Ubiquitous and Mobile Computing
ParkSense: A Smartphone Based Sensing System For On-Street Parking
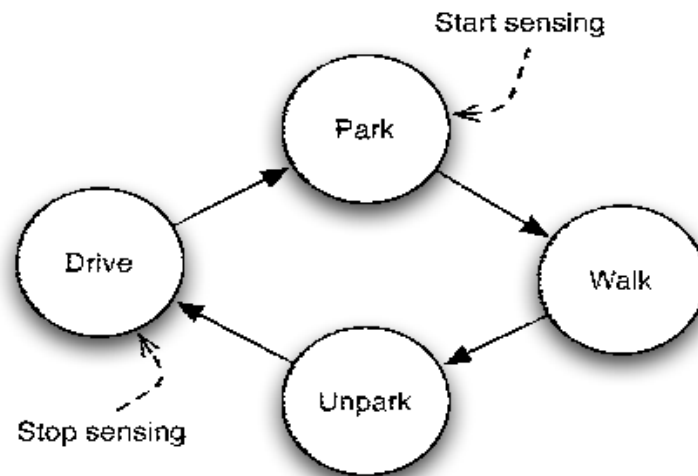
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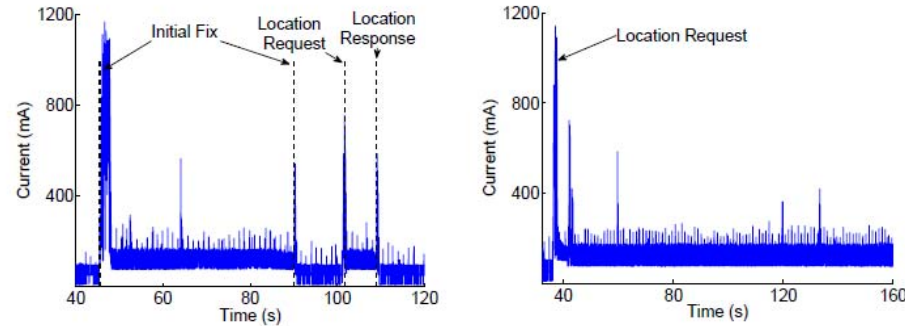
Worcester Polytechnic Institute (WPI)

Introduction

- **30%** traffic congested by cruising driver looking for parking

- Solution: Detect empty parking spot on street

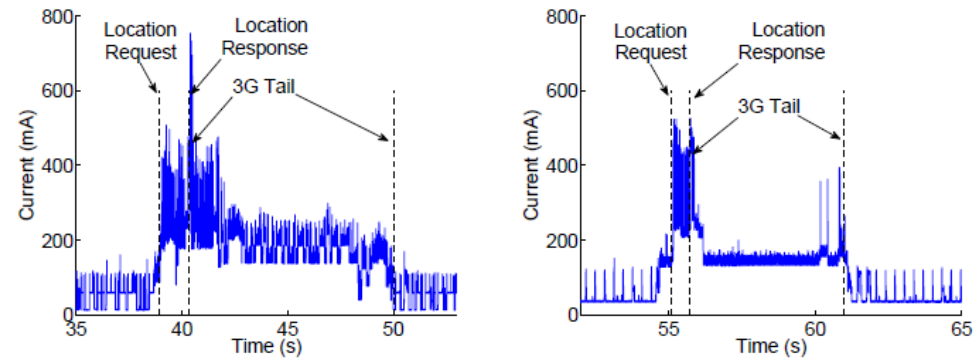- Requirements: Accurate and Low battery impact

