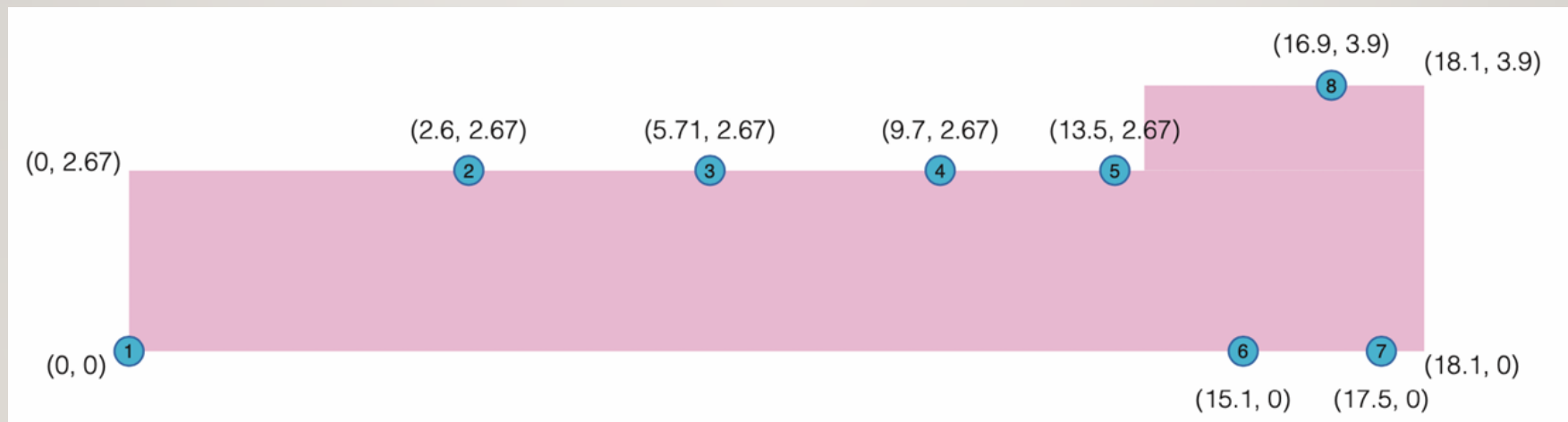# 室內定位演算法

2024 嵌入式系統設計 期末專題報告

動機&目標

- 利用iBeacon達成室內使用者位置即時定位

- 觀察場地配置，可能不利於Propagation Model-based

- 決定利用Fingerprinting-based演算法

演算法說明-1

- 選擇區域 (Improved KNN[1])

  - 找出和目前RSSI最接近的K個參考點。

  - 創建K類，各類中心分別為所選K個參考點。

  - 若其他參考點和該類中心＜M公尺，
   則加入該點成為該類成員。

  - 選擇成員最多的類。

- 避免過於遙遠的參考點影響結果

Algorithm 1: Select_Area method

Input: Selected points from KNN as SelectedPoints, Maximum distance till center as MaxDistance
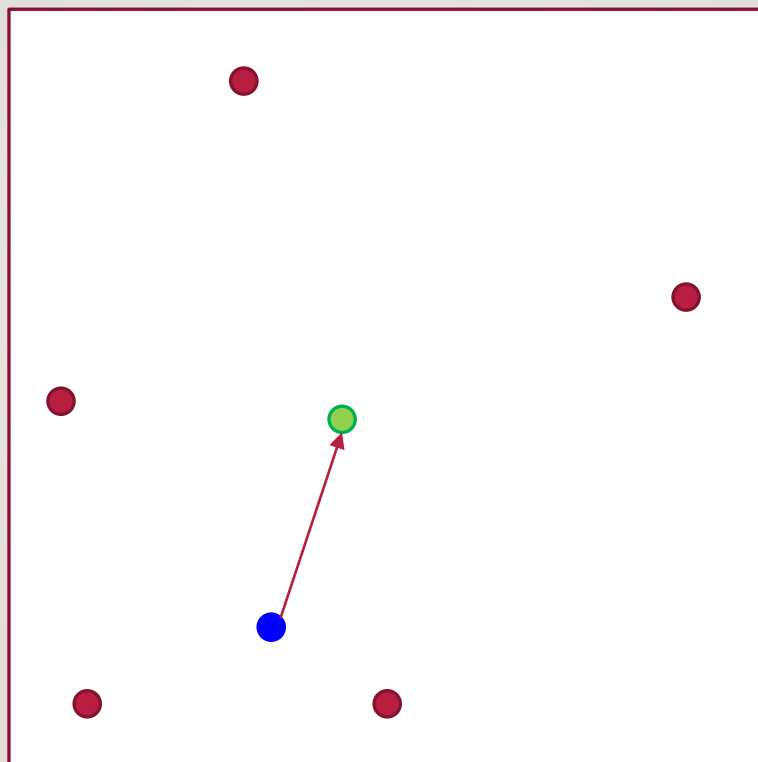
Output: predicted position

