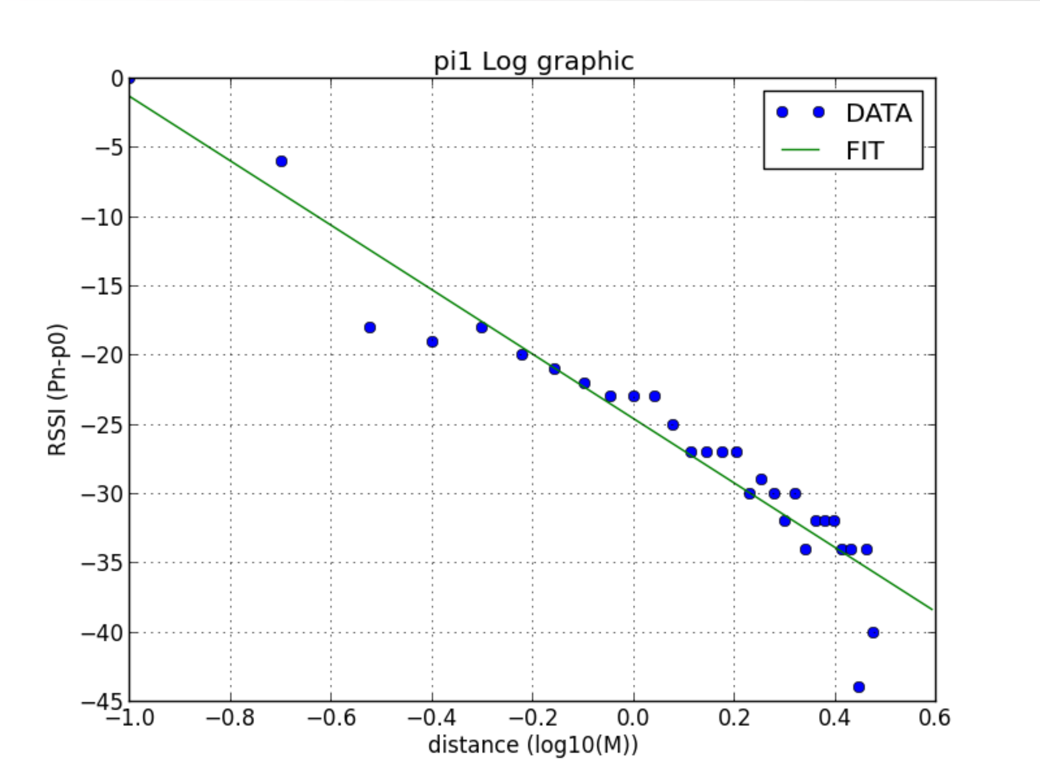
Output

- Linear Transformation



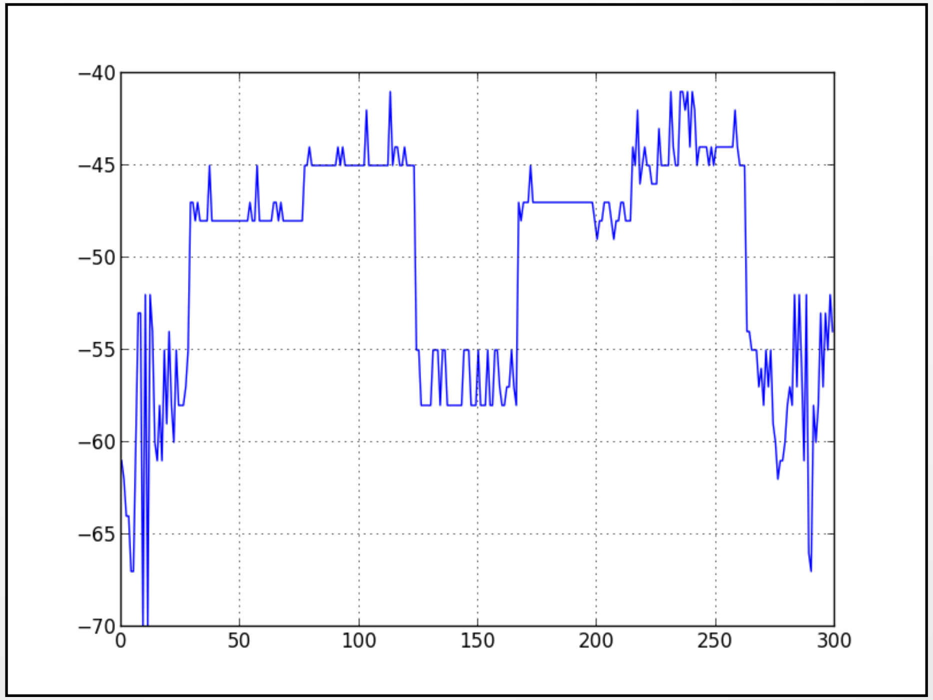
1) The other values are subtracted by first value.
2) Take the Log in the Distance

