

Automating Spectrum Monitoring

Dirk Grunwald[†]
Austin Anderson^{*}

University of Colorado at Boulder

^{*} Aerospace Department

[†]Computer Science Department

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CU-Boulder

Dirk Grunwald

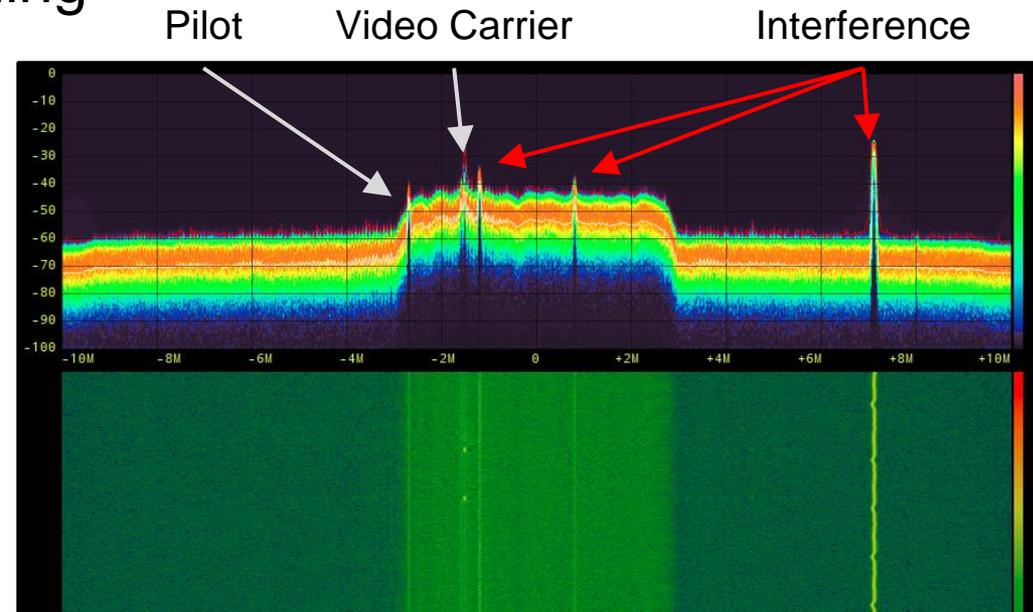
Professor in Department of Computer Science,
University of Colorado, Boulder

Past research in computer architecture & high
performance computing.

Last 10 years, SDR systems, wireless, PHY
and networking.

Motivating Case Study

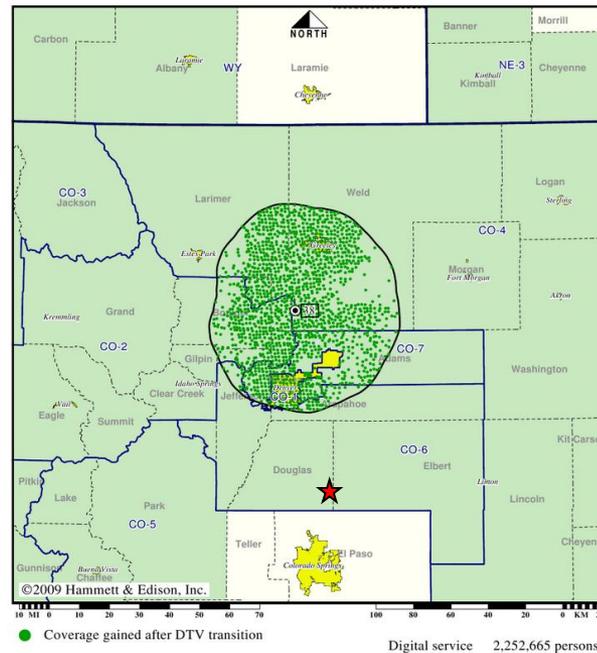
- Interference detected in ATSC band during machine learning collections
- Source is narrow-band
- Intermittent in time
- Powerful
- Found to be TV white-space microphones
 - Used by distance learning courses at CU





Motivating Case Study

DTV Station KPJR-DT • Channel 38 • Greeley, CO
 Expected Operation on June 13: Granted Construction Permit
 Digital CP (solid): 1.20 kW ERP at 362 m HAAT
 Market: Denver, CO



