

MagnifiSense and the Surrogate Sensing Recipe

Kashev Dalmia, Ryan Freedman, & Terence Nip
CS 598tar

Background & Motivation

- Figuring Out What Someone is Doing is **Useful**:
 - Personalized Energy Disaggregation
 - Activity Tracking
 - Medical & Fitness
 - Interactive Smart Kitchen
 - Construction Management
 - Adaptive User Interfaces
 - Advertising
 - Safety Warnings
 - Multi-occupancy Elderly Home Care

Traditional Approaches

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- Voltage Load Monitoring
 - Can't detect user
 - Devices must be connected to instrumented environment
 - Devices not connected to environment cannot be detected
- IMU-Based Activity Trackers
 - Useful & Powerful, but limited to capture of local activity
 - Cannot easily identify device interactions
- Acoustic-Based Activity Trackers
 - Just don't work that well for devices that don't have motors

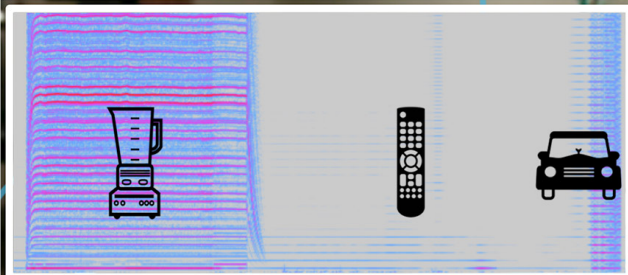
MagnifiSense, presented at UbiComp 2015

- Detect device interaction on a per user basis
 - Regardless of location or sound produced
- Use wrist worn magneto-inductive sensors to detect electromagnetic radiation from devices
 - Use off the shelf, passive parts to reduce monetary & power cost
 - All electronic devices emit electromagnetic radiation

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The finished MagnifiSense Prototype, though effective, is bulky, and needs to be connected to a DAQ at all times.

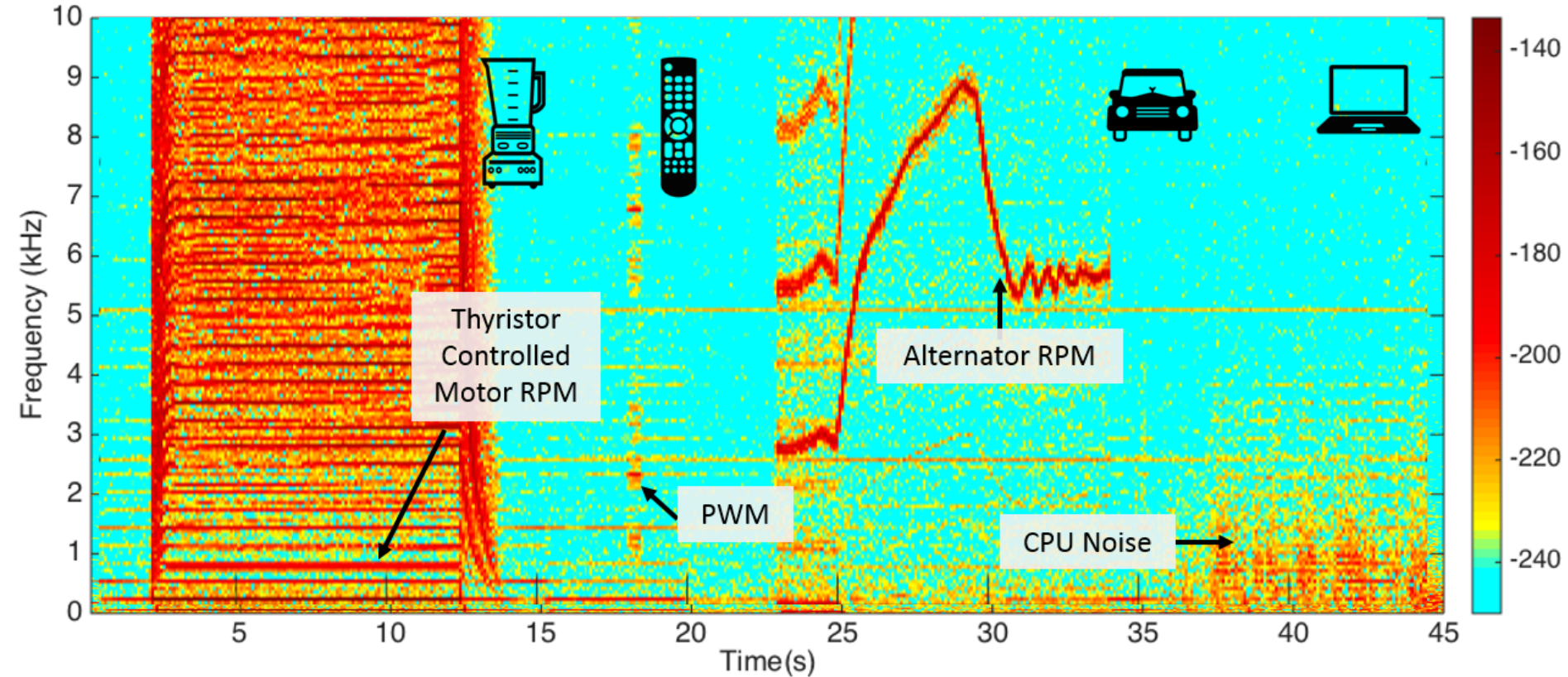


Tested Devices

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| Space | Devices |
|-------------|--|
| Kitchen | Blender, mixer, food processor, food disposal, hood fan, microwave, fridge, resistive/gas/IR stove |
| Living Room | Laptop, wireless mouse, incandescent/compact/fluorescent/dimmer lights, heater, TV remote, vacuum |
| Bathroom | Hairdryer, toothbrush, shaver, vent fan |
| Commute | Gasoline/diesel/hybrid/electric car, train, bus, plane |
| Others | Drills, elevator, overhead power lines |

EMI radiation patterns of commonly found electronic devices depend on the underlying electronic component.



Challenges Overcome

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- 29 of 33 devices were accurately detected, 12 used
- Compound events were successfully detected for devices with high signal strength
- 95% true positive event detection rate, 93.5% classification accuracy over 240 events
- Device issues – weak signal
 - Laptop & TV Remote

Open Challenges

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- Disaggregation of Use of Multiple Devices
 - For instance, stove, blender, and hood fan
- Detection of various makes of Laptops, or interactions with devices that vary more from person to person
 - Mouse vs. Trackpad; Macbook vs. Other
- Hardware is not packaged sufficiently to fit inside of a watch or other IMU-based activity tracker