1.   Classes = []; //A empty list to get filled by each class
2.   **Foreach** Element in SelectedPoints:
3.   TemporaryClass = []; //A empty list for each class
4.   TemporaryClass.ADD(Element); //Add center of each points to each class
5.   Classes.ADD(TemporaryClass); //Add the created class to list of classes
6.   **Foreach** Class in Classes:
7.   **Foreach** Element in SelectedPoints:
8.   **If** Element != Class[0]:
9.   Distance = SpecialDistance(Element, Class[0]) ;
10.   **If** Distance <= MaxDistance:
11.   Class.ADD(Element);
12.   Classes = Update(Classes, Class); //Update Classes by updated Class
13.   SelectedClass = SelectTheBiggestClass(Classes); //Set SelectedClass a Classes' member with biggest size
14.   ComputedPosition = MeanPositions(SelectedClass); //Set ComputedPosition as average of points in SelectedClass
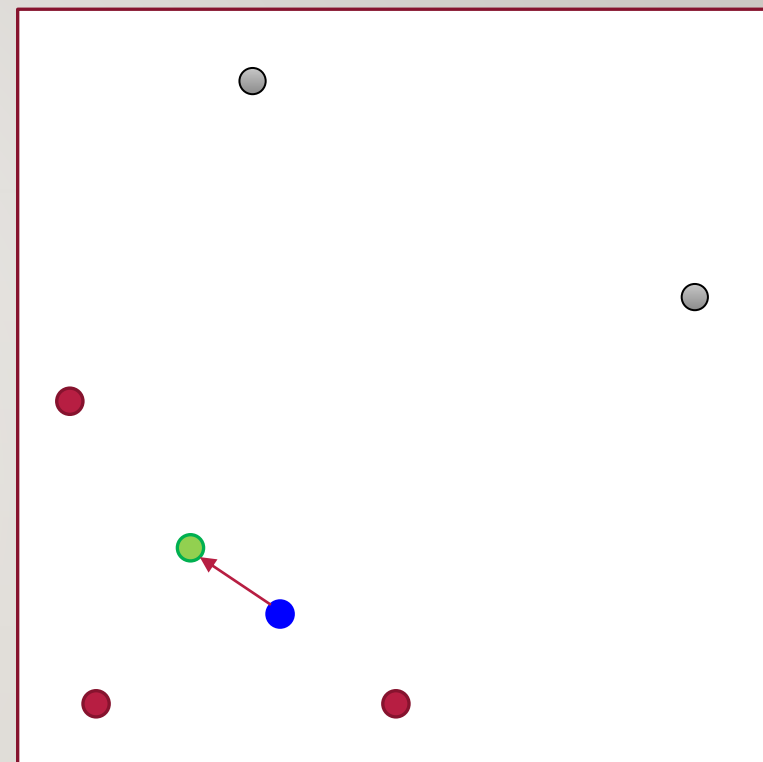15.   **Return** ComputedPosition;
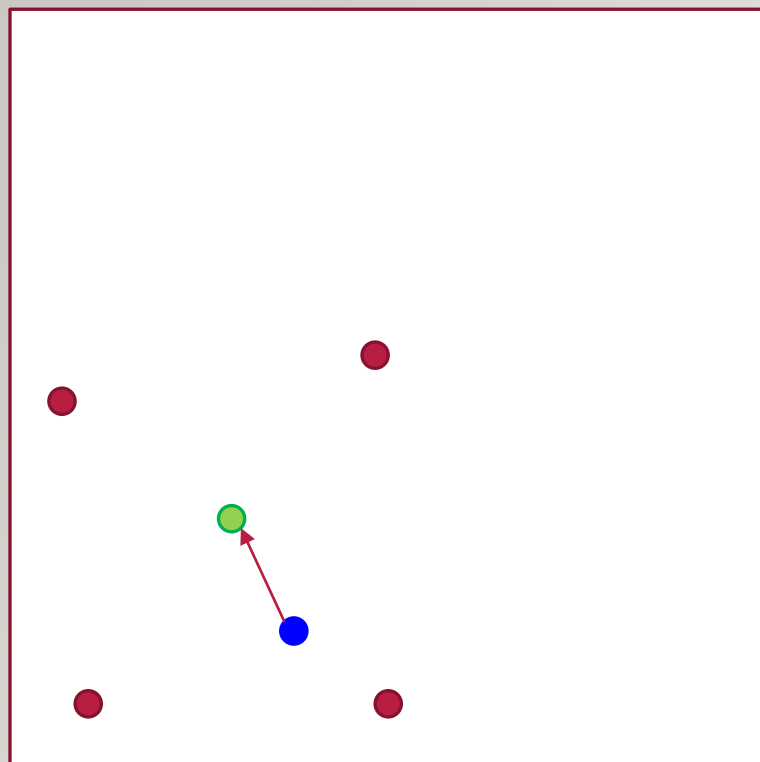
1. 理想情形   2. 實際情形   3. 區域選擇

