Camera identification on YouTube

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Introduction

- Why camera identification?
Agenda

- Pattern noise
- Video encoding
- Experiment
- Results
- Analysis
- Conclusion
Noise sources

Signal processing of a simplified digital camera

Source: FIDIS “D6.8b: Identification of images”
Pattern noise

- Present on all frames
- Fixed pattern noise (FPN)
  - Defective pixels
- Photo Response Non-Uniformity (PRNU)
Algorithm

- Correlation between the reference pattern and the video pattern
- Correlation on each color channel (RGB)
  - Sum of correlation on each color channel
- Correlation value between -3 and 3
PRNUCompare

- Algorithm implemented in PRNUCompare
  - Developed by NFI (Netherlands Forensics Institute)
- http://prnucompare.sourceforge.net/
PRNUCompare

Extract

Camera Model: Apple iPhone
Unique ID: 1
Source: Natural
Resolution: 1280 x 704
Options: sigma=5.0
Cropping:
X: 0
Y: 0
Width: 352
Height: 280
Frame Averaging: 10

Frame averaging ONLY applies to VIDEOS. It specifies the number of frames to average before calculating a PRNU pattern.
Method: Wavelab (Daubechies)
Sigma: 5

Average PRNU extracted.

Average Pattern:
Video encoding

- Advanced Video Codec (AVC)
- Compresses the video stream
- Modifies the pattern noise
- Applies to YouTube
Research question

How does re-encoding the video with the Advanced Video Codec influence the pattern noise?
Experiment

- 5 different camera models
  - Canon Ixus/SX210
  - Panasonic FP7/FZ45
  - Apple iPhone 4
- 5 different cameras per model
- Multiple resolutions
  - 640x480
  - 1280x720
Experiment

- 1 reference video per camera per resolution
- 1 natural video per camera per resolution
- re-encode each natural video
  - AVC encoding setting: CRF 18, 21, ..., 39
- Upload/download videos to/from YouTube
Encoding quality 18
Encoding quality 21
Encoding quality 24
Encoding quality 27
Encoding quality 30
Encoding quality 33
Encoding quality 36
Encoding quality 39
Results

- Extracting the pattern noise for each video
- Correlate each video to the reference patterns
- Total number of videos processed: 835
Analysis

- Verify that pattern noise can be used for source identification before re-encoding
Analysis

The graph illustrates the PRNU correlation for various camera models and video qualities. The x-axis represents different camera models (FP-7, FZ-45, iPhone, LXUS, SX210) and video qualities (480p, 720p). The y-axis shows the PRNU correlation range from -0.5 to 2.5. The squares represent matched conditions, while the circles indicate the highest mismatch. Different video qualities are indicated by superscript 1 or 2, with Motion JPEG and AVC (H.264/MPEG-4) noted in the legend.
Analysis

- Correlation between re-encoded videos and reference patterns
Analysis
Analysis

Canon PowerShot SX210 IS

- YouTube intersections
- pmm 480p
- Canon PowerShot SX210 IS 480p
- pmm 720p
- Canon PowerShot SX210 IS 720p
Conclusion

- Depends on the level of compression
- Presence of pattern noise differs per model
- Higher resolutions videos perform better
  - More pixels == more noise
Even after a re-encode on the video with a compression similar to YouTube, it is still possible to identify the source camera for most cameras.
Questions?

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