Related Work
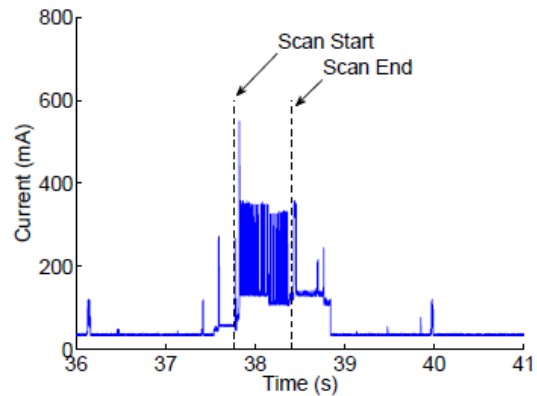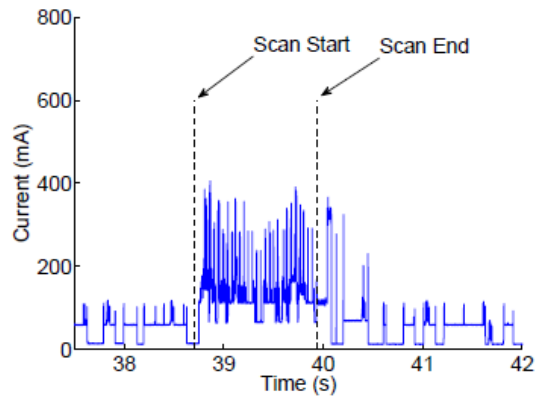
- GPS

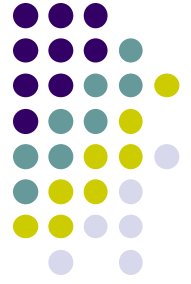- A-GPS and Network Based localization

- Accelerometer

Wireless Based Sensing

- Uses Beacons, a special frame sent from AP to broadcast its SSID

- Low Energy Consumption

Localization Algorithm 1
User Leaves the car

- Start sensing (triggered by payment)

Sp = {sp(1), sp(2), . . . sp(n)}   (SSID array)

Wp = {wp(1),wp(2), . . .wp(n)} (Beacon reception ratio array)

$wp(i) = vp(i) / m$

vp(i): the number of scans in which a beacon frame is received from AP i

Localization Algorithm 2
User Returning to Car

- Normalized beacon reception ratios

$$\hat{W}_p = \{\hat{w}_p(1), \hat{w}_p(2), \ldots, \hat{w}_p(n)\}$$
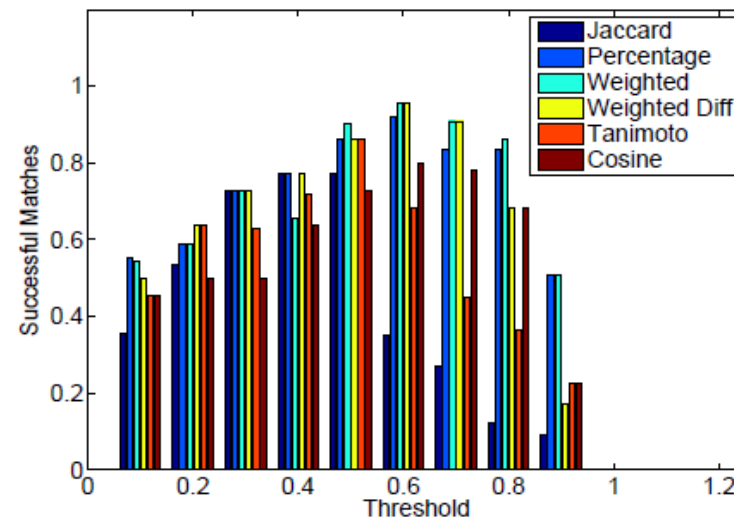
- 3 Ways to determine