- ● Selected Reference Points
- ● Real Position
- ● Predicted Position

演算法說明-2

- 利用所選的類計算**加權座標(**M-WKNN matching algorithm[2])

- 考慮RSSI與實際距離的關係為**非線性**

  - $PL_d = PL_0 + 10n \log \frac{d}{d_0}$

  - $\Delta_{rssi} = |rssi_i - rssi| = PL_0 + 10n \log \frac{d}{d_0}$

  - $d = d_0 \cdot 10^{\frac{\Delta_{rssi} - PL_0}{10n}}$

  - $k_1 = 10n; k_2 = 10^{-\frac{PL_0}{10n}}$

  - $\frac{d_1}{d_2} = \frac{k_2 \cdot 10^{\frac{\Delta_{rssi1}}{k_1}}}{k_2 \cdot 10^{\frac{\Delta_{rssi2}}{k_1}}} = 10^{\frac{\Delta_{rssi1} - \Delta_{rssi2}}{k_1}}$

$$\Delta_{\Delta_{rssi}} = \Delta_{rssi1} - \Delta_{rssi2}$$
$$= k_1 \cdot (\log d_1 - \log d_2)$$
$$\boldsymbol{\Delta_{rssi} \propto \log d}$$

演算法說明-2

- 利用所選的類計算**加權座標**

- $(x, y) = \sum_{i=1}^{k} w(P_i) \cdot (x_i, y_i); \quad P_i = (x_i, y_i) \in C_m$

    - $w(P_i) = \dfrac{w_i(P_i)}{\sum_{m=1}^{k} w_m(P_m)}$

    - $w_m(P_m) = \dfrac{1}{10^{\Delta rssi}} = \dfrac{1}{10^{|rssi_m - rssi|}}$

APP簡介

Monitoring

[State Inside] Start Ranging
Enter region
[State Outside] Stop Ranging
[Start Monitoring] area-location
[State Outside] Stop Ranging
Exit regine

目前接收數量

4

Ranging

[1]
Major: 1
Minor: 1
RSSI: -56
Proximity: Near
Accuracy: 2.2579534698652233
[2]
Major: 1
Minor: 2
RSSI: -58
Proximity: Far
Accuracy: 5.705675083518917
[3]
Major: 1
Minor: 3
RSSI: -64
Proximity: Far
Accuracy: 12.638172469479448
[4]
Major: 1
Minor: 4
RSSI: -75
Proximity: Far
Accuracy: 11.576020730553537

RSSI紀錄　　　　　　　清除

-56.0 , -58.0 , -64.0 , -75.0
-54.0 , -59.0 , -66.0 , -69.0
-54.0 , -58.0 , -65.0 , -69.0
-56.0 , -61.0 , -65.0 , -70.0
-58.0 , -60.0 , -66.0 , -68.0
-56.0 , -59.0 , -68.0 , -68.0
-54.0 , -66.0 , -67.0 , -68.0
-53.0 , -62.0 , -69.0 , -67.0
-53.0 , -63.0 , -68.0 , -67.0
-53.0 , -62.0 , -66.0 , -65.0