Description

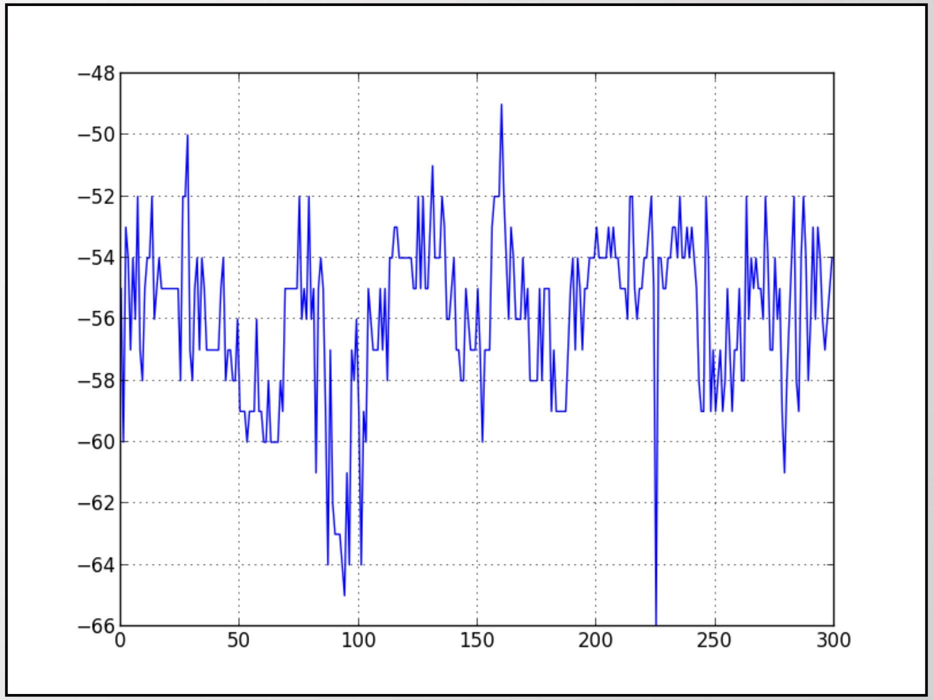
1. **BLE**
2. **Devices**
3. **Measurement**
4. **Output**