- (1) Weighted

$$M = \sum_{i=1}^{l} \hat{w}_p(i) \quad for \quad s_p(i) \in S_p \cap S_t$$

- (2) Weighted Difference

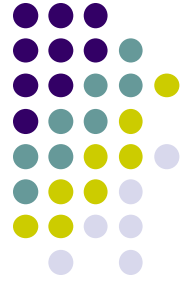$$M = \sum_{i=1}^{l} \hat{w}_p(i)(1 - |w_p(i) - w_t(i)|)$$
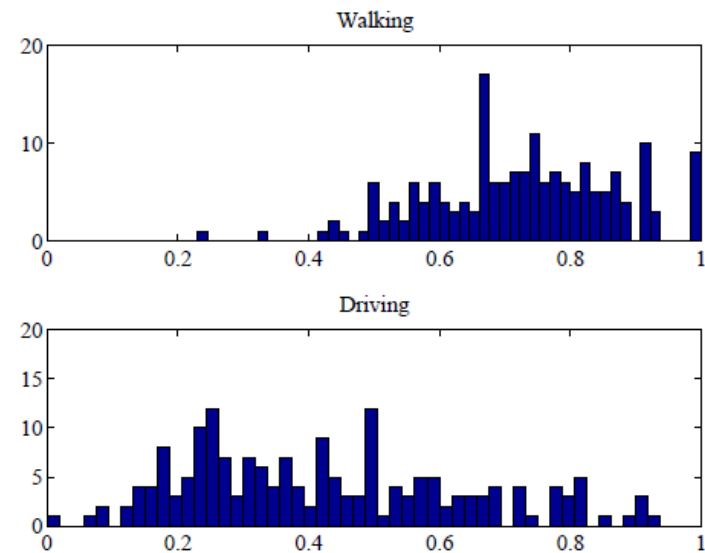
- (3) Percentage
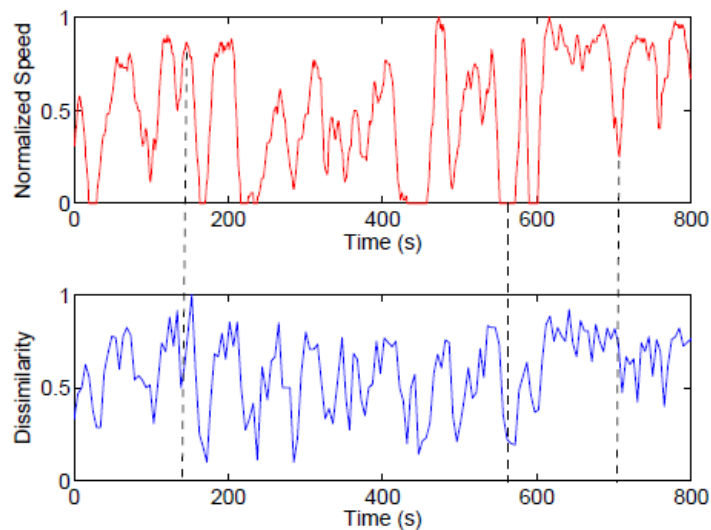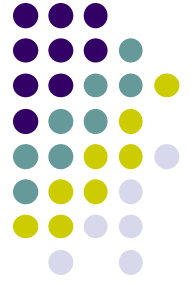
$$M = \frac{|S_t \cap S_p|}{|S_p|}$$
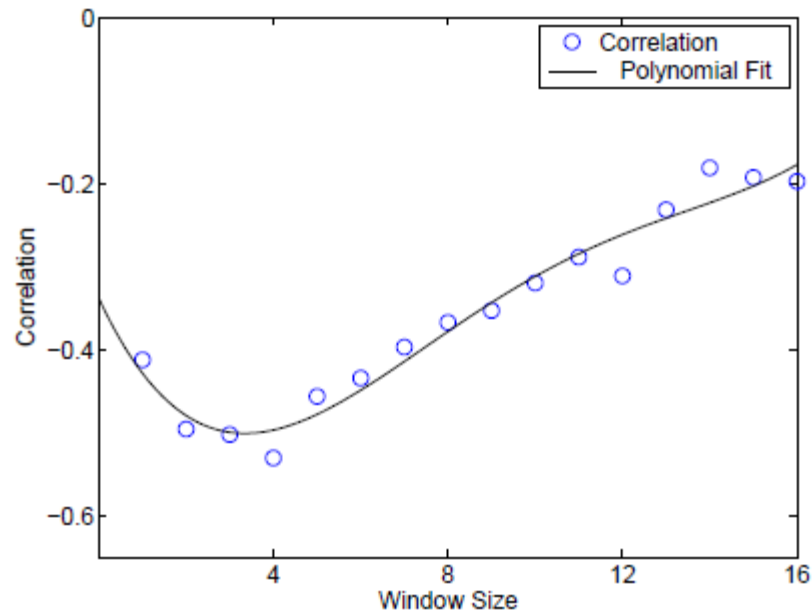
Localization Algorithm 3 User Driving Away

