TrafficSense

Rich Monitoring of Road and Traffic Conditions using Mobile Smartphones

Prashanth Mohan

Venkata N. Padmanabhan

Ramachandran Ramjee

Motivation

Research Challenges

- Accelerometer data
  - Inferring bumps, potholes and hard braking
  - Distinguishing slow moving vehicles from pedestrians
- Analyzing Microphone data
  - Distinguish horns from other noise
- Localization challenges
  - GPS is power hungry, insufficient reach
  - Enabling accurate GSM based localisation

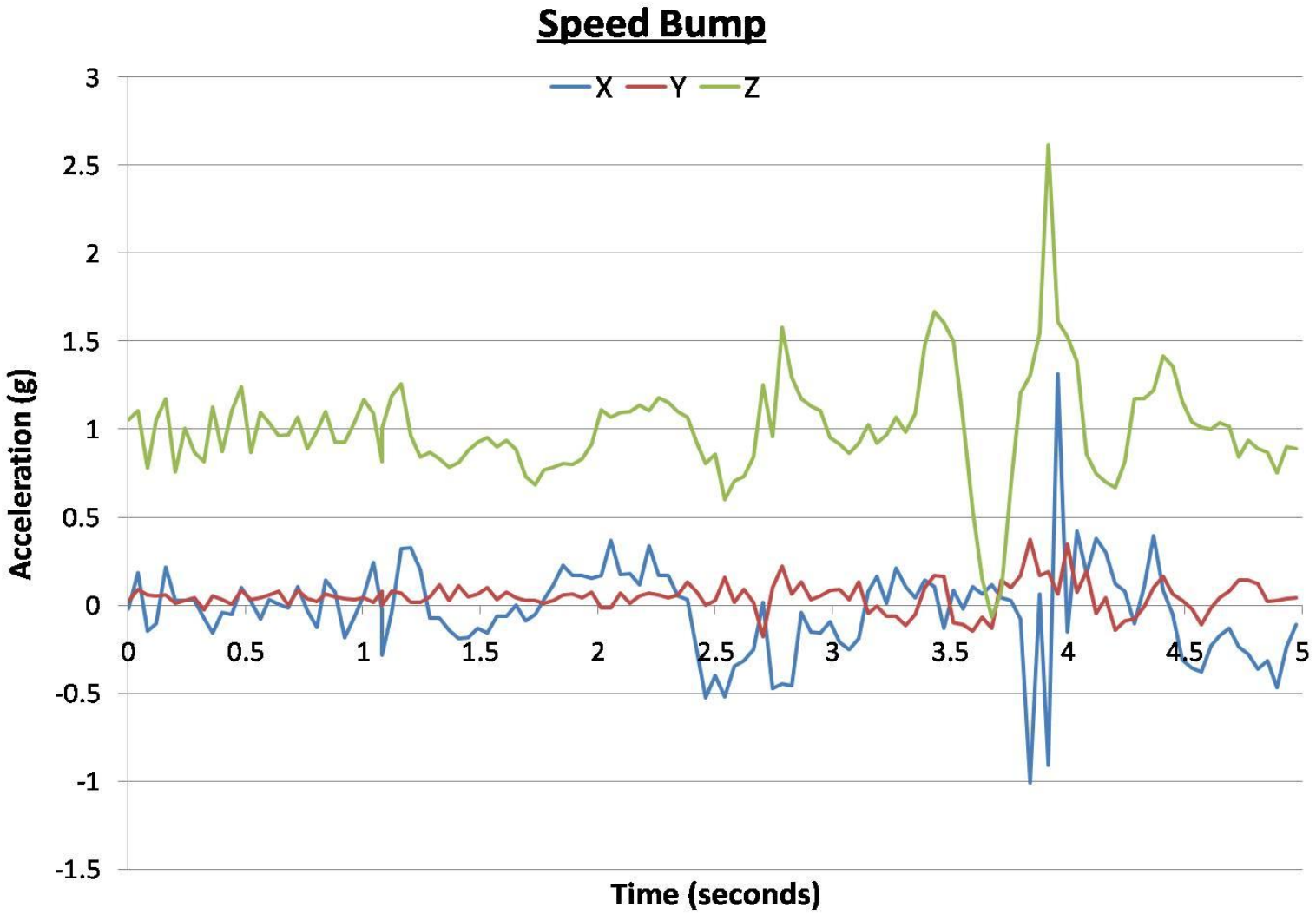
Overview

- Mobile smart phone based sensing
- Rich sensor info:
  - (i) GSM radio => lightweight localization
  - (ii) Accelerometer => road quality
  - (iii) Microphone => honk detection
- Triggered sensing
- Neighborhood communication
- New mapping applications
  - e.g., route planning to optimize for "blood pressure"

