

Innovation in individual vehicle noise management

Presentation to TEKH Acoustics 2019

Introduction

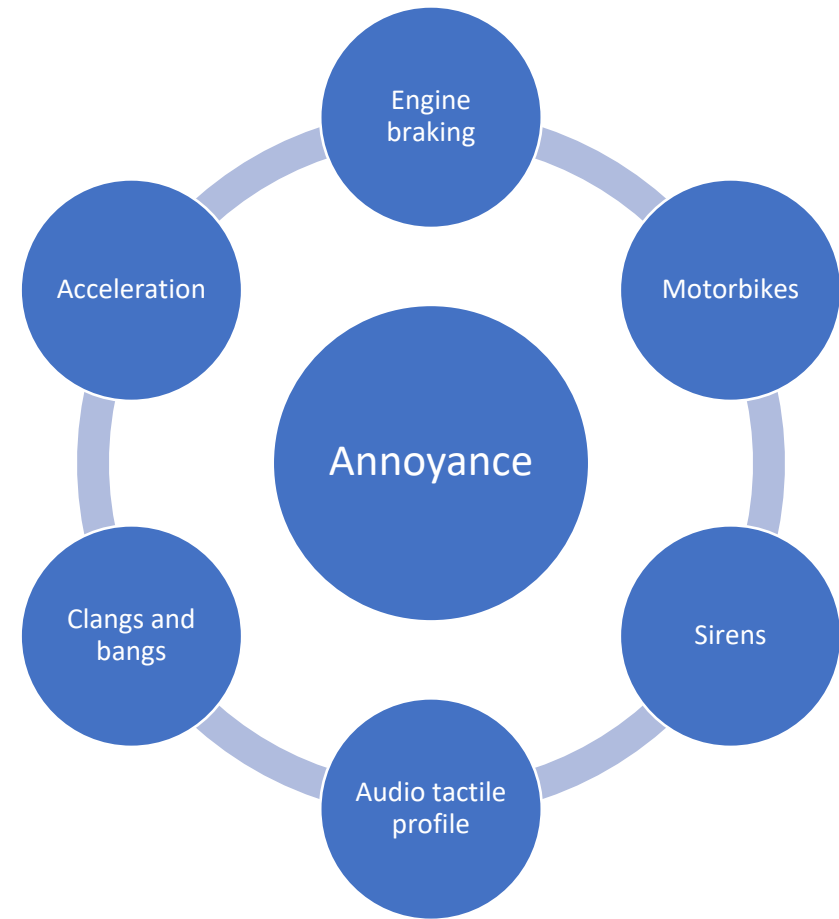
Contents

- Problem definition
- Solutions in Aus/NZ
- Analysis techniques
- Alternate hardware
- Classification



Individual vehicle noise

- Complaints
- Investigations required
- Is the source actually what people think?
- Limited ability to mitigate



Engine braking



- Supplementary braking system that vents during the compression cycle
- Not just using gears to slow down
- Less of an issue with modern trucks
- Culture of drivers

Current hardware

Installation details



Features / issues

- High resolution camera with Number Plate Recognition
- Uses "in-service engine braking algorithm"
- Limited fixed cameras with high relocation costs
- Long lead time to address community concern

Current processing algorithm

RMS Modulation

- A-weighted
- 5ms average
- 200 Hz resample
- Band-pass filter (5-80Hz)

