

# EnergySniffer: Home Energy Monitoring System using Smart Phones



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## 1. MOTIVATION

- Tracking home energy usage for each individual running home's appliances and electrical devices (Machines) is a prerequisite for making energy conservation and management efficient.
- Existing energy monitoring solutions require invasive and expensive installation of sensor devices.
- Smartphone comes with useful sensors that can be utilized.

*EnergySniffer*, which exploits various sensors, such as magnetic sensor, light, microphone, temperature, camera, WiFi, Bluetooth etc. in smart phones to monitor energy usage for each individual machine.

## 2. SYSTEM ARCHITECTURE

EnergySniffer System has two main components:

### 1. Energy Profile:

- Energy Profile is a database with energy consumptions details of the machines.
- Database is maintained in a background web server.
- The user can download/upload the energy consumption profiles of the machines through mobile application.

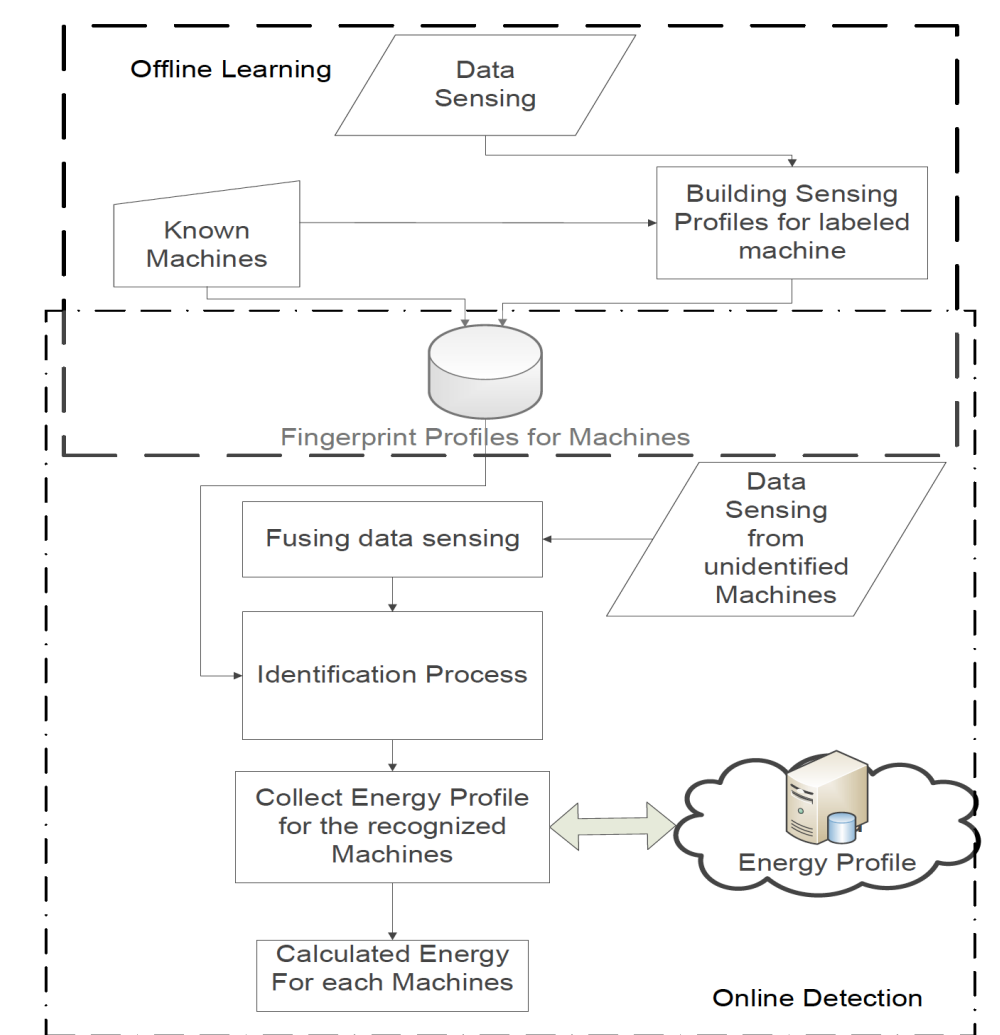
### 2. Multi Sensing Framework:

#### Building fingerprint profile:

- Identify the sensors that are relevant to the machine.
- Building sensing profile using each sensor.
- Combining multiple sensing profile.