Motivating Case Study

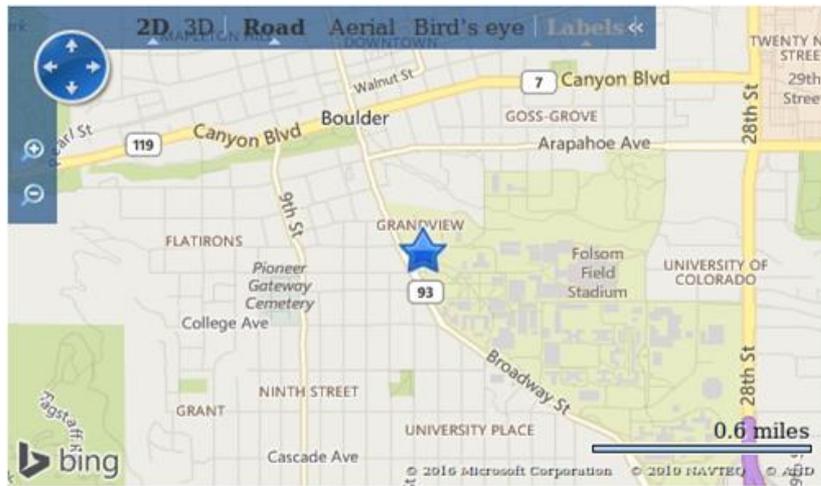
Enter your device type and location below

Fixed TVBD
 Personal/Portable TVBD
 Wireless Microphone

CU Boulder

Search

Best match: University of Colorado, CO

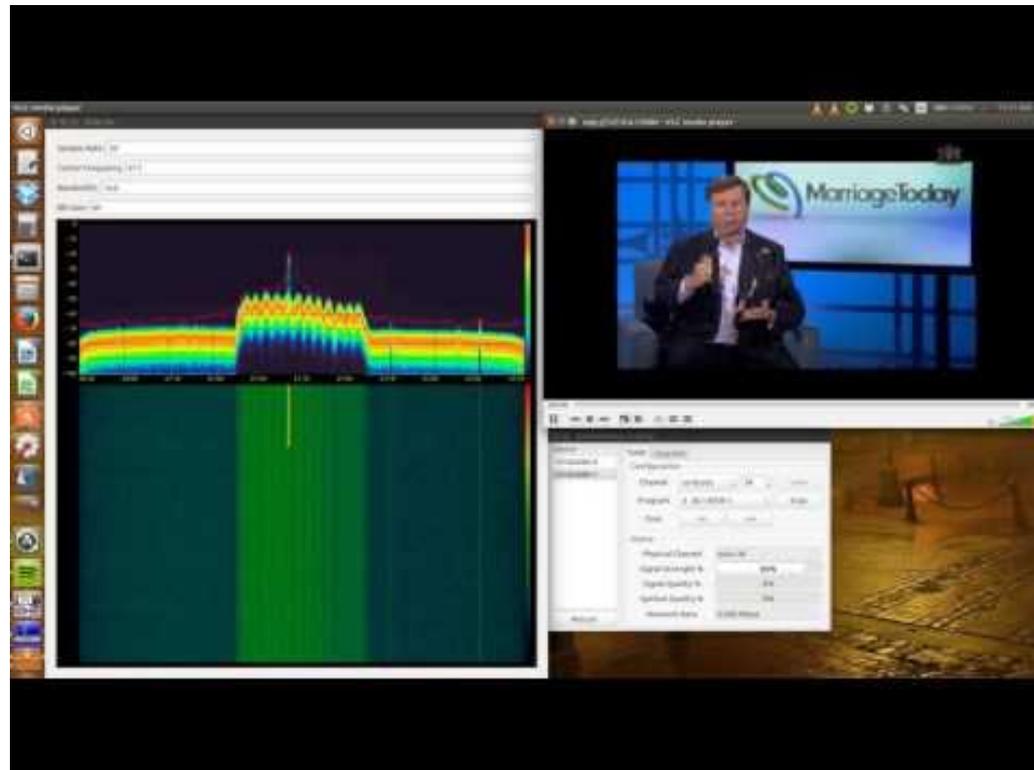


Channel Number	Frequency Range (MHz)	Availability	Noise Floor (dBm)
33	584-590	Reserved	**
39	620-626	Reserved	**
8	180-186	Available	**
10	192-198	Available	**
12	204-210	Available	**
14	470-476	Available	**
20	506-512	Available	**
2	54-60	White Space	**
21	512-518	White Space	**
22	518-524	White Space	**
23	524-530	White Space	**
25	536-542	White Space	**
28	554-560	White Space	**
30	566-572	White Space	**
42	638-644	White Space	**
44	650-656	White Space	**
47	668-674	White Space	**
49	680-686	White Space	**
50	686-692	White Space	**
51	692-698	White Space	**

