



TrafficSense

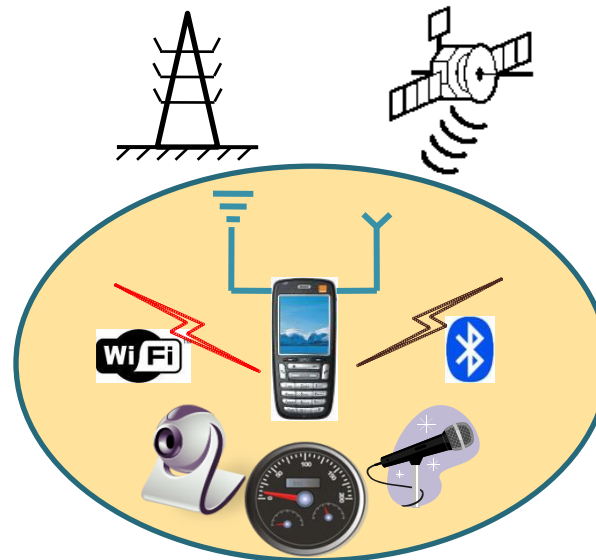
**Rich Monitoring of Road and Traffic
Conditions using Mobile Smartphones**

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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

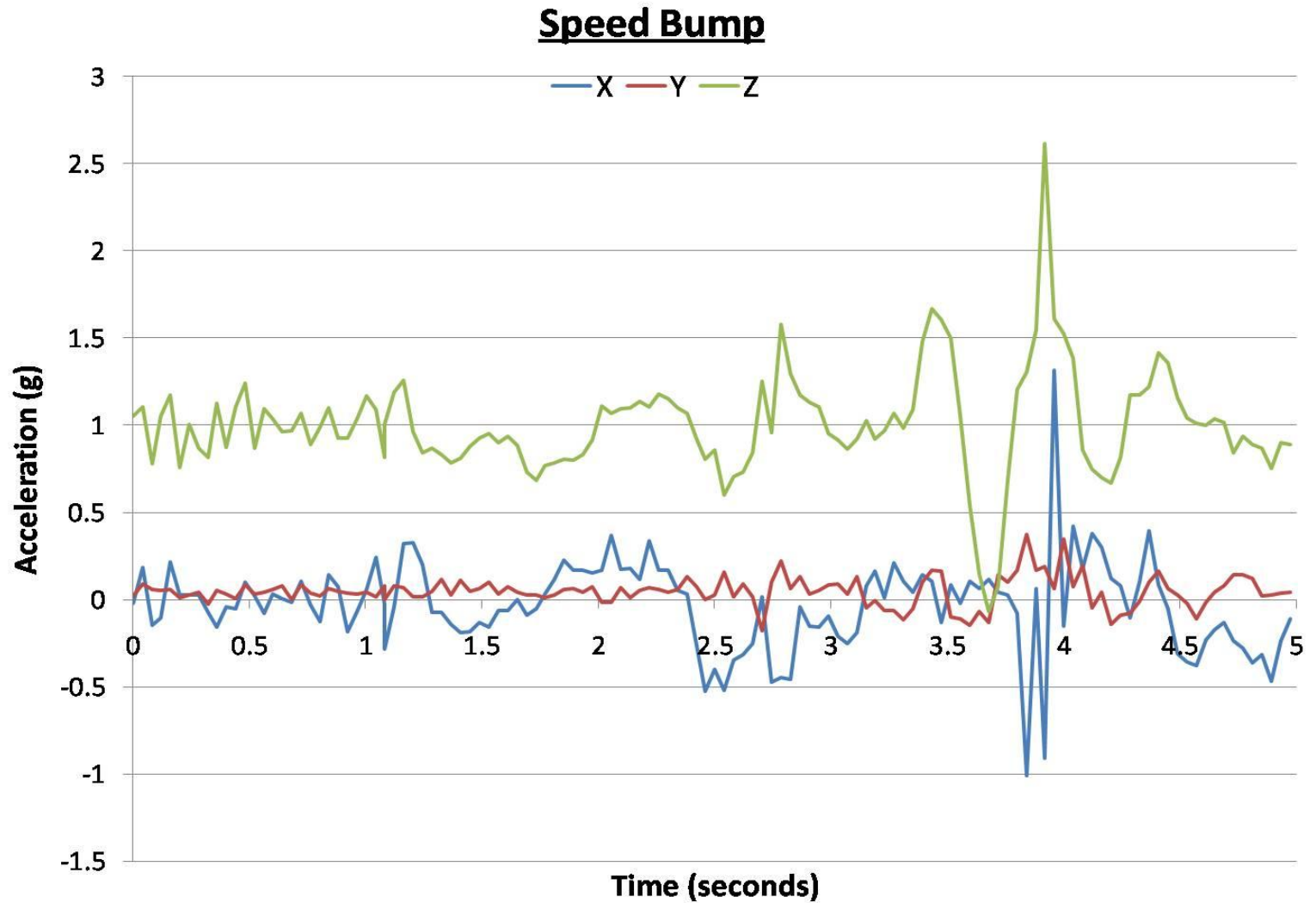
Overview

- 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

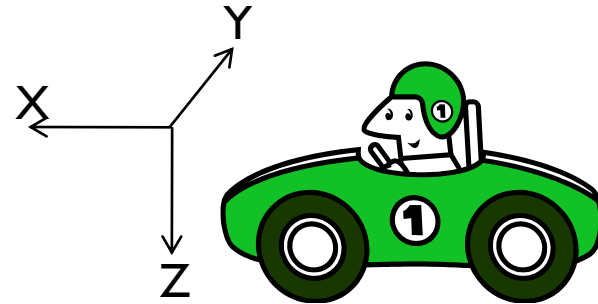
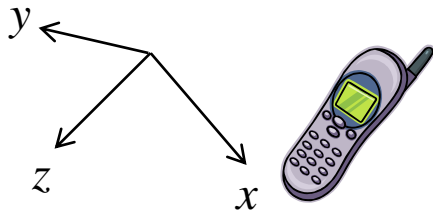
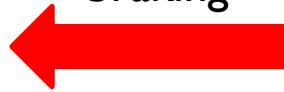