#### Online detection:

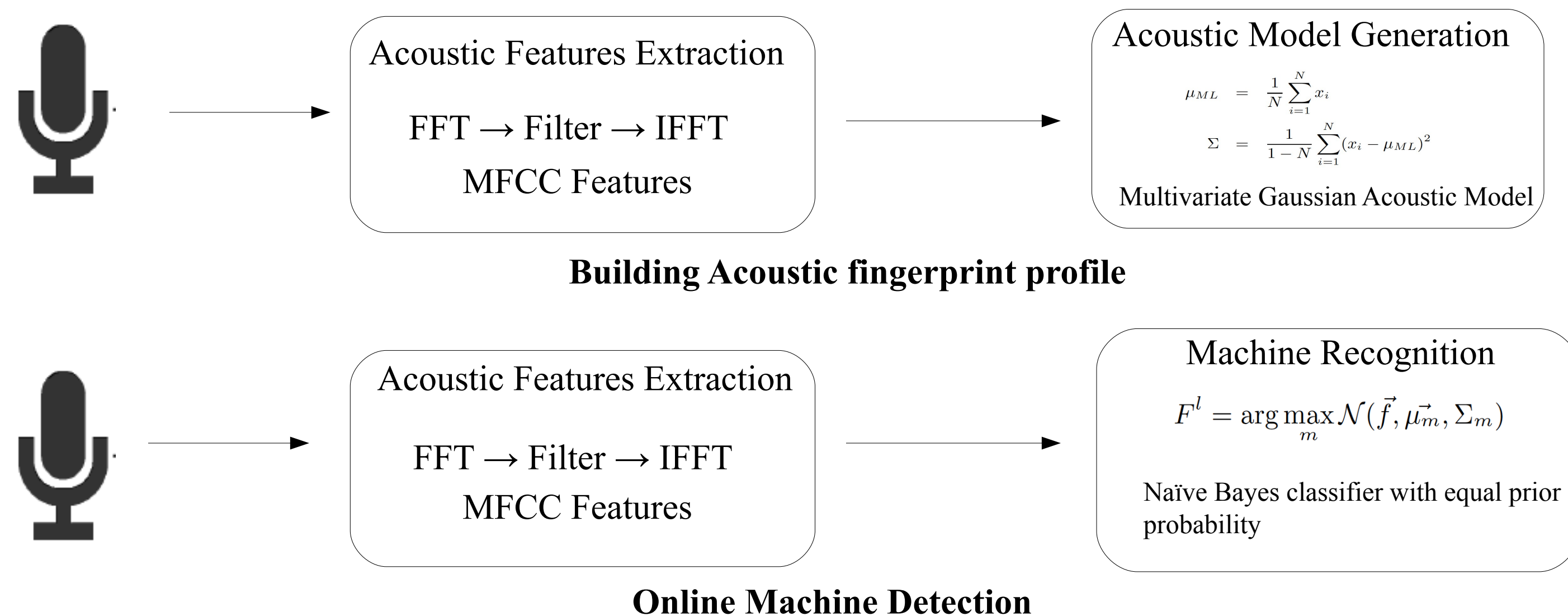
- Collecting sensing data and fusing them.
- Tracking the running machines using pre-build fingerprint profiles.