Variables

- RMS threshold level
- Bandpass filter

Accuracy

Sources of error

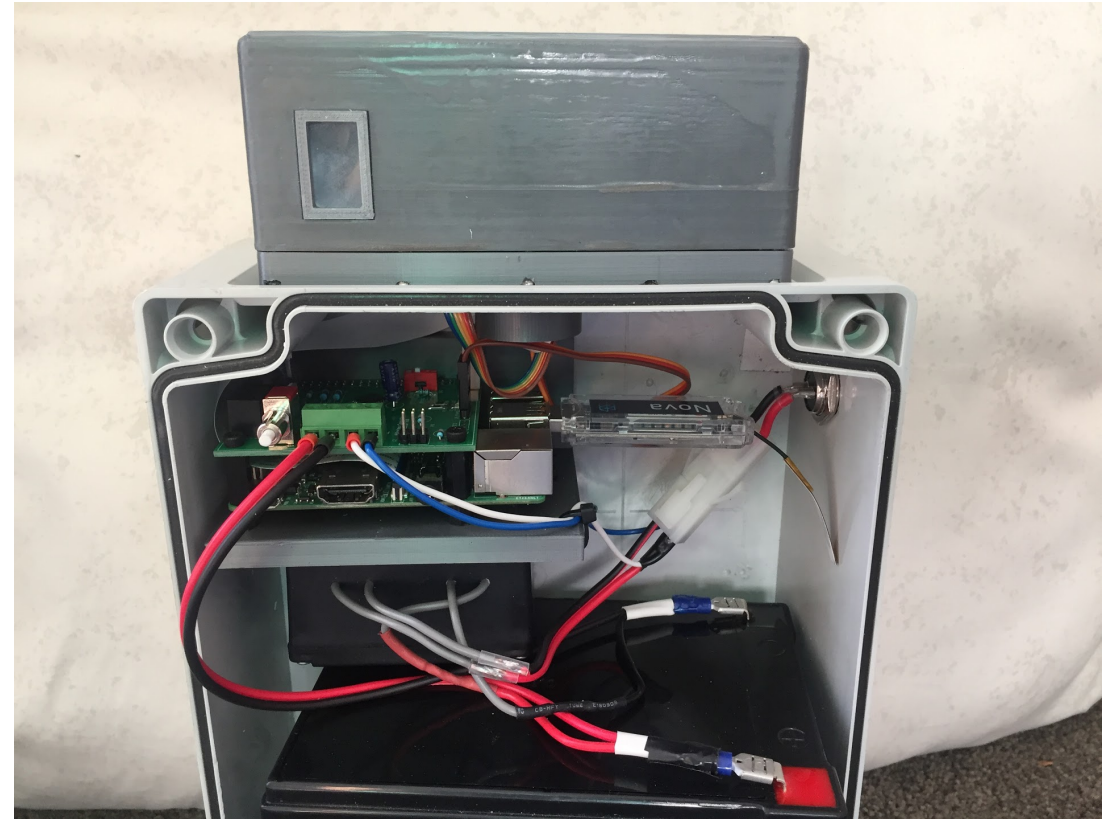
- False positives
 - Birds
 - Rain
 - Wind
- Truck vs bike