- Divide WiFi scans into windows of size m
- Compute Jaccard similarity between successive windows $\quad J = \dfrac{|\mathbf{S}_t \cap \mathbf{S}_{t-1}|}{|\mathbf{S}_t \cup \mathbf{S}_{t-1}|}$
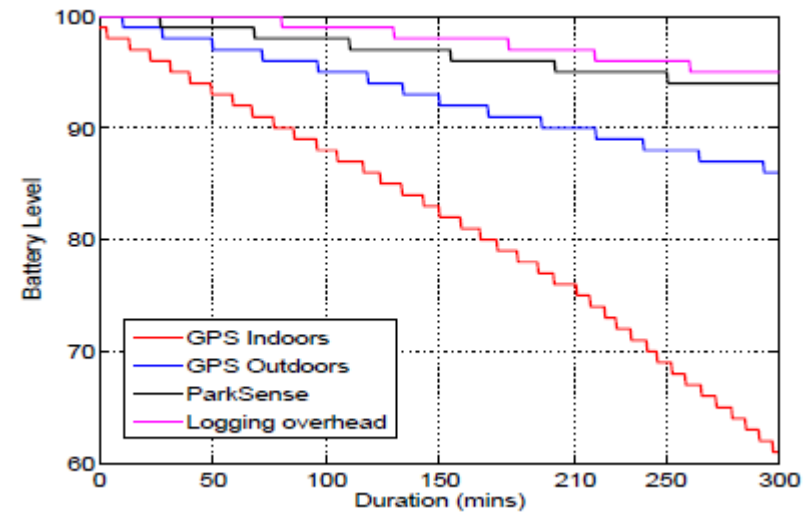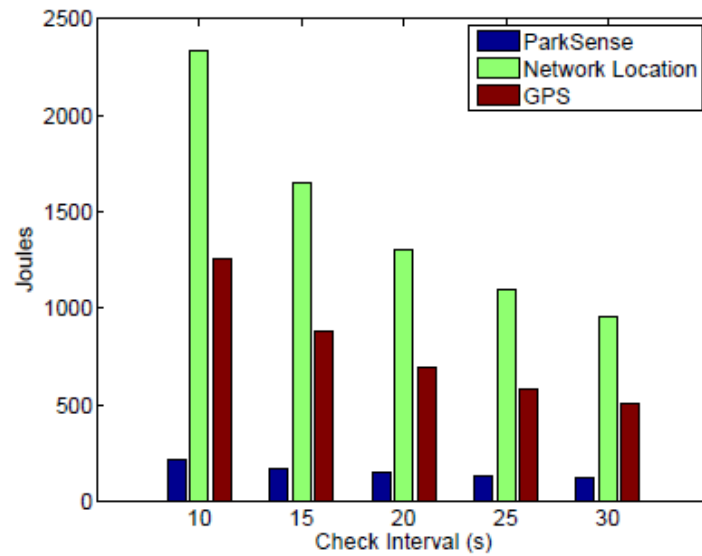
Performance Accuracy

- Accuracy affected by window size:

Performance Power

Discussions

- Capture real time parking occupancy
- Low power, equal or higher accuracy compare to GPS and network location based solution
- Future: integrate into exist parking payment framework
- Special cases: Personal Hotspot, Not follow particular pattern

References

- *ParkSense: A Smartphone Based Sensing System For On-Street Parking Sarfraz Nawaz, Christos Efstratiou, and Cecilia Mascolo in Proc Mobicom 2013*

- *Elliott D. Kaplan and Christopher Hegarty. Understanding GPS: Principles and Applications. Artech House Publishers, 2 edition, November 2005.*