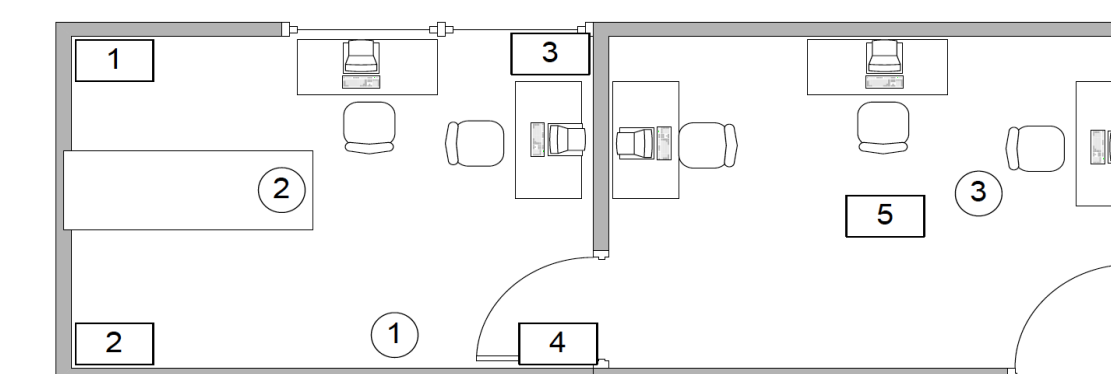
EnergySniffer System Architecture

## 3. SOUND SENSING FRAMEWORK

As a proof of concept we utilize only the microphone sensor of the smart phones to build a Sound Sensing Framework (SSF).



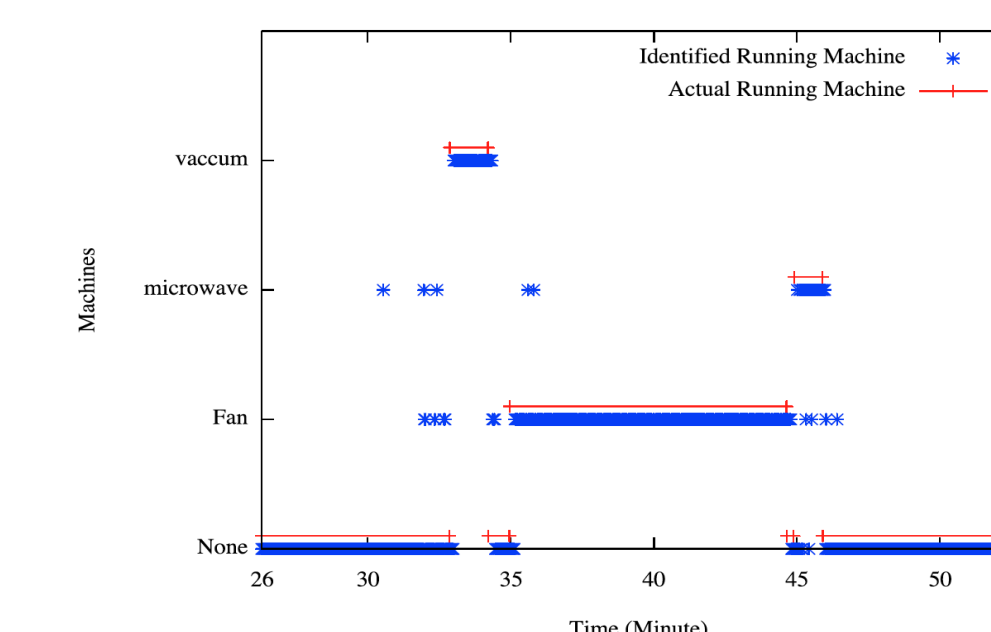
## 4. PRELIMINARY EVALUATION RESULT



Machine	Position	microwave	fan	vacuum	none
Microwave	1	64.06%	23.43%	3.12%	9.37%
	2	71.87%	9.37%	0.00%	18.75%
	3	65.62%	28.12%	0.00%	6.25%
	4	60.93%	20.31%	0.00%	18.75%
	5	53.12%	12.5%	0.00%	34.37%
Fan	1	32.81%	67.19%	0.00%	0.00%
	2	42.19%	54.68%	0.00%	3.12%
	3	43.75%	56.25%	0.00%	0.00%
	4	32.81%	57.81%	0.00%	9.37%
	5	48.44%	29.69%	0.00%	21.87%
Vacuum	1	3.12%	0.00%	96.88%	0.00%
	2	0.00%	0.00%	100.00%	0.00%
	3	15.66%	0.00%	84.34%	0.00%
	4	0.00%	0.00%	100.00%	0.00%
	5	0.00%	0.00%	100.00%	0.00%

Detection of running machines from different positions. In the table "none" is a sound profile that represents when none of the machine is running. From each location we identified the machine using different orientation of the mobile phone.