Accelerometer based sensing

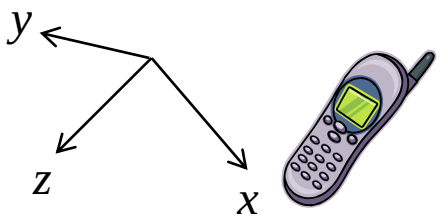
- We use Sparkfun WiTilt BlueTooth 3-axis accelerometer
- Analyses:
  - Bump/pothole detection
  - Braking detection
  - Distinguish slow moving vehicles from pedestrians
- Automatic correction for “disorientation”

Pothole/Bump Detection

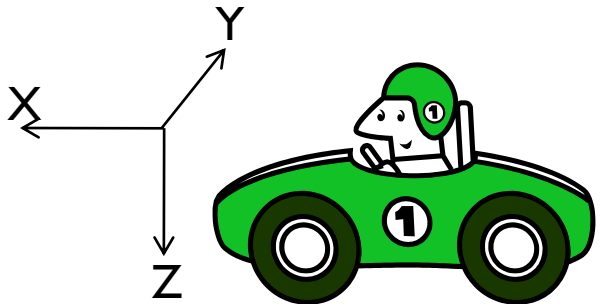


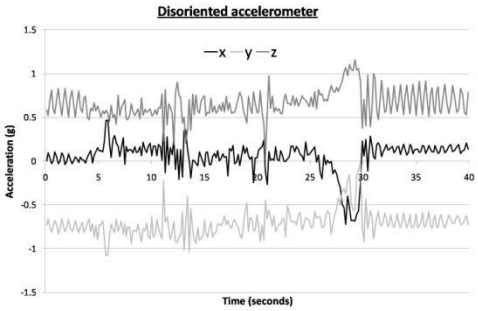
Correcting Orientation

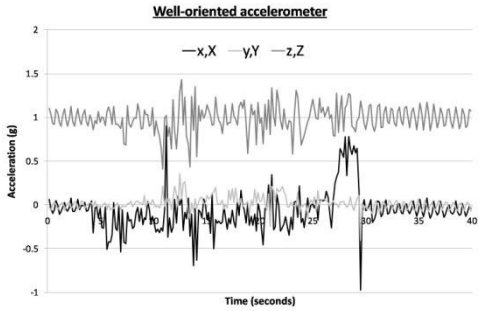
braking

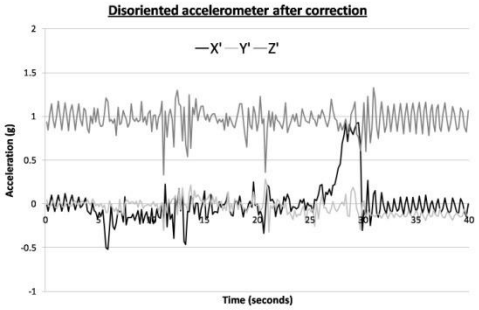


