Requirements for extracting ENF data to correctly timestamp a video

Thomas Ouddeken
Niels den Otter

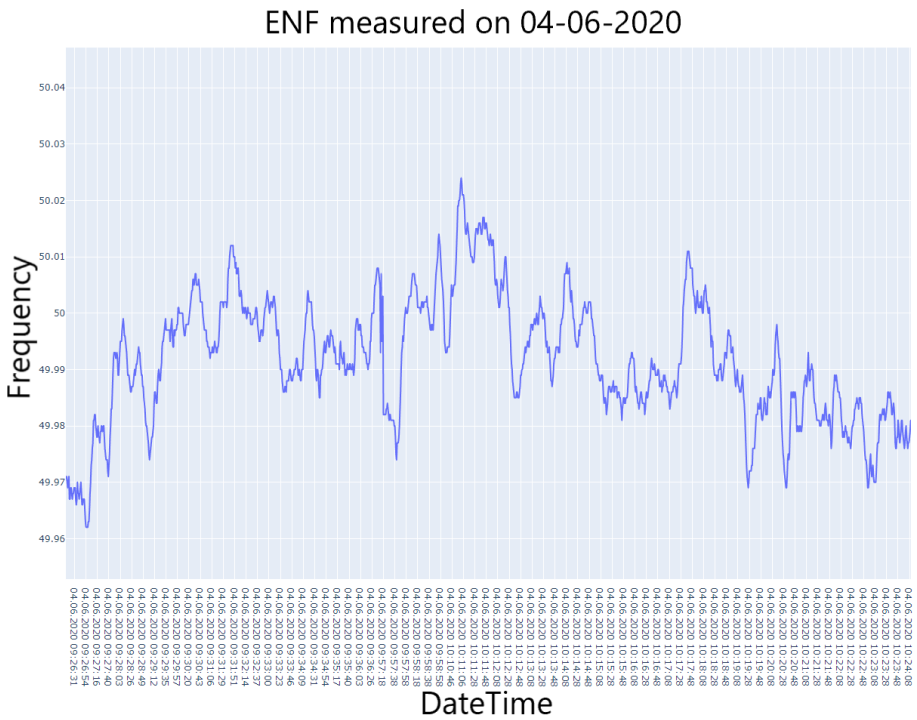
Supervisor
Zeno Geradts

What is ENF?

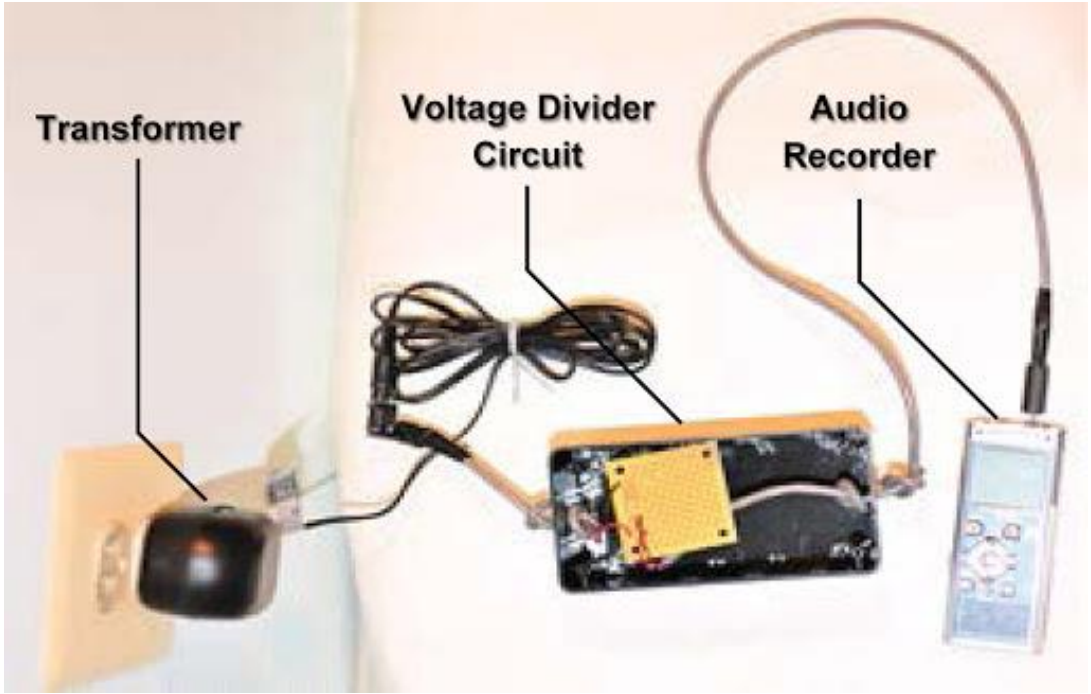
- Electrical Network Frequency (ENF)
- 50Hz for Europe; 60Hz for America and parts of Asia
- Fluctuations in frequency
  - Unique
  - Grid-wide
  - Possibility of fingerprinting/timestamping
- ENF in audio
  - Devices generate mains hum
  - Hum can be recorded to deduce ENF