目前接收資料
最新10筆平均

平均

-54.7 , -60.8 , -66.4 , -68.6

XX.XX, YY.YY　　　　　　　Add

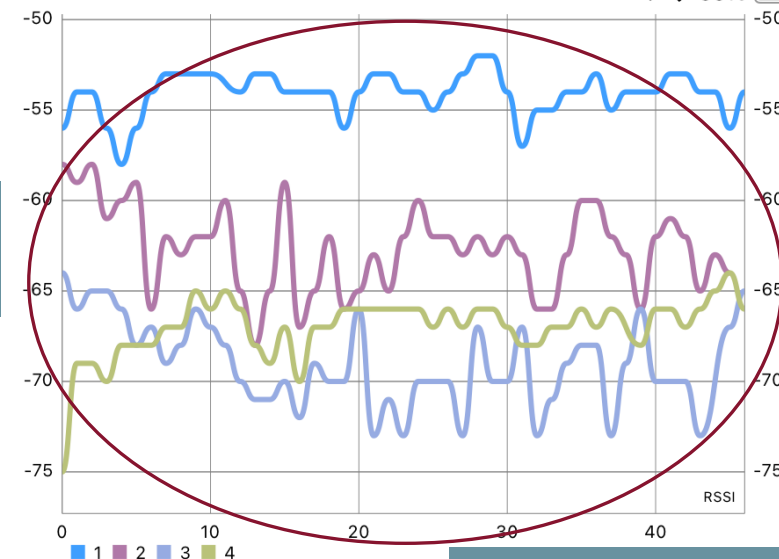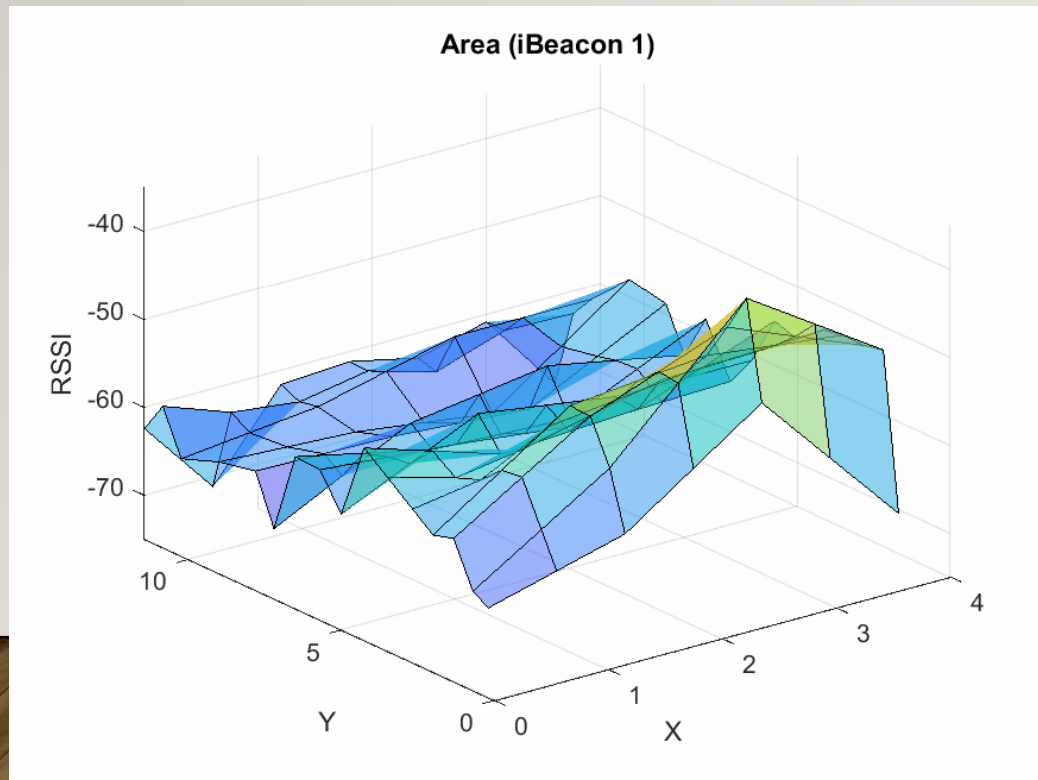| 座標	RSSI
(2.4,11.43)	-62.8 , -63.5 , -65.6 , -37.5
(3.0,11.43)	-60.8 , -64.1 , -61.5 , -46.4
(3.6,11.43)	-69.9 , -69.0 , -58.5 , -50.0
(3.6,10.83)	-61.0 , -64.3 , -55.9 , -52.3
(3.0,10.83)	-60.8 , -64.5 , -53.8 , -45.9
(2.4,10.83)	-63.4 , -62.4 , -64.0 , -41.4
(1.8,10.83)	-61.2 , -67.5 , -63.8 , -51.2
(1.2,10.83)	-62.6 , -60.9 , -61.2 , -52.7
(0.6,10.83)	-61.7 , -64.1 , -64.6 , -55.3