gravity

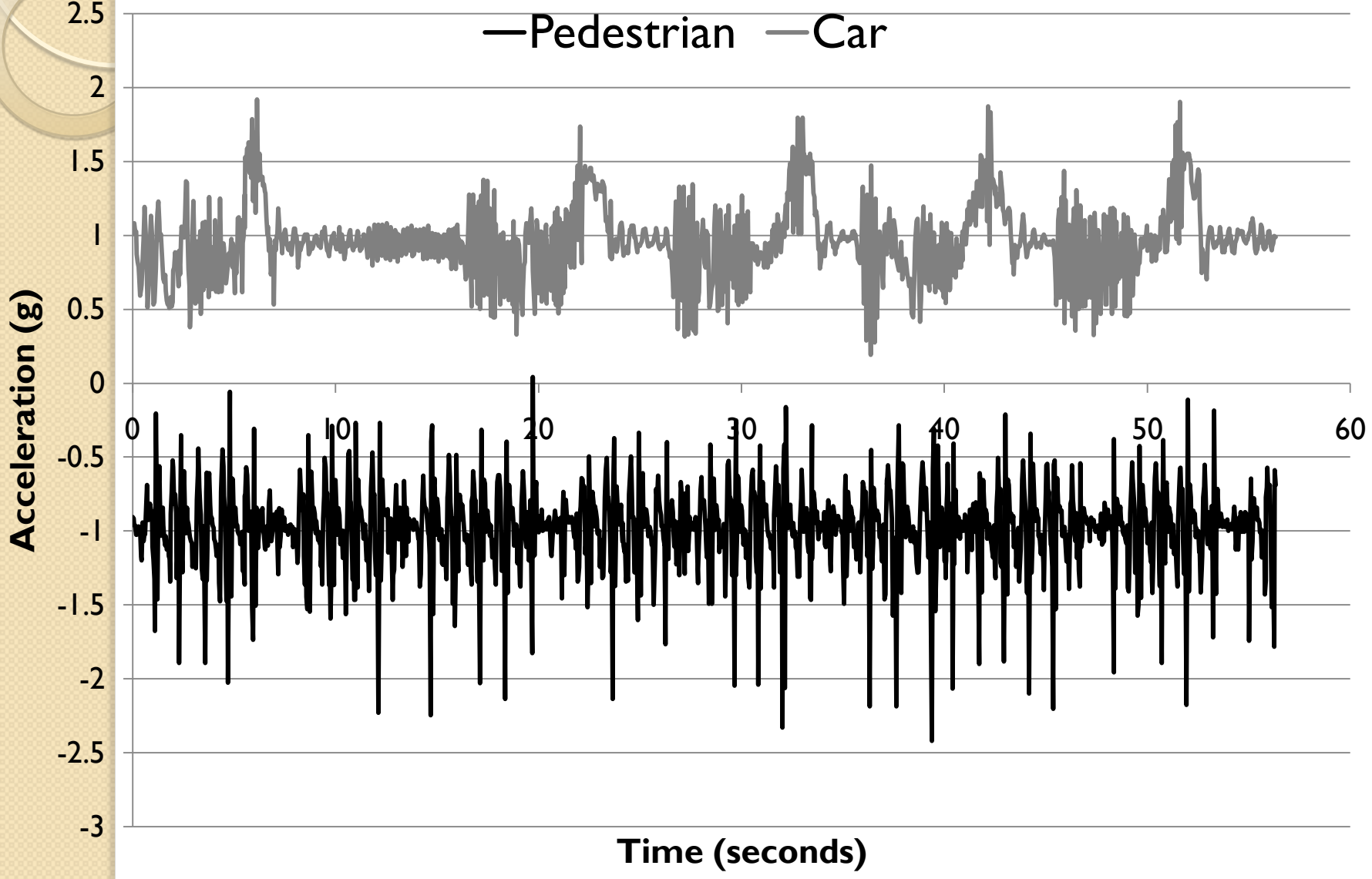








Distinguish Pedestrians from Vehicles



Localisation

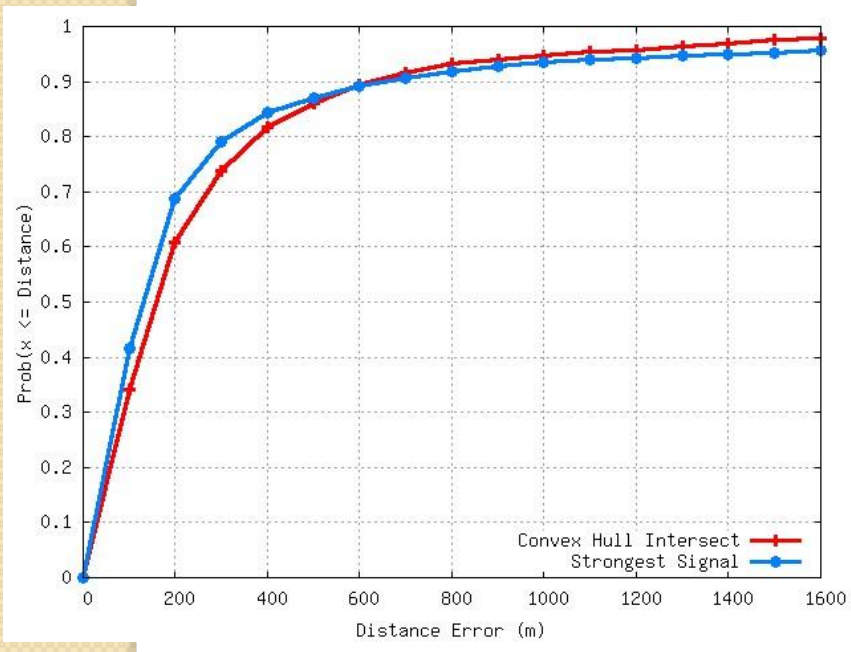
- Why not just GPS?
  - Coverage (indoors, urban canyons, inside a bus)
  - Time to lock (~26 secs even with warm start)
  - Energy (~600 mW on iPAQ 6965)
  - Not all phones have it
- GSM tower based localization
  - Accessible to every GSM phone
  - Energy cost is low or even zero
  - Fast
  - Challenge: accuracy!