 - Unable to differentiate

Limitations

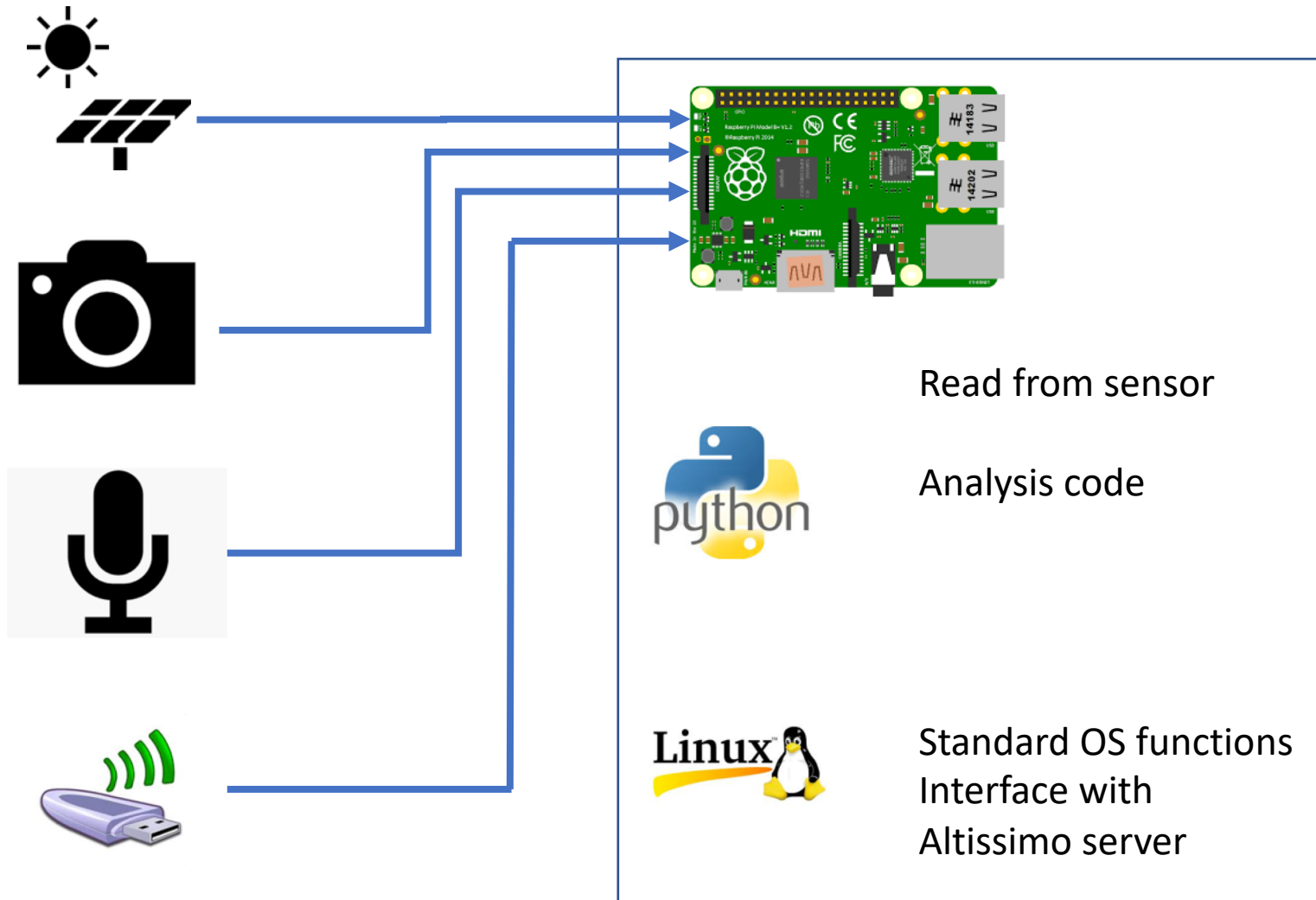
- Too many events to manually view
- Commercial system restricts this to samples with valid number plate