RSSI折線圖

B

0.90, 3.40

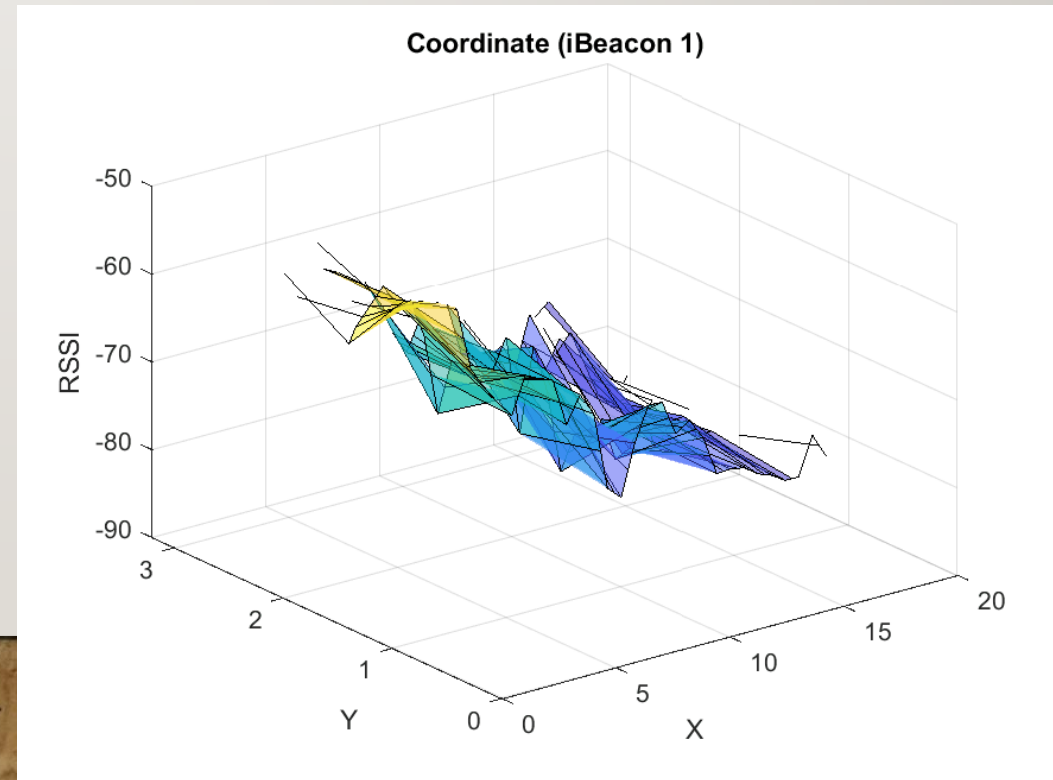定位開關
判定座標結果

Area　　　　　Coordinate

切換區域

實驗數據

- Area

  - X軸距1.2m

  - Y軸距0.6m

  - 約80個參考點，各參考點一筆RSSI

- Coordinate

  - X軸距0.7m

  - Y軸距0.6m

  - 約110個參考點，各參考點一筆RSSI

Area (iBeacon 1)

Coordinate (iBeacon 1)

實驗結果

- 誤差來源
  - 打點時位置量測錯誤
  - 人體干擾
  - iPad面向方向
- 精準度僅達公尺級
- 改進方向
  - 提升參考點密度及數量
  - 適應性更改分類數量(K)及判斷距離(M)

參考資料

- [1] S. A. Zibaei and R. Ali Abbaspour, "**Evaluation of Improved K-Nearest Neighbors for Indoor Positioning System in Real Complex Buildings**," *2023 9th International Conference on Web Research (ICWR)*, Tehran, Iran, Islamic Republic of, 2023, pp. 12-19, doi: 10.1109/ICWR57742.2023.10139137.

- [2] W. Liu, X. Fu, Z. Deng, L. Xu and J. Jiao, "**Smallest enclosing circle-based fingerprint clustering and modified-WKNN matching algorithm for indoor positioning**," *2016 International Conference on Indoor Positioning and Indoor Navigation (IPIN)*, Alcala de Henares, Spain, 2016, pp. 1-6, doi: 10.1109/IPIN.2016.7743694.