YAI Team Presentation

Track 3

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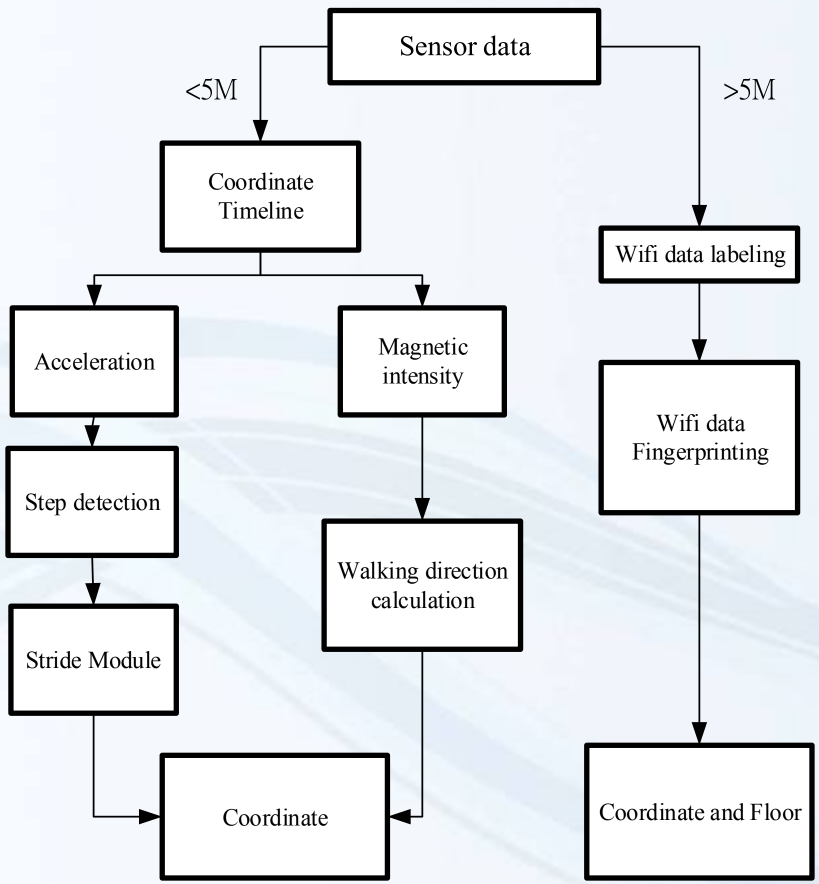
Outline

- Building Distinction
- Floor Distinction
- Coordinate Localization

Flow Chart



Sensor data
<5M
>5M
Coordinate Timeline
Wifi data labeling
Acceleration
Magnetic intensity
Wifi data Fingerprinting
Step detection
Walking direction calculation
Stride Module
Coordinate
Coordinate and Floor

Building Distinction

We use GPS data to determine the correct building because their coordinate range does not have the intersection. No matter what the validation data has been put in, it still return to an individual result.

CAR

UJITI

UJIUB

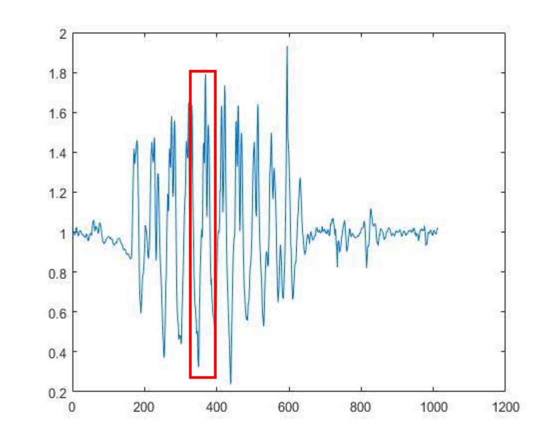
Coordinate Localization

Acceleration Decomposition

- $\mathbf{g}_0 = \frac{1}{t}\left(\sum_{i=t-N-1}^{t} g_{i,x}, \sum_{i=t-N-1}^{t} g_{i,y}, \sum_{i=t-N-1}^{t} g_{i,z}\right)$
  - where $\mathbf{g}_0$ represents unit vector in the vertical direction. t is the *i*-th reading of the g-sensor. *N* is the number of readings in the window
- $g_i^{\perp} = (\mathrm{g}_i \cdot \mathrm{g}_0)$
  - where $g_i^{\perp}$ represents the vertical component of $\mathbf{g}_i$