Output

- Solution of the Fluctuation problem



Old



New

Description

1. BLE
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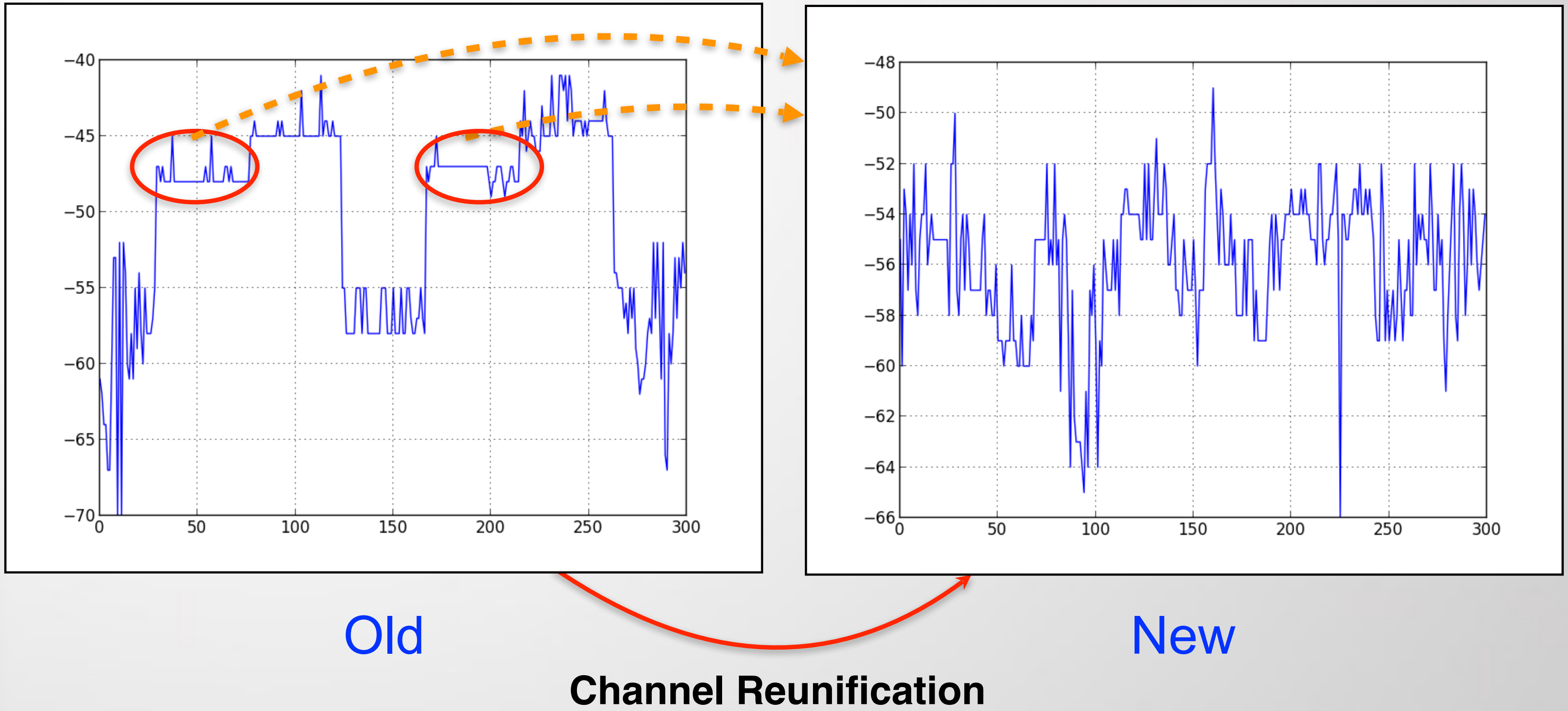
Output

- Solution of the Fluctuation problem



Next Step

1. Low Pass Filter

2. Triangulation

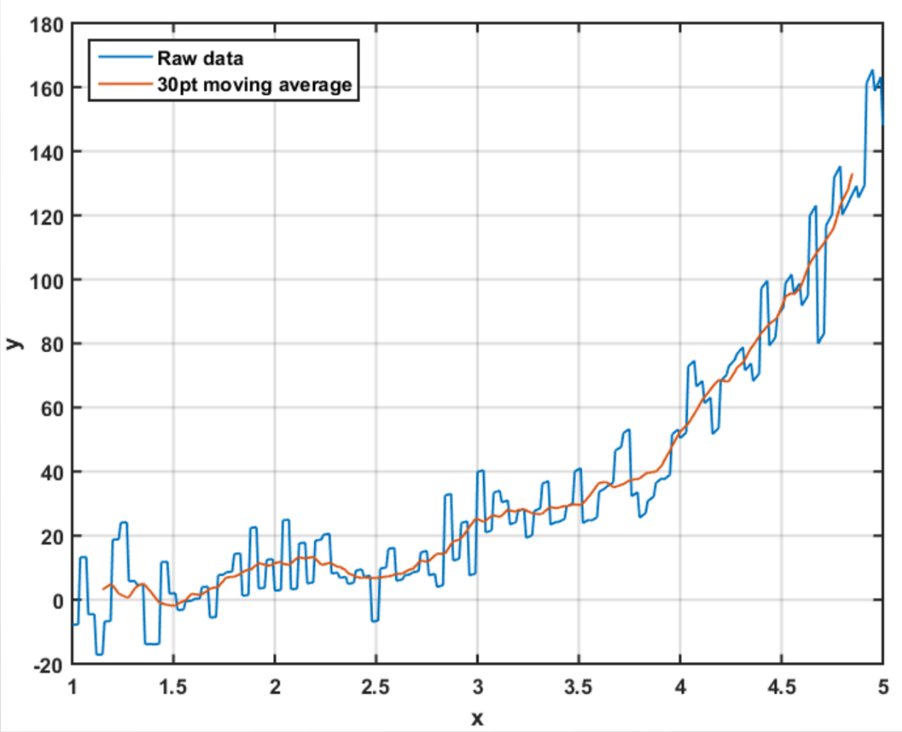
3. Kalman Filter

Low Pass Filter

- What is Low Pass Filter   cf) Median Filter

A low-pass filter is a filter that passes signals with a frequency lower than a certain cutoff frequency and signals with frequencies higher than the cutoff frequency.

$$y' = \frac{y_n}{30} + \frac{y_{n-1}}{30} + \frac{y_{n-2}}{30} + \cdots + \frac{y_{n-29}}{30}$$



Next Step

1. Low Pass Filter

2. Triangulation