Our solution - hardware

- Pole mounted
- Solar powered
- Low-power processor (Raspberry Pi)
- Camera
- Remote access (3G)



General concept



altissimo Camera-05 Camera-06

Camera-05

From: 2018-03-16 To: 2018-03-18

Show 10 entries Search:

Camera ID	Date	Time	Duration (sec)	Images	Audio file
camera-05	2018-03-16	06:09:49	2.8	True	Listen
camera-05	2018-03-16	07:31:42	2.5	True	Listen
camera-05	2018-03-16	07:31:47	1.3	True	Listen
camera-05	2018-03-16	09:07:46	1.2	True	Listen
camera-05	2018-03-16	09:36:01	1.5	True	Listen
camera-05	2018-03-16	09:37:19	1.2	True	Listen
camera-05	2018-03-16	09:39:33	1.7	True	Listen
camera-05	2018-03-16	09:39:52	1.2	True	Listen
camera-05	2018-03-16	09:44:59	1.3	True	Listen
camera-05	2018-03-16	10:00:48	2.5	True	Listen

Showing 1 to 10 of 20 entries (filtered from 69 total entries)

Previous 1 2 Next



Problems

Power

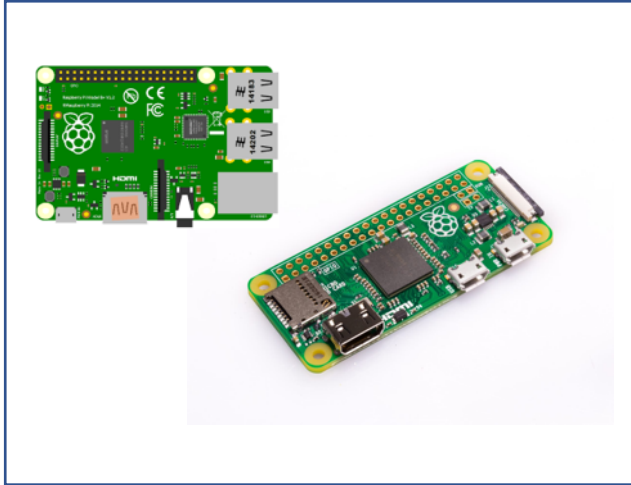
- Solar panel capacity
- Charging circuits
- Reboot cycle corrupt disk image
- Newer hardware has higher power draw

Remote access / communications

- USB modems targeted at consumers (Windows)
- Support for linux
- Bulk availability
- No remote 'reboot' facility