- We use Sparkfun WiTilt BlueTooth 3-axis accelerometer
- Analyses:
 - Bump/pothole detection
 - Braking detection
 - Distinguish slow moving vehicles from pedestrians
- Automatic correction for “disorientation”

Pothole/Bump Detection

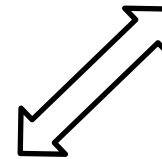
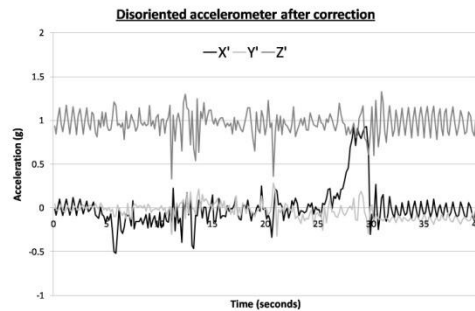
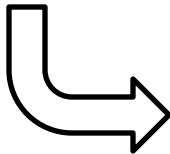
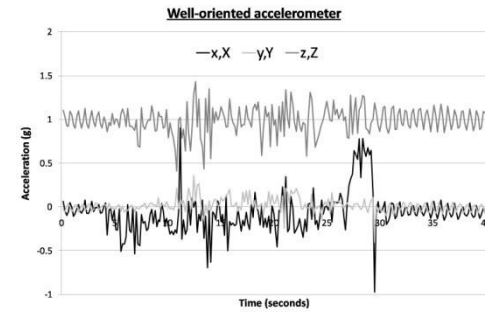
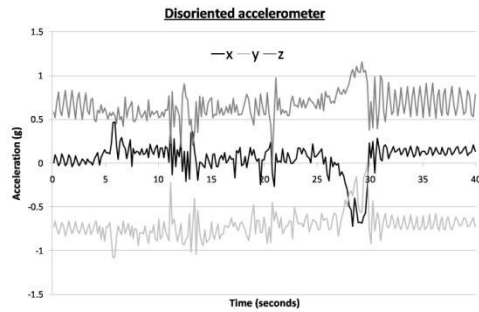