GSM Tower based localisation

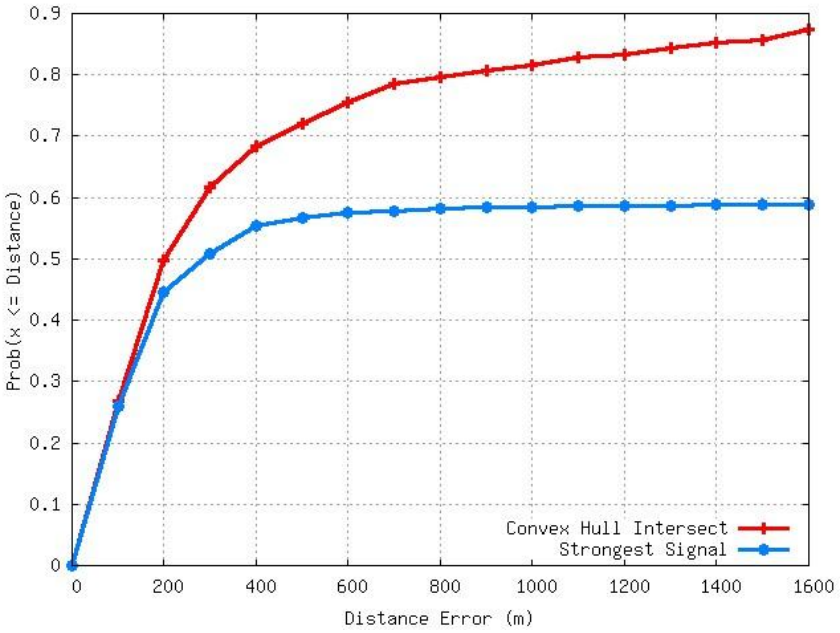
- Approach:
  - offline war-driving to get<tower list, GPS location>
  - match observed tower info against database
- Q: which features to pick and how to match?
  - RSSI: fluctuates wildly (much more so in BLR vs. SEA)
- Two algorithms based on just tower IDs
  - strongest signal (SS)
  - convex hull intersection (CHI)

404	: 86	: 50005	: 8361	: 543	: -87
country	: operator	: loc area	: cell ID	: channel:	rssi