No instruction for channel 38



Motivating Case Study

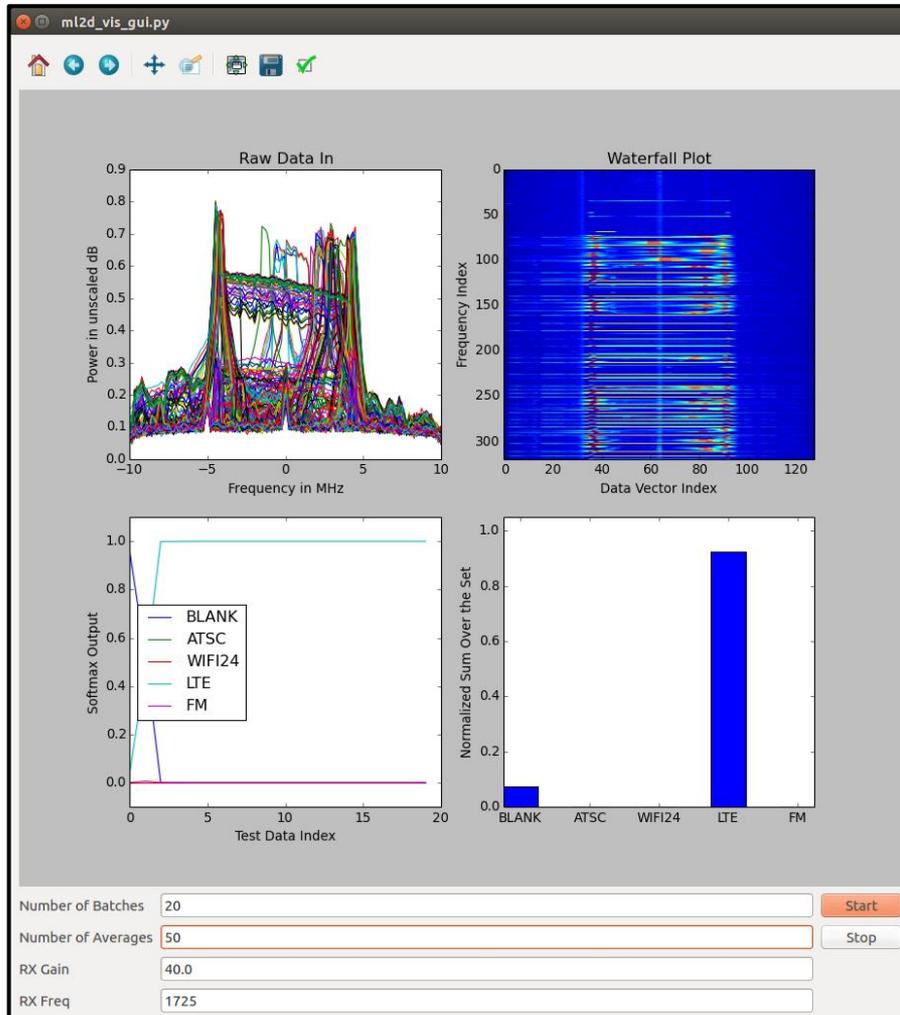


Waveform Identification *via* CNN

- FFT samples
- Max-hold

Effectively a waterfall of max-hold (rather than average)