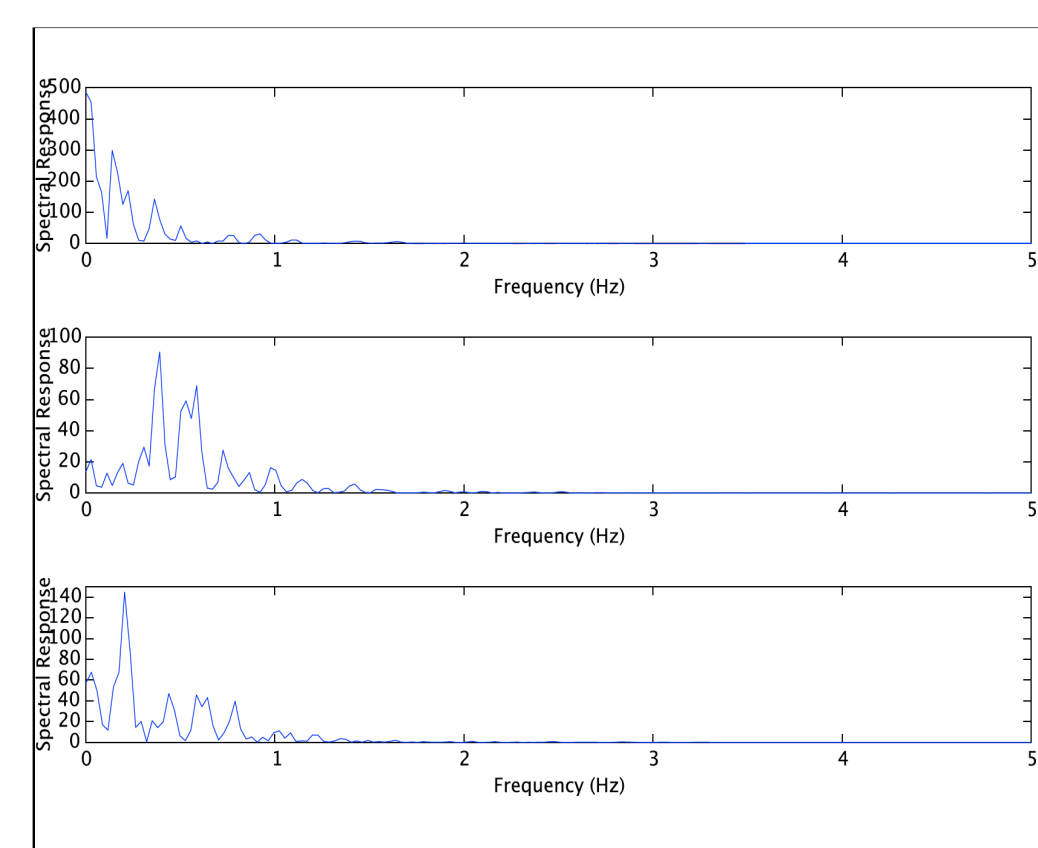
Circle 1,2,3 shows the position of a microwave, a fan and a vacuum cleaner respectively at our lab office. Square 1,2,3,4 and 5 shows the position from we have identified the current running machine using our prototype application. We develop a prototype system in Android phone (Nexus S)



Comparison of actual running machine and recognized running machine using our prototype system for 25 minutes of time.

## 5. CHALLENGES

- Some smartphone sensors are limited in functionality.
- Smartphone sensors show differences in sensitivity among different devices and platforms.
- Detecting multiple machines at a time and recognizing running machines from different positions.
- Location and orientation of the smart phone.



Low pass narrow bandwidth Frequency Response of Magnetic sensor reading for X, Y and Z axis (Nexus S)

## 6. FUTURE WORK

- Making the challenges more approachable by knowing the layout/position of the machines in addition with the smart phone location. Extensive experiment on using smart phones location in addition with layout information of the machines, to detect multiple machine.
- Leveraging multiple smart phone with wireless communication for improvising the detection of multiple machines.
- Interfacing additional sensors with the smart phone to create sophisticated fingerprints for the machine.