Why use ENF?

- Imagine adversary manipulating a recording
  - False Frame Injection attack
  - Deletion of metadata
- ENF allows timestamping recordings

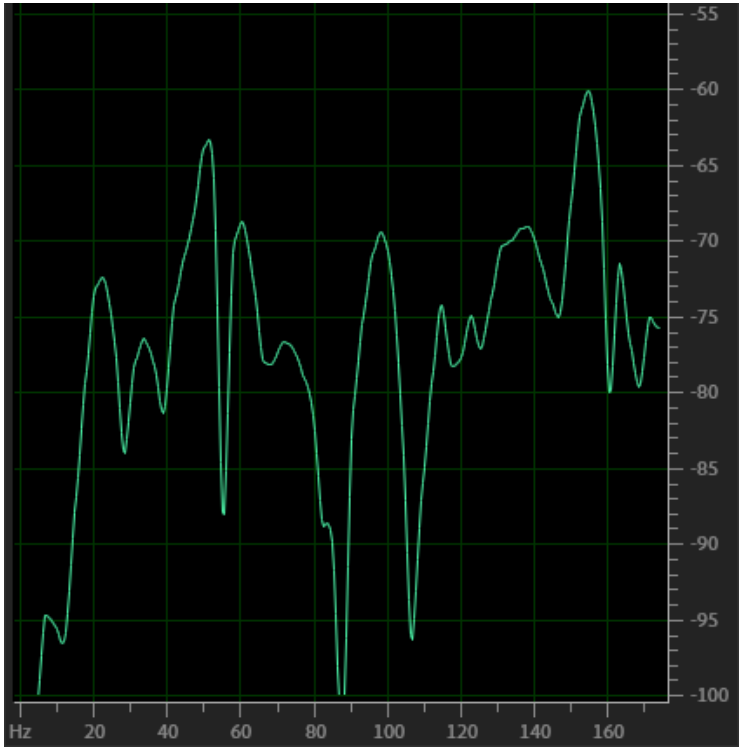


Retrieving ENF from audio

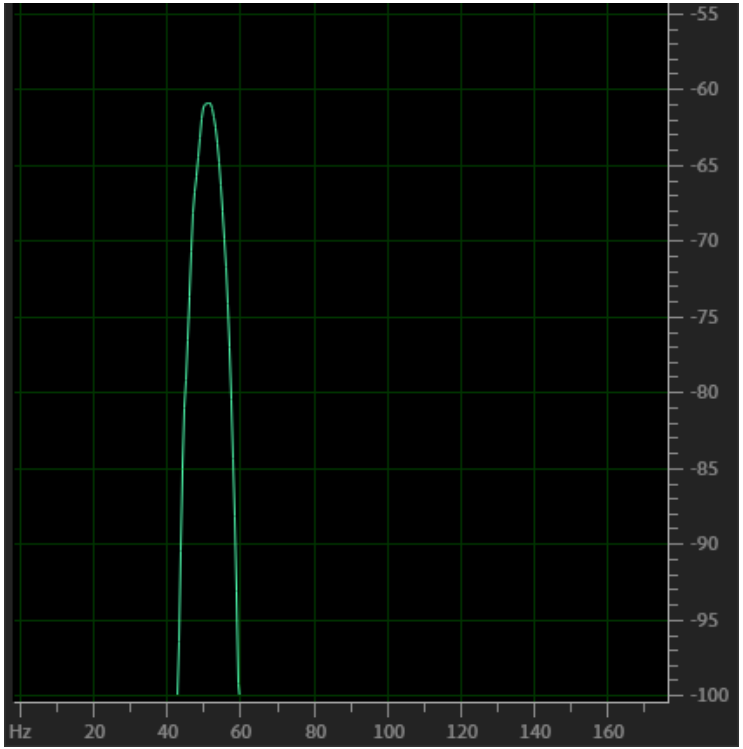


http://www.mast.umd.edu/research.php?t=enf

Retrieving ENF from audio



Before filtering



After filtering

Related Work

- Previous research mainly focussed on audio
- M. Huijbregtse and Z. Geradts [1]
  - Maximum correlation coefficient
  - Length of audio sample
- R. Garg and H. Su extract ENF data from video [2] [3]
  - Unclear in methodology
  - No other reproductions

[1] M. Huijbregtse and Z. Geradts, “Using the enf criterion for determining the time of recording of short digital audio recordings,” in Computational Forensics