Stride Module

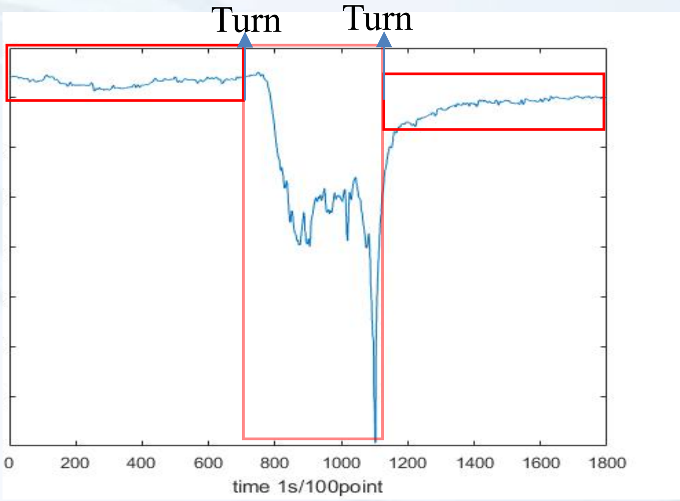
- We calculate step distance using multi-variable linear regression equation for each step
- $\mathrm{D}(\Delta\mathrm{A}, \mathrm{X}_1) = \mathrm{c}_0 + \mathrm{c}_1\Delta\mathrm{A} + \mathrm{c}_2\mathrm{X}_1$
  - ΔA represents $\Delta\mathrm{A}_1 + \Delta\mathrm{A}_2$, where $\Delta\mathrm{A}_1$ is the left peak-valley difference, $\Delta\mathrm{A}_2$ is the right peak-valley difference.
  - c_0, c_1 and c_2 are parameter.
  - X_1 is the first component of DFT of $g_i^{\perp}$ in the period.



Coordinate Localization

Walking Direction Calculation

- We calculate the direction of movement by the accelerometer horizontal direction and the magnetometer value.
- we used the orientation of the smartphone to Calculate the horizontal component of m-vector
- $\mathbf{m}_i^{=} = \mathbf{m}_i - (\mathbf{m}_i \cdot \mathbf{g}_0)\mathbf{g}_0$ where $\mathbf{m}_i$ represents the i-th reading of the m-sensor
- Calculate the horizontal component of $\mathbf{e}_z = (0,0,1)$. It can be formulated as
- $\mathbf{e}_z^{=} = \mathbf{e}_z - (\mathbf{e}_z \cdot \mathbf{g}_0)\mathbf{g}_0$
- The angle between the smartphone orientation and the north is obtained by combining $\mathrm{m}_i^{=}$ and $\mathrm{e}_z^{=}$.
- $\cos^{-1}\left(\frac{\mathbf{m}_i^{=} \cdot \mathbf{e}_z^{=}}{\|\mathbf{m}_i^{=}\|\|\mathbf{e}_z^{=}\|}\right)$



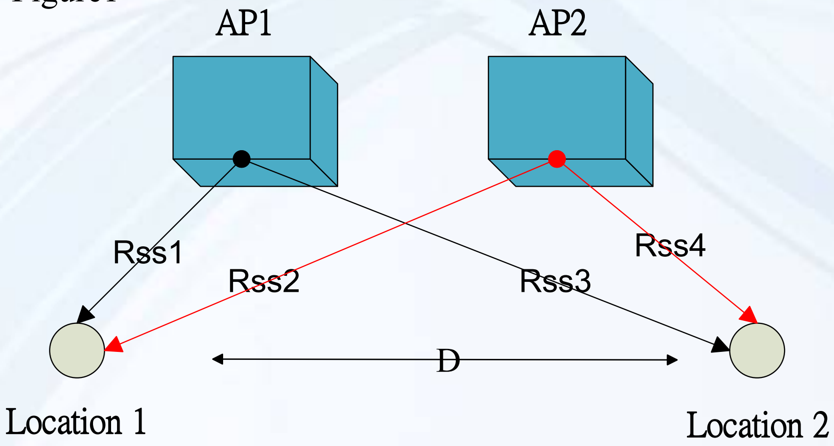
Floor Distinction And Coordinate Localization

Nearest Neighbors in Signal Space

$$D = \frac{1}{N}\{\sum_{k=1}^{n} | u(k) - s'(k) |^{2}\}^{\frac{1}{2}}$$

- where u represents the RSS value of the testing point, S' represents the RSS value of the training point of the same access point of u, D represents the relative distance between the training point and the testing point.
- We use this equation to determine the similarity of the training point and the testing point. If we find the minimum value of D, we map the coordinate and floor number, which we labeled at the training data from the training point to the testing point.

Figure1



$$D = \frac{1}{2}\{((Rss1 - Rss3)^2 + (Rss2 - Rss4)^2)^{\frac{1}{2}}\}$$

Labeling Data

- For Floor:

UJITI: 3 differences(1,2,3)

UJIUB: 6 differences(0,1,2,3,4,5)

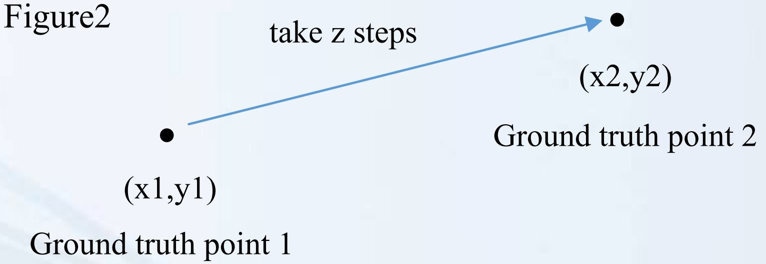
- For Coordinate:

Acceleration Decomposition

$$\mathbf{g}_0 = \frac{1}{t}\left(\sum_{i=t-N-1}^{t} g_{i,x}, \sum_{i=t-N-1}^{t} g_{i,y}, \sum_{i=t-N-1}^{t} g_{i,z}\right)$$

$$g_i^{\perp} = (\mathrm{g}_i \cdot \mathrm{g}_0)$$

Figure2



New Coordinate: $\left(x + \frac{x1-x}{z},\ y + \frac{y1-y}{z}\right)$

Thank you for your attention