Correcting Orientation

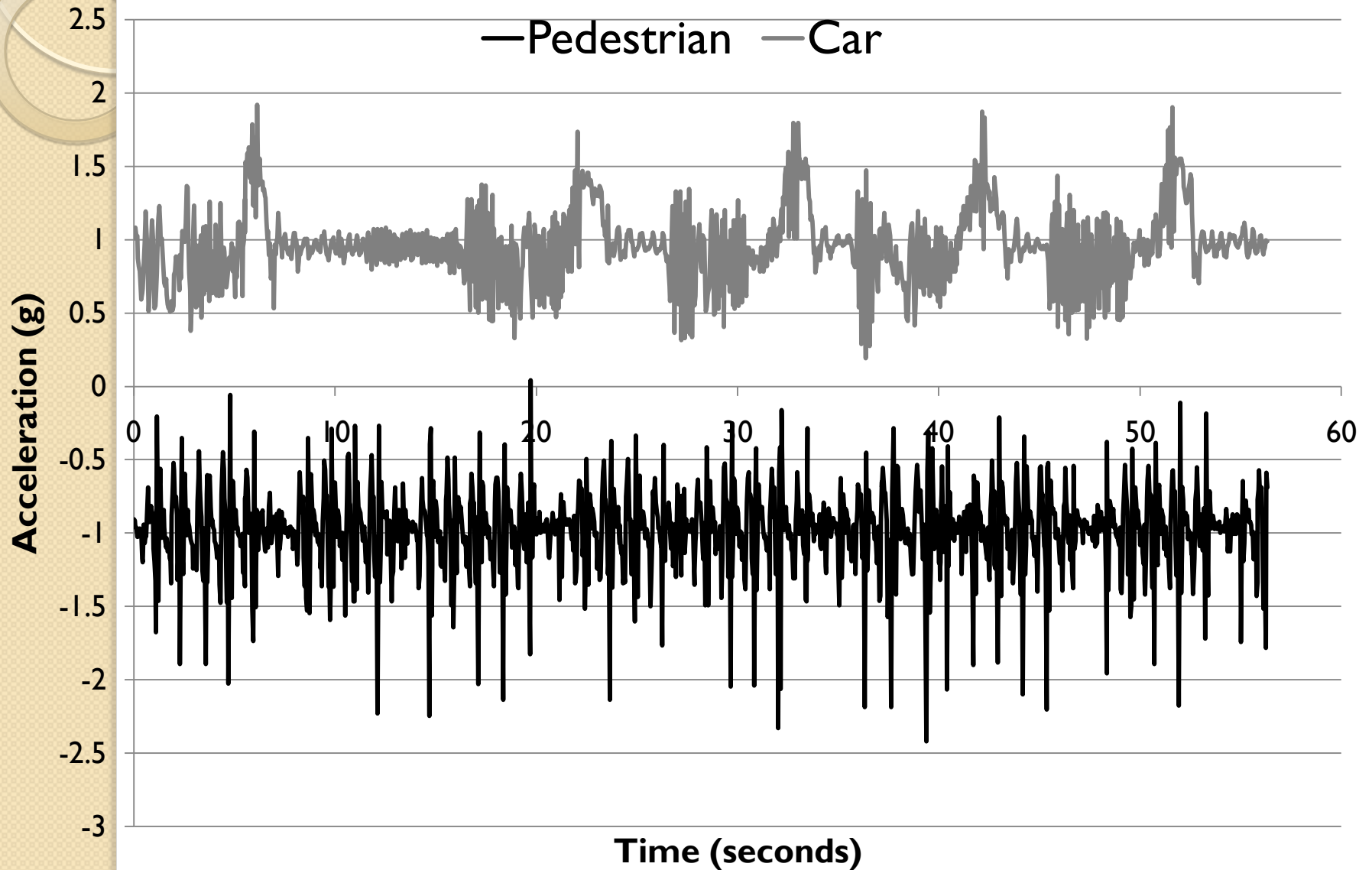
braking



gravity



Distinguish Pedestrians from Vehicles



Localisation

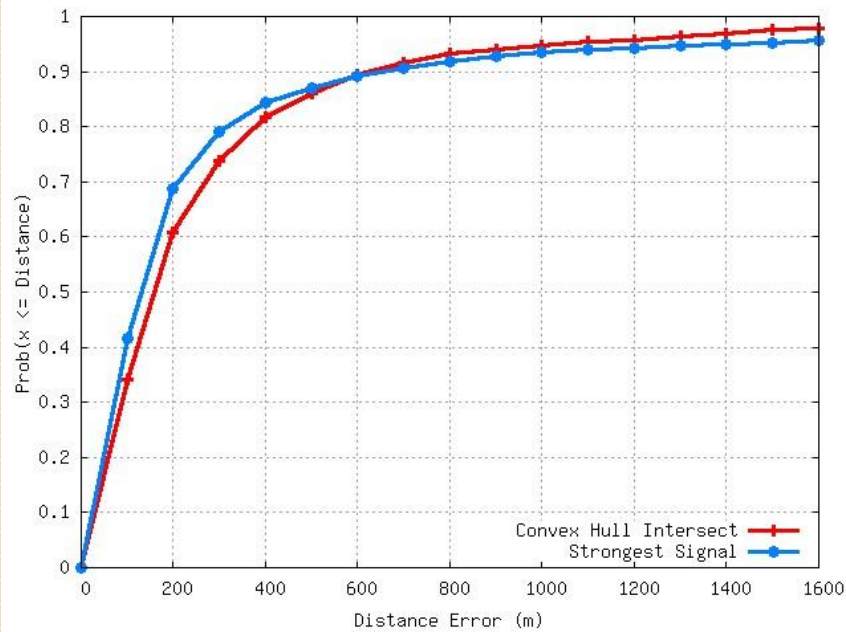
- Why not just GPS?
 - Coverage (indoors, urban canyons, inside a bus)
 - Time to lock (~26 secs even with warm start)
 - Energy (~600 mW on iPAQ 6965)
 - Not all phones have it
- GSM tower based localization
 - Accessible to every GSM phone
 - Energy cost is low or even zero
 - Fast
