Indoor Localization using WiFi & accelerometers

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Opportunity for Wireless Sensing

- Significant wiring & installation costs
- Low spatial density of sensing
- Suboptimal operation
Mobile Sensing

- Multiple integrated sensors
- Gesture recognition
- Opportunity-Distributed sensing
  - Accelerometers – Position
  - Ambient light – Lighting control
Position estimation - Setup

- Hallway – 21 locations, 11 access points (APs)
- Signal strength vector at each location, $\vec{z} \in \mathbb{R}^{11}$
Bayes rule – Training

- \( \tilde{z} \sim N(\tilde{m}, V) \)

- Training
  - Multiple scans at each location
  - Identify \( \tilde{m} \) and \( V \)
Bayes rule - Estimation

\[
P(X = i) = \frac{p(\tilde{z} \mid X = i)P(X = i)}{p(\tilde{z})} = \frac{p(\tilde{z} \mid X = i)P(X = i)}{\sum_{i=1}^{N} p(\tilde{z} \mid X = i)P(X = i)}
\]

\[p(\tilde{z} \mid X = i) \sim N(\bar{m}, V) \text{ known}\]
Position Estimation - Gaussian process

\[ k(x, x') = \sigma_f^2 \exp\left(-\frac{1}{2l^2} \mid x - x' \mid^2\right) \]

- **Accuracy**: 3.5-4m
Use of accelerometer

- Predictor corrector architecture
  - Predictor
    \[
    \hat{v}(k + 1) = \hat{v}(k) + T\alpha_m(k) \\
    \hat{x}(k + 1) = \hat{x}(k) + T\hat{v}(k)
    \]
  - Corrector
    - WiFi scan done and position measurement \(y(k+1)\)
      \[
      \hat{x}(k + 1) \leftarrow \hat{x}(k + 1) + K(y(k + 1) - \hat{x}(k + 1))
      \]
Accelerometer – WiFi results

- Only accelerometer – inaccurate estimate
- WiFi scan every 3 time steps
Future Work

- Use of orientation sensors –

- Analysis of energy consumption by various sensors

- Verification of assumptions on posterior distribution and Bayes filter implementation

- Activity recognition on phones