



CAMCOM 2010

Verification of Source Video Camera Competition

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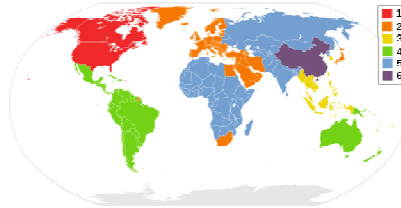
Overview

- Problem description
- Method
- Contest/Result
- Analysis
- Conclusion

22/08/2010

Problem description

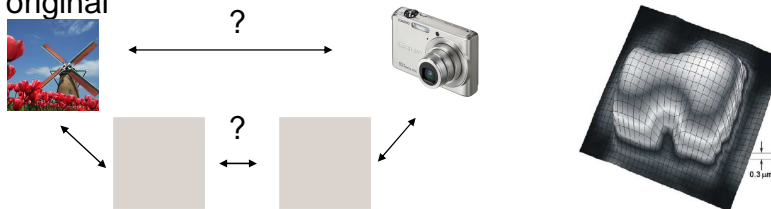
- Camera identification can be a very important tool in forensics:
 - Bootleg DVDs of new movies
 - Production or possession of child pornography?



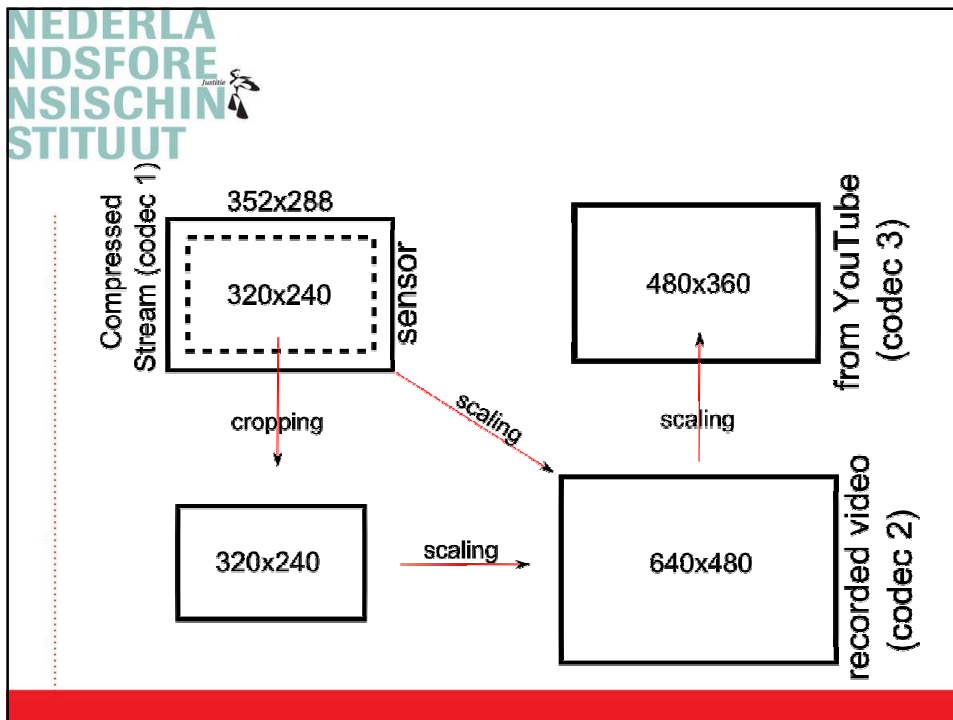
- YouTube? Large databases?