[2] R. Garg, A. L. Varna, and M. Wu, ““seeing” enf: Natural time stamp fordigital video via optical sensing and signal processing,” in Proceedings of the 19th ACM International Conference on Multimedia
[3] H. Su, A. Hajj-Ahmad, C.-W. Wong, R. Garg, and M. Wu, “Enf signal induced by power grid: A new modality for video synchronization, ”in Proceedings of the 2nd ACM International Workshop on Immersive Media Experiences

ENF in video

- Studies have shown possibility to retrieve ENF from video
- Aimed to reproduce these studies
- Research how properties of video affect obtaining ENF

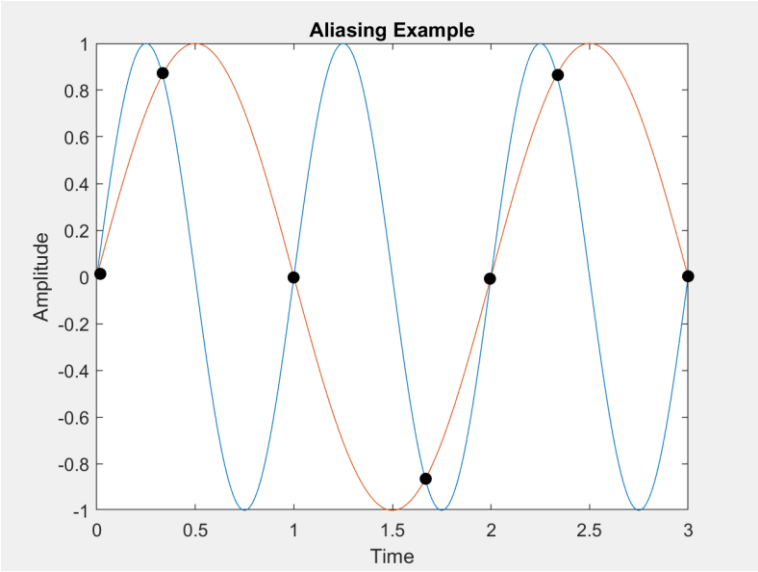
What requirements are there to correctly timestamp a video recording using ENF data?

Is it possible to extract ENF data from video?

How do the properties of a video affect the presence of ENF data in a recording?