Hardware details

Processor



- Full size 3B/3B+
- Pi Zero
- Balance between processor power and current draw

Power management

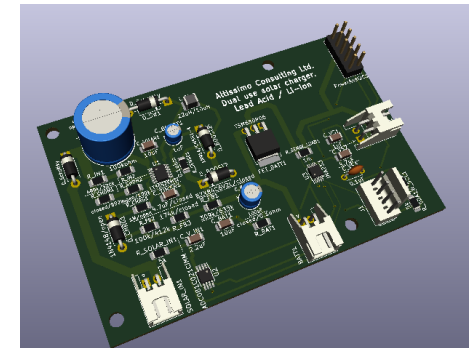


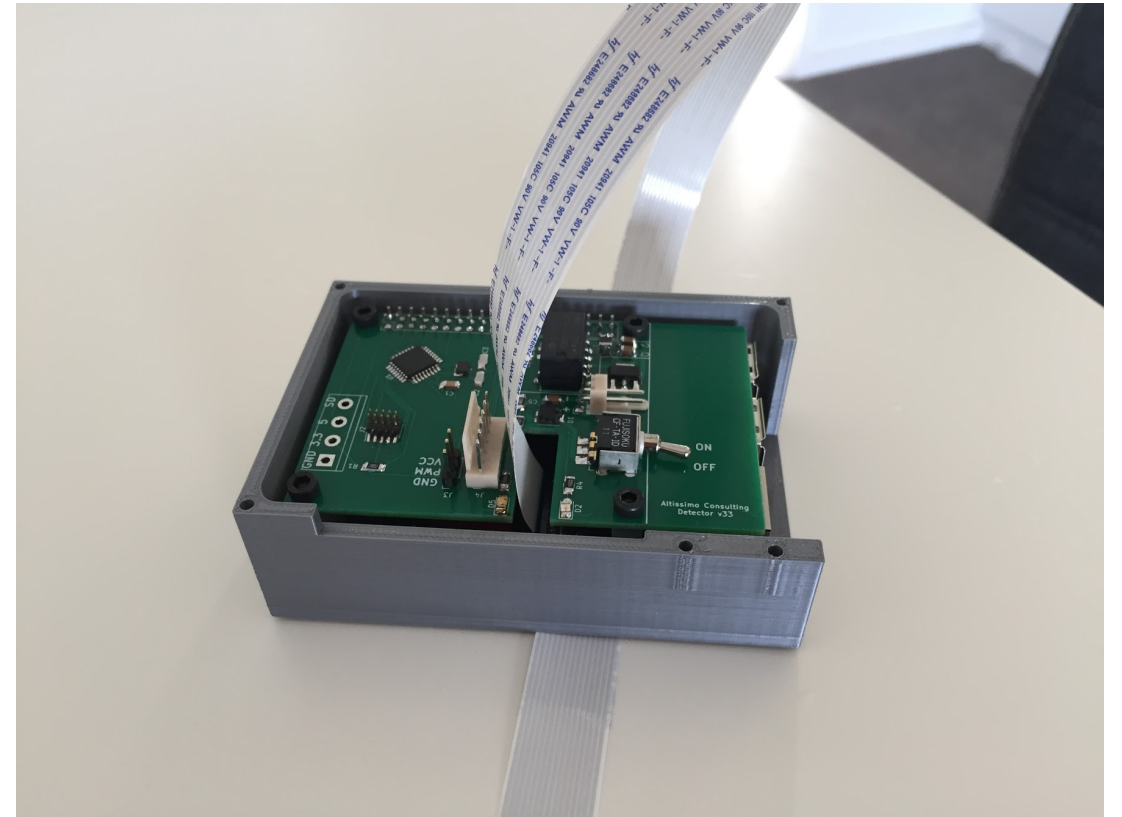
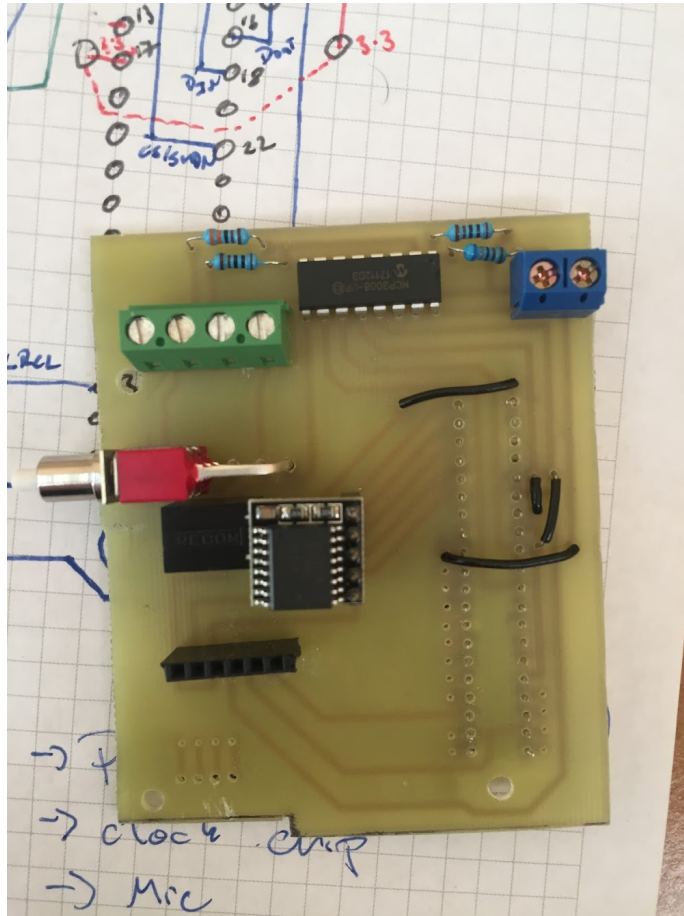
- Shuts down on low battery voltage
- Watchdog to restart Pi if software stops running