GSM Localization Accuracy

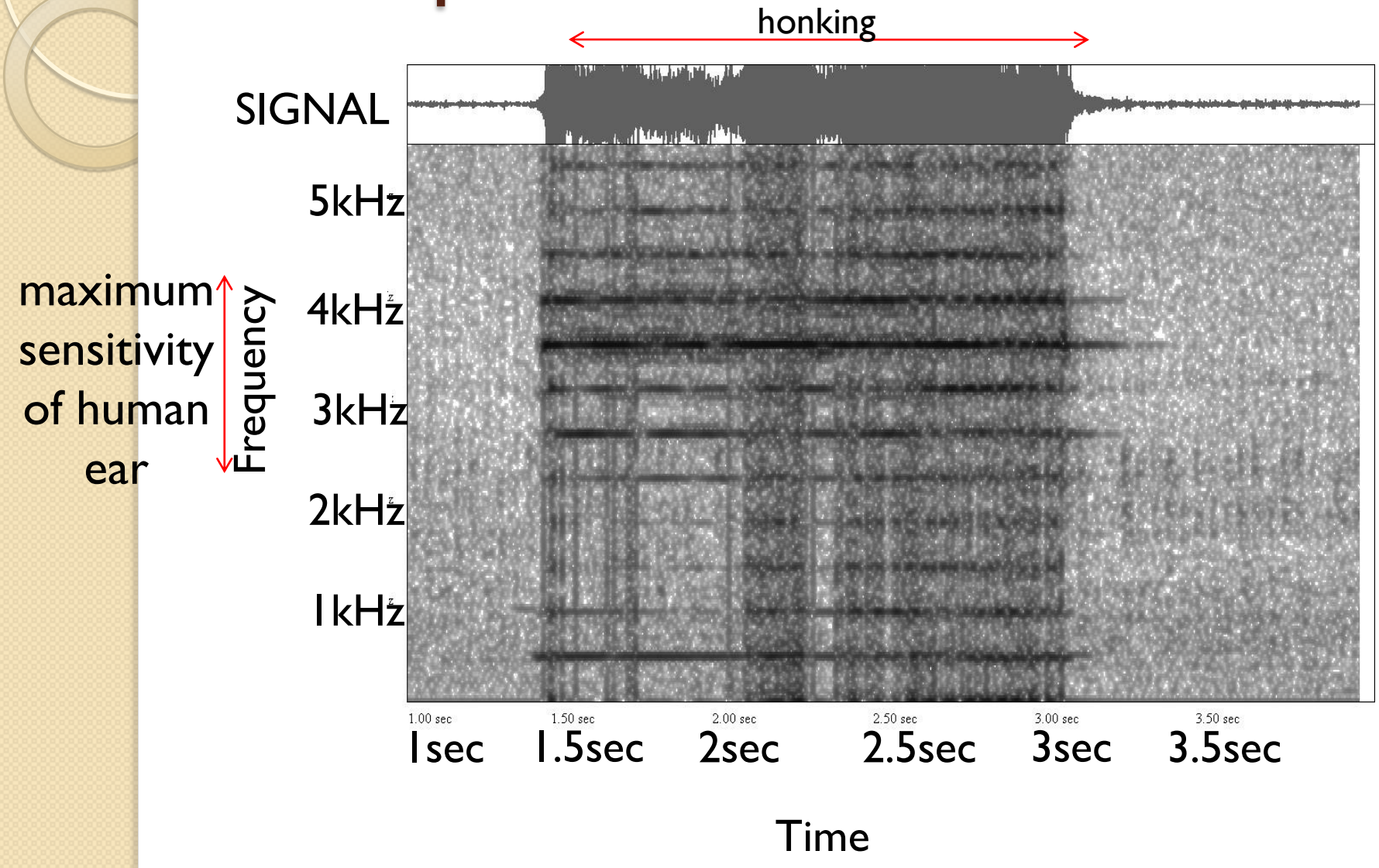


Fresh war driving data

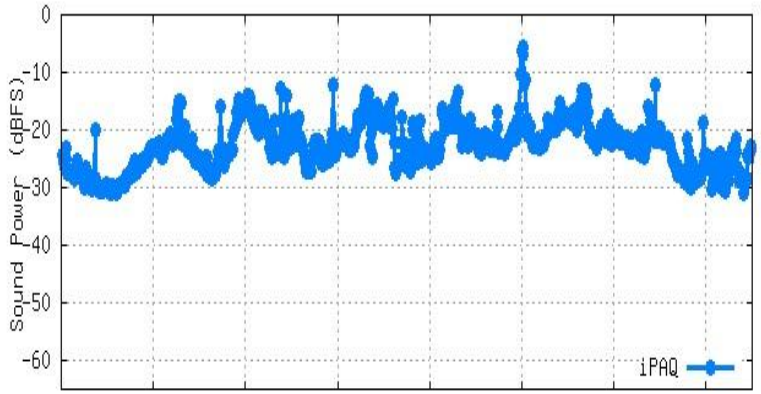


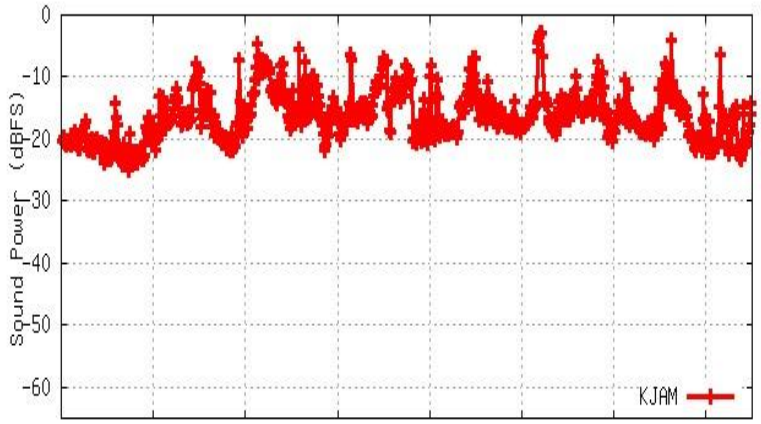
2 month old stale data

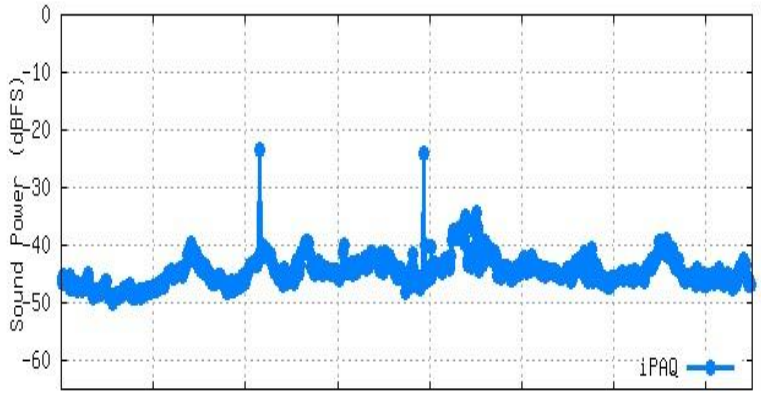
Microphone: Honk Detection

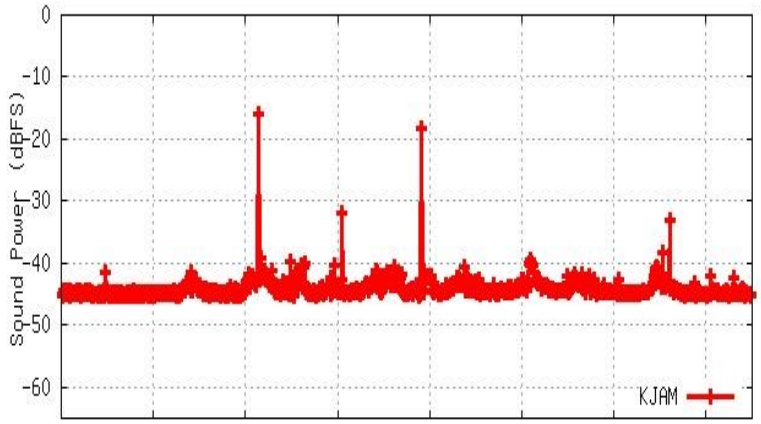


Exposed and Closed Vehicles









Applications

- Routes optimized for "blood pressure"
  - Avoid chaotic intersections (identified by excessive honking + braking)
- Automatic road condition updates to road works department
  - Potholes detected and notified as soon as they develop
- Traffic estimates customized for different vehicle types (motorbike, car, bus,…)
  - Traffic noise level to disambiguate exposed vs. enclosed vehicles
  - Bluetooth neighbourhood to distinguish individual vs. shared ride vehicles

Conclusion

- Chaotic intersection:
  - braking + honking
- Vehicle type
  - Traffic noise level (exposed vs. enclosed)
  - Bluetooth neighbourhood (individual vs. shared ride)
- Triggered sensors:
  - Accelerometer $\Rightarrow$ Microphone
  - GSM localization $\Rightarrow$ GPS