Sampling rate

- Nyquist-Shannon sampling theorem
- Nyquist sampling rate



Camera frame rate

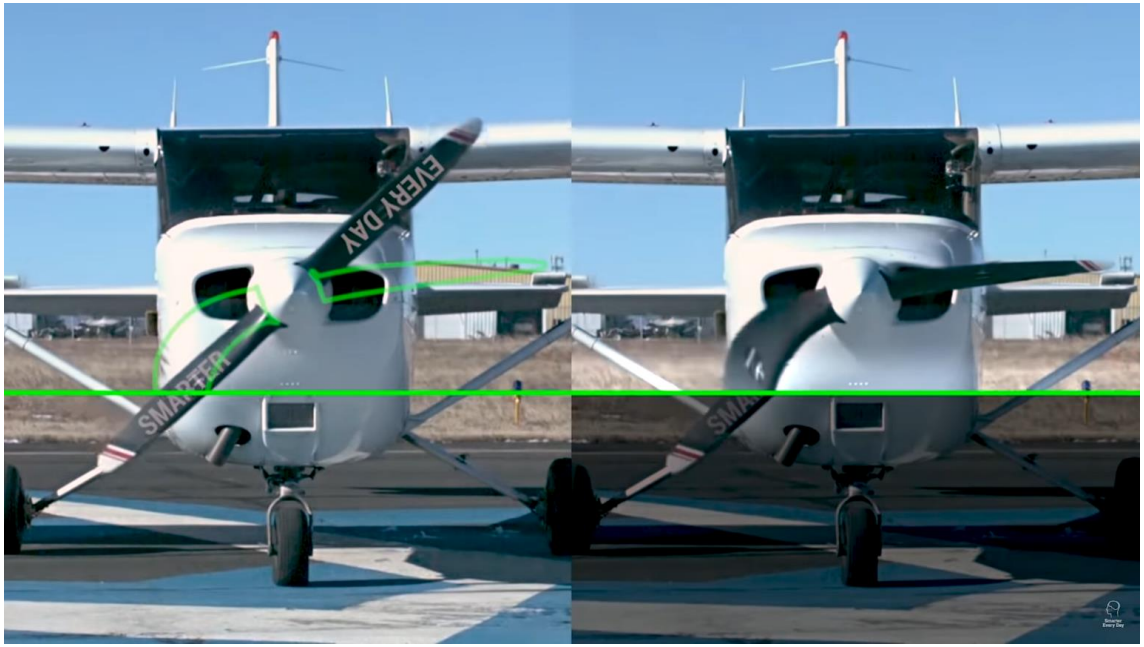
- 25 or 30 frames per second
- Sampling rate too low
- High speed cameras

Sampling target

- Fluorescent light
- Incandescent light bulb
- Photosensitive sensor

CMOS Sensors

- Per row basis
- Rolling shutter effect
- Increases sampling rate



https://www.youtube.com/watch?v=dNVtMmLlnoE
- “SmarterEveryDay”

Methodology

- Gathering a baseline of ENF data
- Three methods to do so:
  - Find online source that provides data
  - Connect power outlet to audio recorder
  - Use audio of a recording and verify against database

Test environment

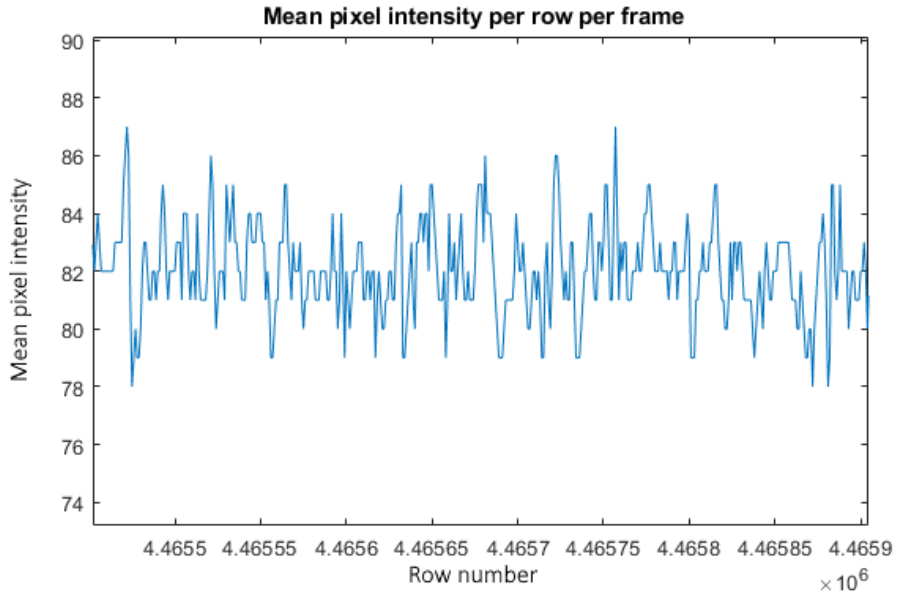
- Recreate test environment from R. Garg’s research
- Light up a white wall with light
  - Fluorescent light
  - Record lit wall for long period of time
- Split up recording into multiple parts