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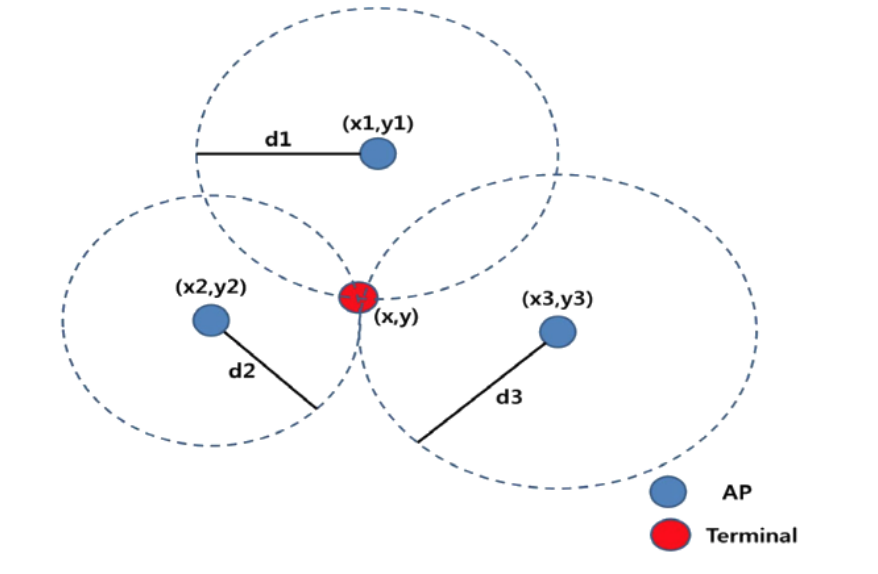
Triangulation

- What is Triangulation

Triangulation is a way of determining something's location using the locations of other things.

- Triangulation Schematic



$$d_1^2 = (x - x_1)^2 + (y - y_1)^2$$
$$d_2^2 = (x - x_2)^2 + (y - y_2)^2$$
$$d_3^2 = (x - x_3)^2 + (y - y_3)^2$$

Next Step

1. Low Pass Filter

2. Triangulation

3. Kalman Filter

Kalman Filter

- What is Kalman Filter

You can use a Kalman filter in any place where you have uncertain information about some dynamic system, and you can make an educated guess about what the system is going to do next.

Q & A

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THANK YOU !!

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