Hologram IoT modems



MPPT solar charger





Machine learning

Training dataset

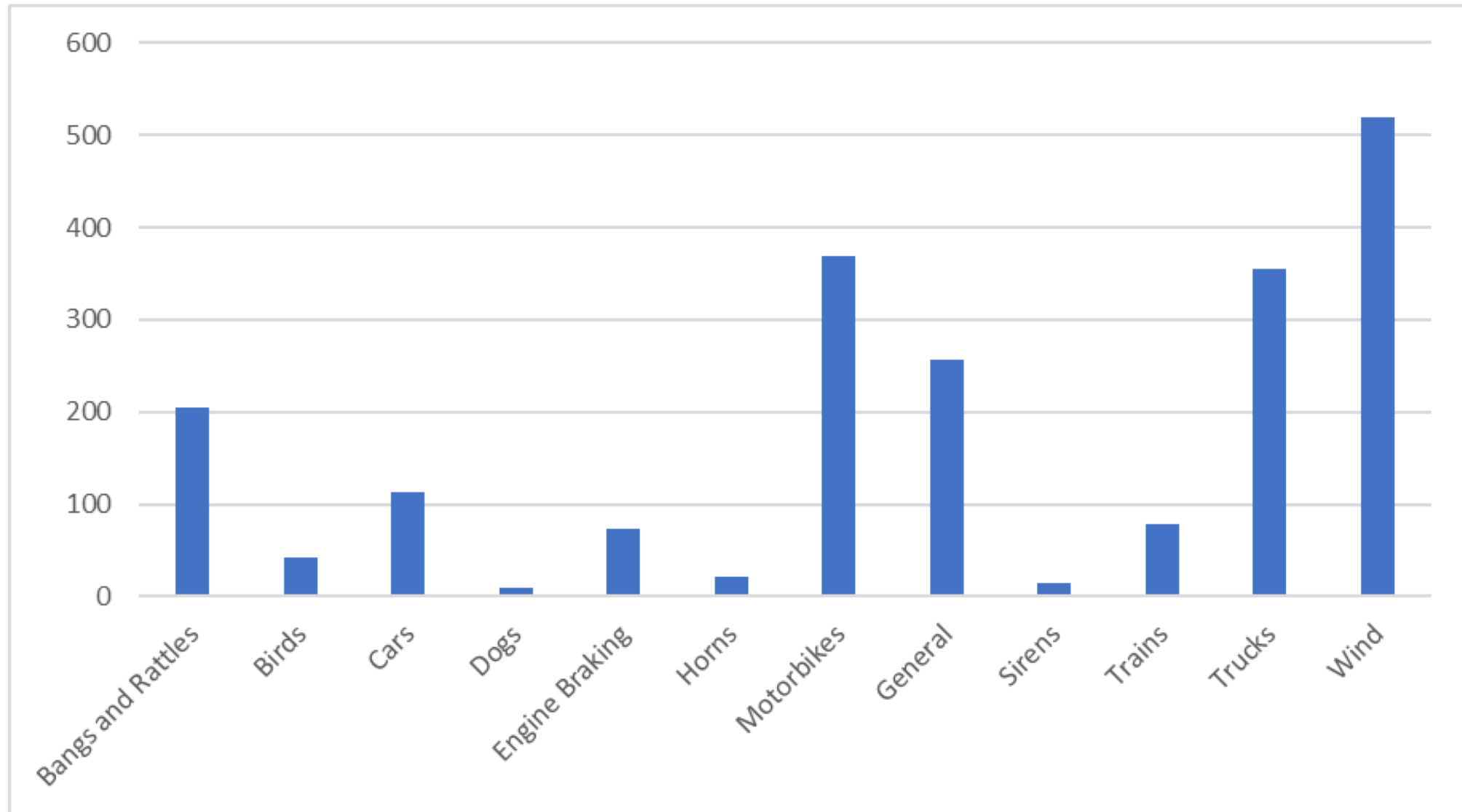
Feature extraction