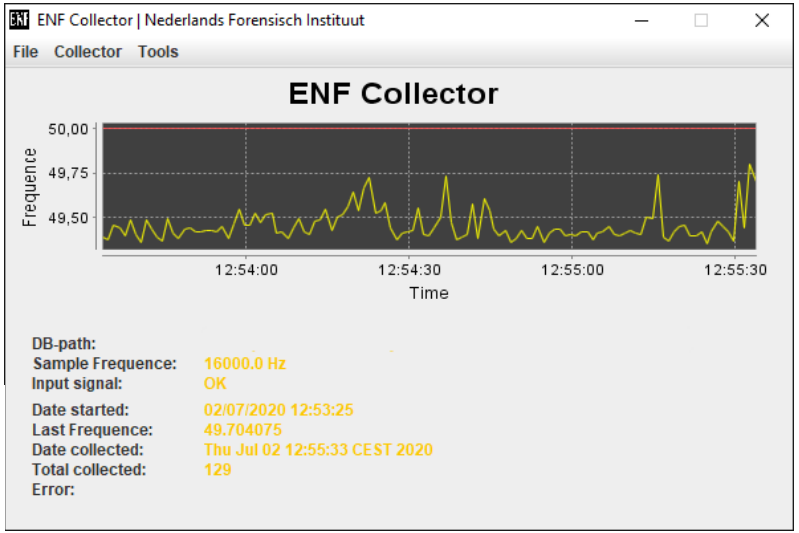
Filtering

- Blur
- High pass filter

Results

- ENF from audio
- Data from CMOS





Discussion

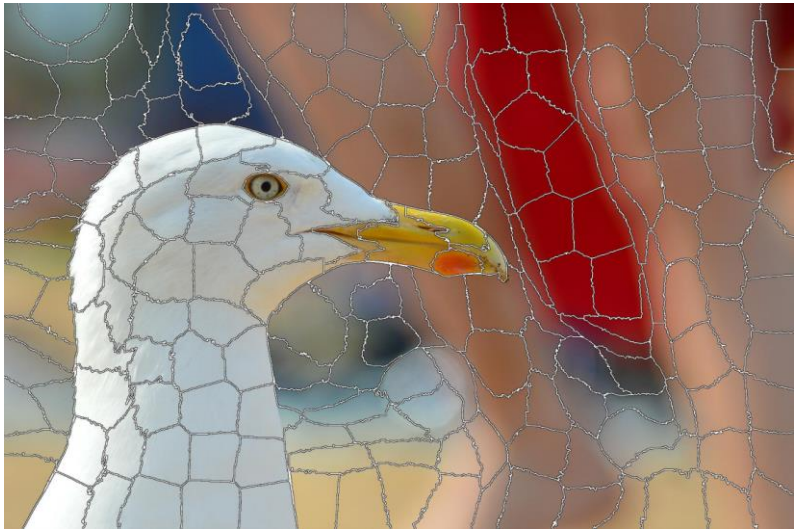
- Time constraints
- Filtering
- CMOS
- Prevention

Conclusion

- Using CMOS sensors shows promising results
- We theorise it should be possible
- Specific conditions are needed

Future work

- Extracting ENF data from CMOS sensor video
- Super pixel based dynamic approach
- Combine footage



Detecting the Presence of ENF Signal in Digital Videos: a Superpixel based Approach

https://arxiv.org/pdf/1903.09884.pdf

Questions?

- Using CMOS sensors shows promising results
- We theorise it should be possible
- Specific conditions are needed