Method

- Photo Response Non-Uniformity (PRNU)
 - 'Invisible' noise-like pattern present due to variations in manufacturing
 - Present in each image sensor, and, to a certain extent, in each image produced with that image sensor
 - Obtained by subtracting a denoised image from the original



- For photos, Flickr can be successfully used as database (EXIF contains the brand/model camera)
- For videos, no such metadata standard/database exists
- 100 low-cost webcams (320x240, 352x288, 640x480, 800x600) used to generate videos which were uploaded to YouTube
- Videos can be recorded in different resolutions, resulting in PRNU desynchronization
 - Webcam driver does cropping, scaling or combination





Contest

- Reasons
 - Create benchmark
 - See which problems we encounter in practice
- Two scenarios
 - First scenario: camera identification (reference video available)
 - Second scenario: linking videos (no reference video available)



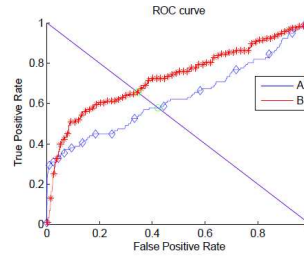
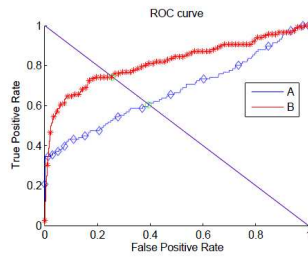
Contest – Scenario I

- Camera identification
 - Scenario I - Reference video provided
 - 148 videos of approximately 35 seconds
 - 148 videos of approximately 10 seconds
 - Recorded with resolutions of 320x240, 352x288, 640x480, 800x600 independent of physical resolution



Results

- Results for long (left) and short (right) videos



Recall Rate $R = TP/(TP+FN)$

Precision $P = TP/(TP+FP)$

	P(A)	P(B)	R(A)	R(B)
ScI:Long	0.95	0.72	0.33	0.18
ScI:Short	0.79	0.52	0.13	0.12

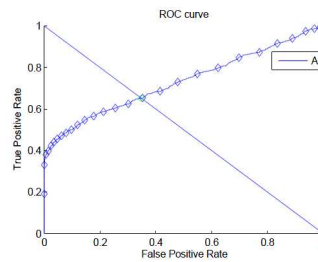
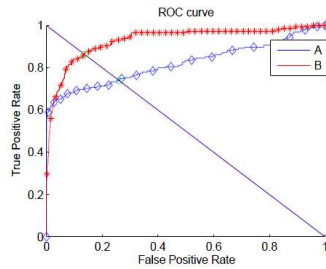
Contest – Scenario II

- Common source identification
 - Scenario II - Linking natural videos
 - 158 videos of approximately 20 seconds
 - 100 videos of approximately 60 seconds
 - All videos recorded in 640x480 resolution, independent of physical resolution



Results

- Results for long (left) and short (right) videos



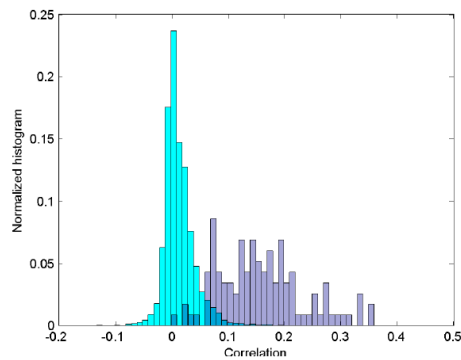
$$\text{Recall Rate } R = \text{TP}/(\text{TP}+\text{FN})$$

$$\text{Precision } P = \text{TP}/(\text{TP}+\text{FP})$$

	P(A)	P(B)	R(A)	R(B)
ScII:Long	0.98	†	0.31	†
ScII:Short	1.00	†	0.17	†

Analysis

- Correlation used as similarity measure
 - Elevated correlation values due to non-identifying patterns (compression artifacts)



- Averaging multiple frames to reduce shotnoise, speed up PRNU extraction
- Different similarity measure, e.g. PCE
- Characterize the non-identifying artifacts (mostly compression)
- Can these characteristics be used for classification; if so: can we cluster these videos?
- Based on this cluster, find the correlation value above which a value is significant

Conclusion

- Camera identification and linking videos works when videos originate from YouTube
- There is a lot left to be done to make this reliable
- For now, confined to closed sets