Train/test

Result

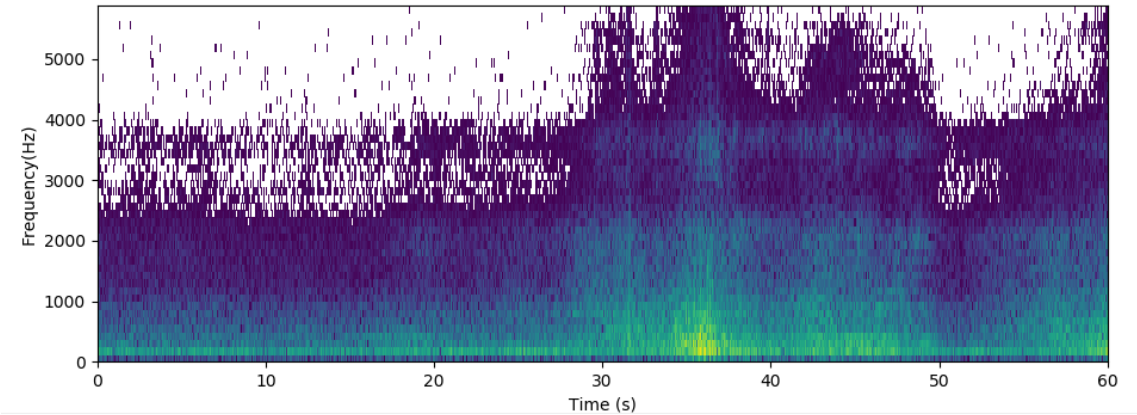
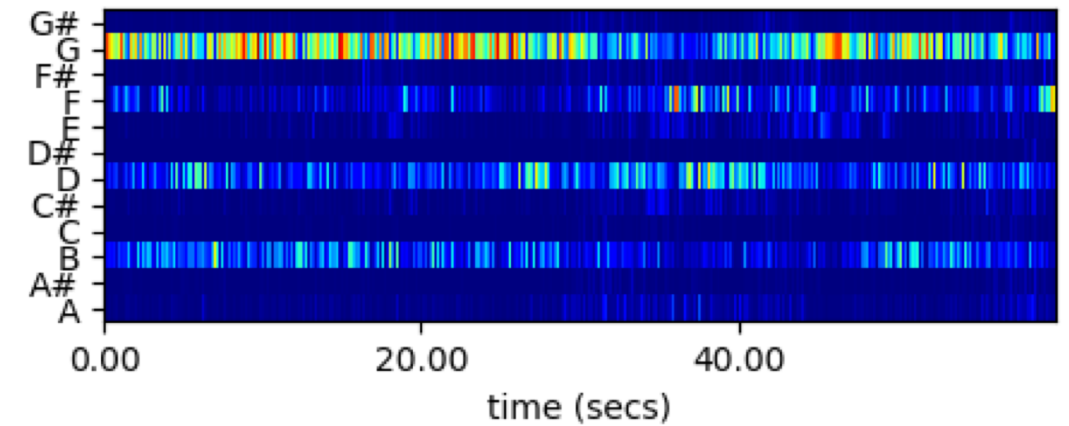
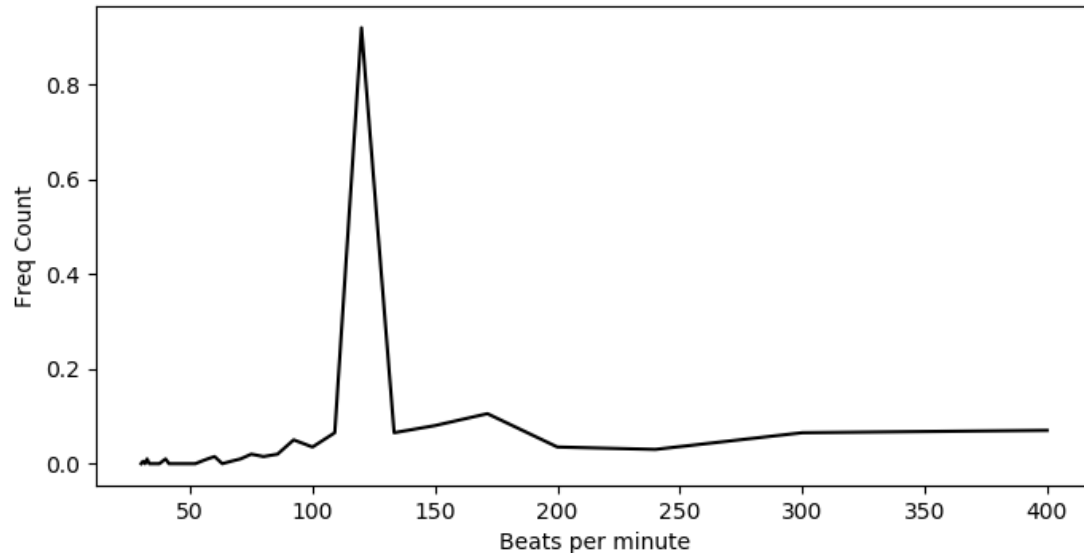