 - Challenge: accuracy!

GSM Tower based localisation

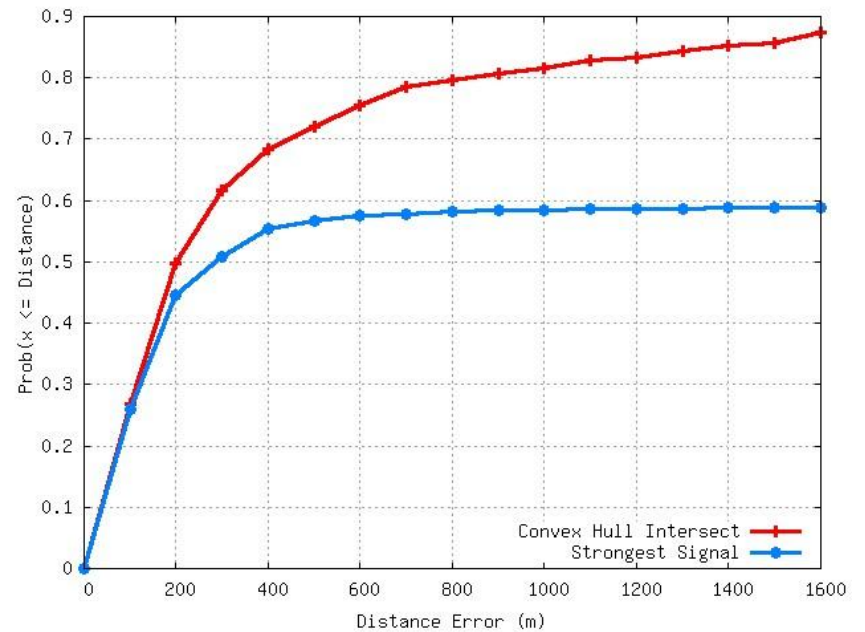
- Approach:
 - offline war-driving to get <tower list, GPS location>
 - match observed tower info against database
- Q: which features to pick and how to match?
 - RSSI: fluctuates wildly (much more so in BLR vs. SEA)
- Two algorithms based on just tower IDs
 - strongest signal (SS)
 - convex hull intersection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