Train classifier with different true signals



Classification Accuracy

High single-waveform
classification accuracy

Even with frequency
offset

WIP: identifying
interference such as
microphone

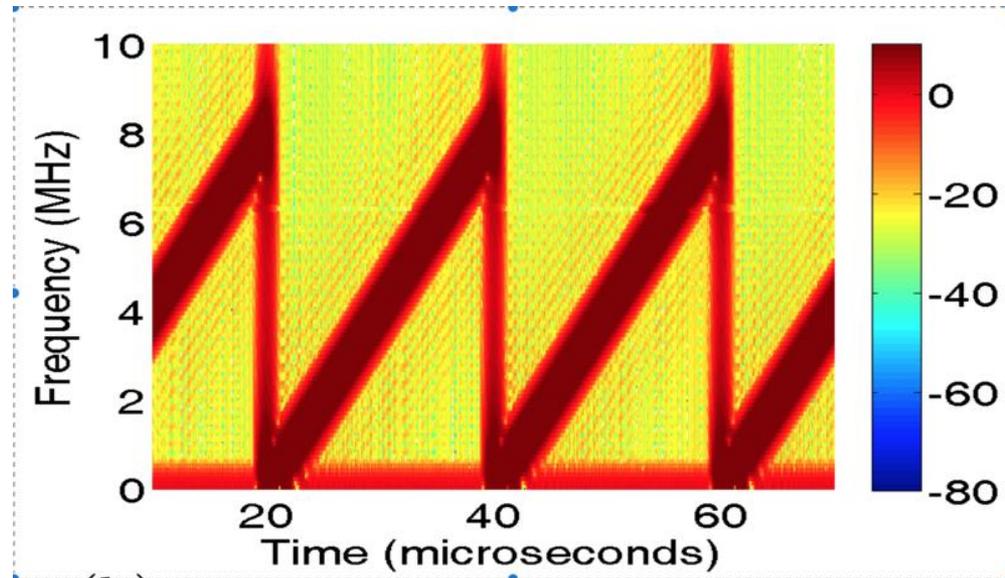
Actual/Predicted	Blank	ATSC	WIFI	LTE	WSM
Blank	768	0	0	0	22
ATSC	0	831	0	0	0
WIFI	0	0	784	4	0
LTE	60	11	0	661	41
WSM	313	0	0	13	494

Data	Number of Samples	Accuracy	Test Rate (MSPS)
Test	4002	0.884	0.74
Train	4002	0.887	0.74

How to identify interference?

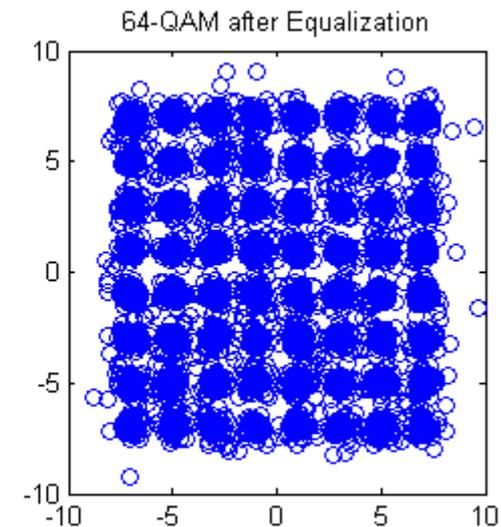
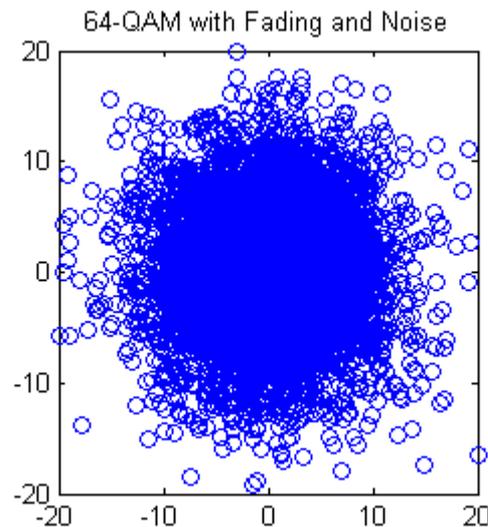
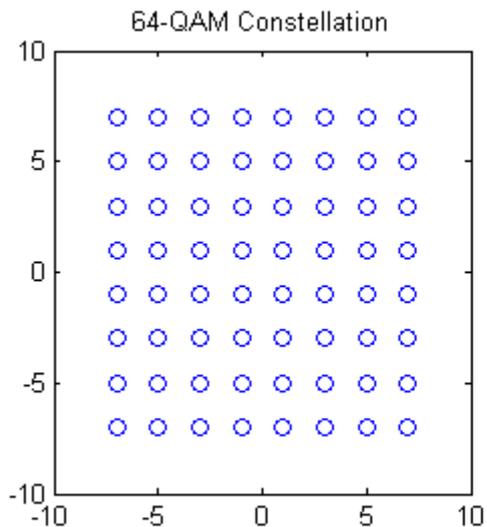
Intentional (microphone)
& unintentional (gps)

E.g. swept-wave signal
should impact OFDM
subcarriers in distinct
way. Reflected in EVM



Identifying distorted waveforms?

There are standard changes to constellation plots from phase noise, equalization error





Automating Identification

Training can be a closed loop:

- Use ATSC signal quality to identify distorted signal
- Provide automatic labeling

Future: can we automate “change detection”

- Train on “standard environment”
- Indicate “non-standard” environment - non-trivial