Machine learning – training dataset

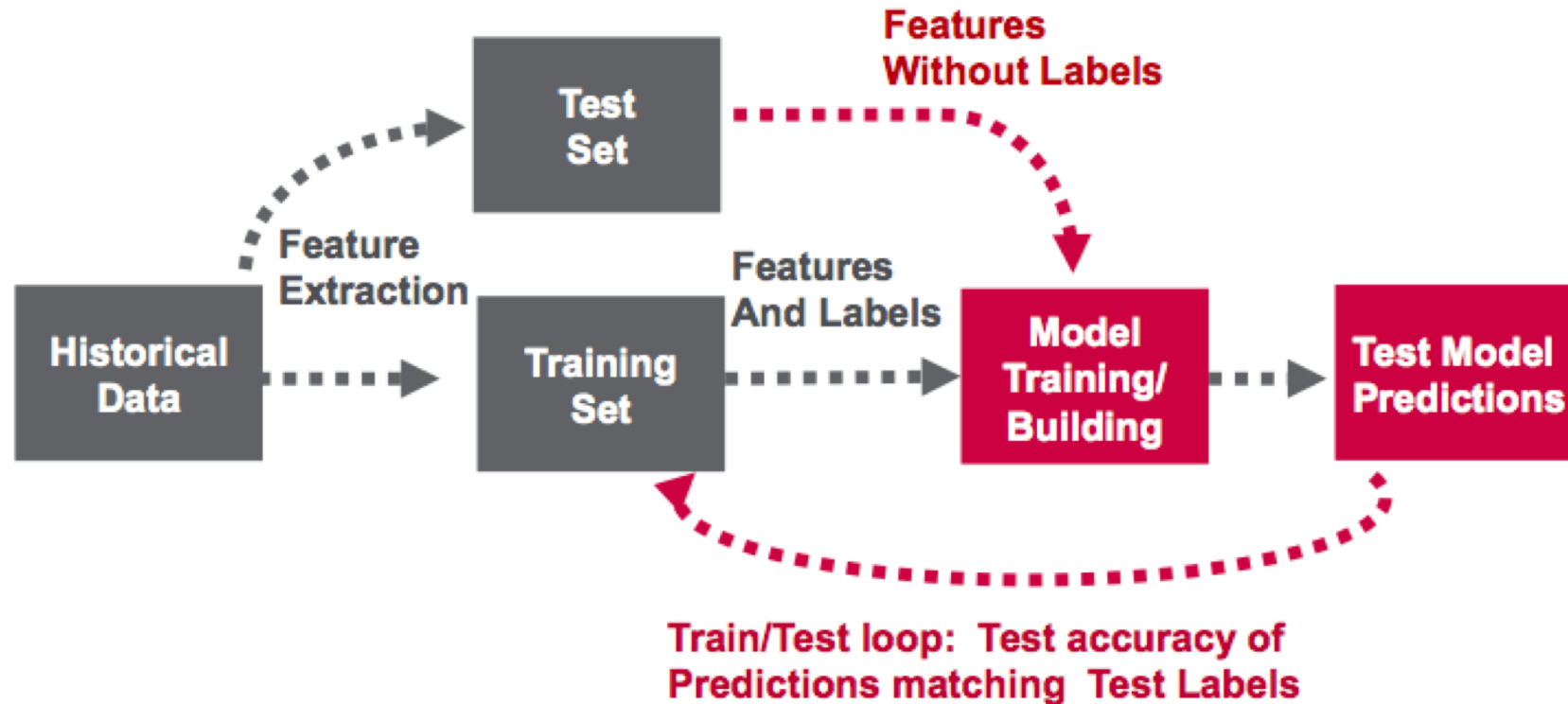


Machine learning – feature extraction

- 32 different analyses
 - Spectral
 - Energy
 - Chroma
 - Beats



Machine learning – test/train



Machine learning - classification

Engine Braking classified as:

Engine braking	Trucks	Motorbikes	Other
98%	1%	0%	1%

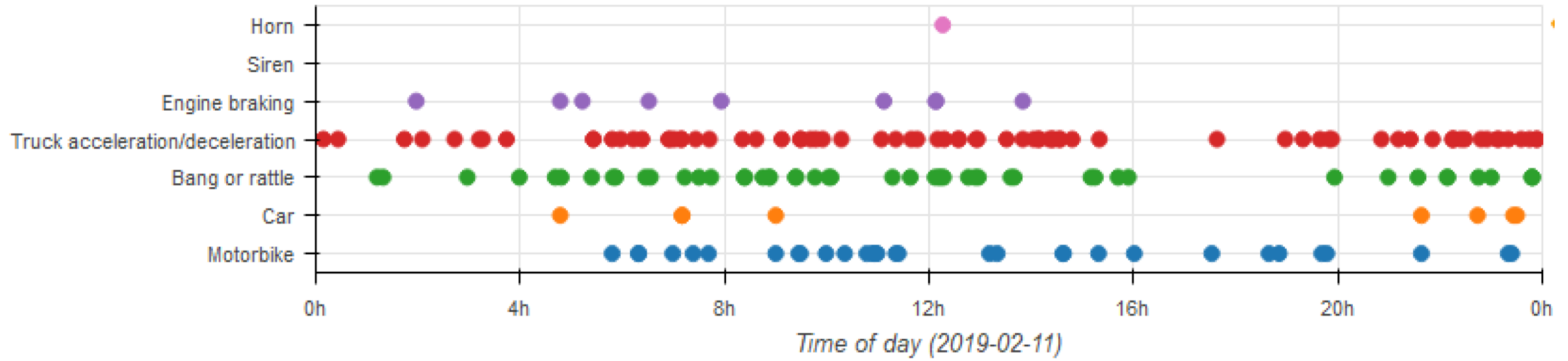
Motorbikes classified as:

Engine braking	Trucks	Motorbikes	Other
2%	6%	83%	9%

Trucks classified as:

Engine braking	Trucks (accel/decel)	Motorbikes	Trucks – body slap / curbing	Other
3%	63%	4%	18%	11%

Results



Differences in analysis techniques

Analytical

- Come up with a metric
 - Level
 - Frequency
 - Modulation
- Compare with criteria

Machine learning

- Define output categories
- Manually classify training set (~2000 events)
- Train
- Test and tweak parameters

Conclusion

- Site selection is important
- Cheaper hardware allows more units to be installed
- Ability to mount directly to pole significantly reduces lead time
- Machine learning can give better outcomes than trying to come up with analytical solutions

Contacts

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