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

GSM Localization Accuracy



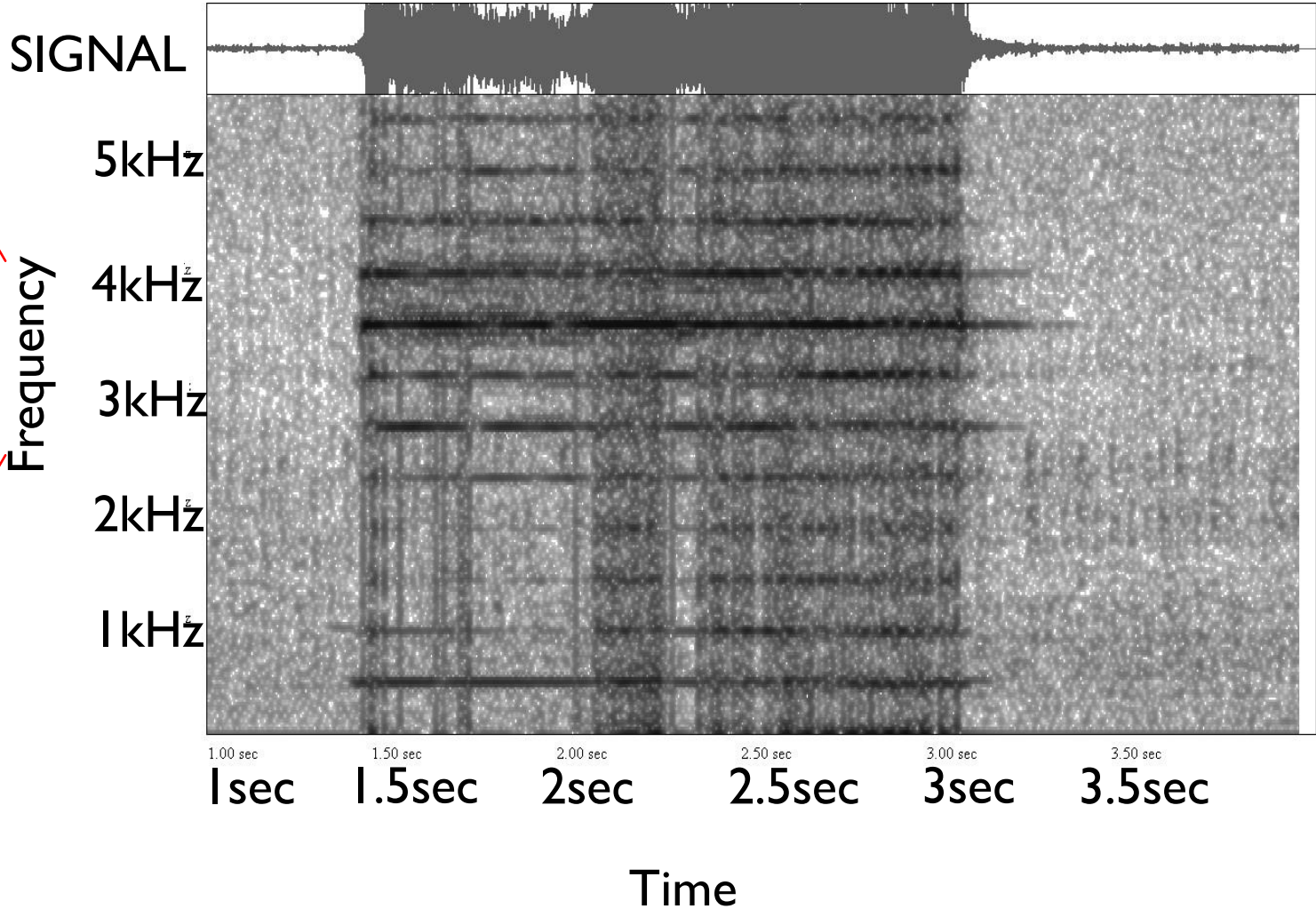
Fresh war driving data



2 month old stale data

Microphone: Honk Detection

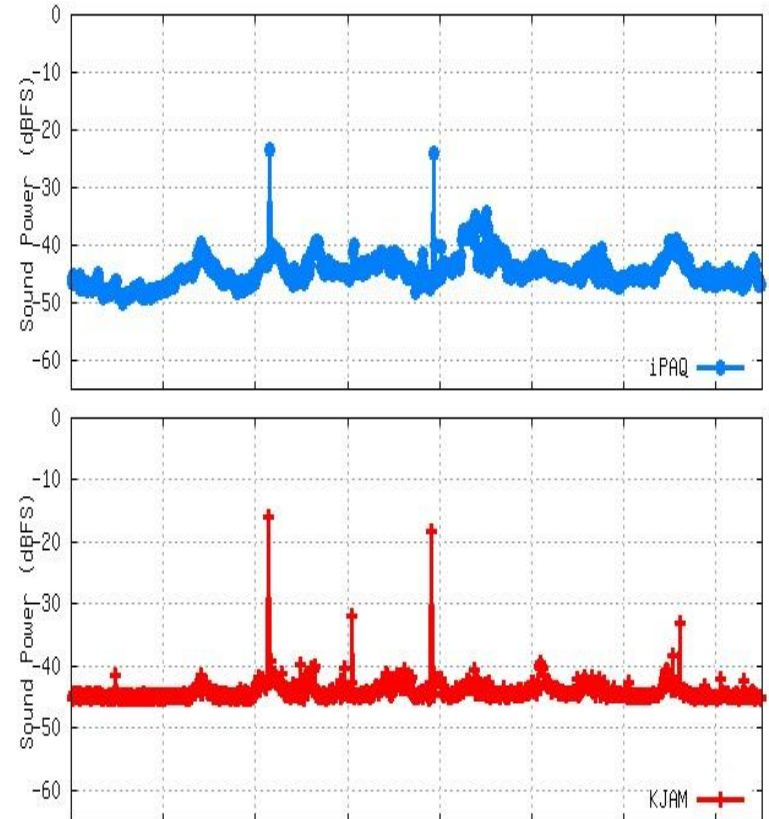
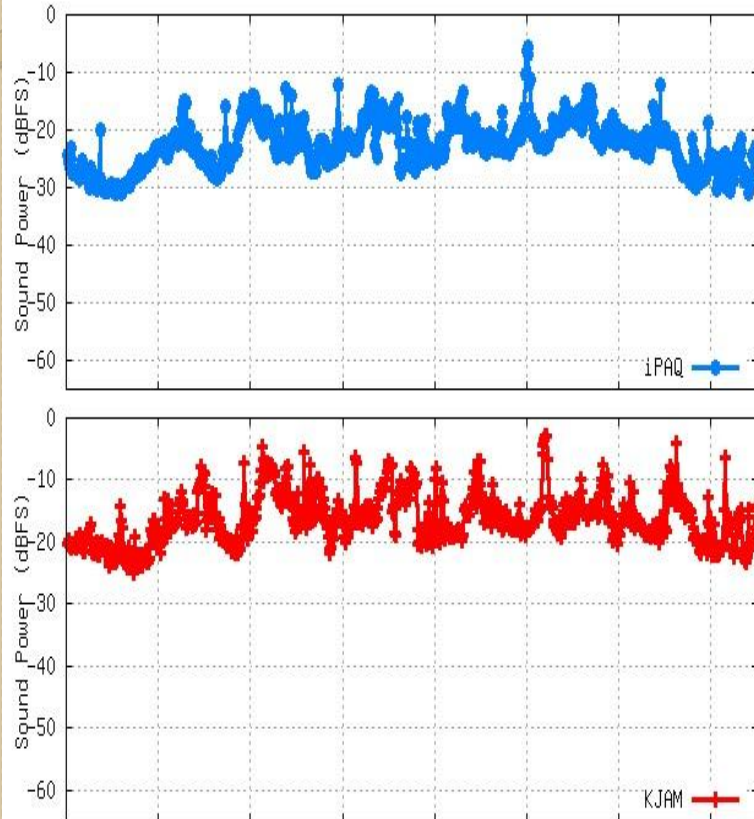
← honking →



maximum
sensitivity
of human
ear

↑
Frequency
↓

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