

# Blind Biometric Source Sensor Recognition using Advanced PRNU Fingerprints

EUSIPCO 2015

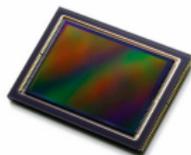
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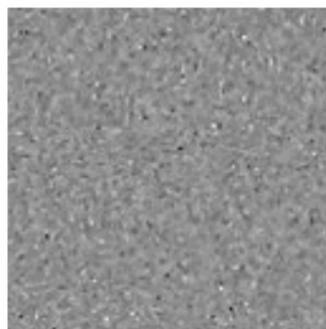
01.09.2015

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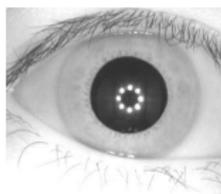
- Devices (Sensors) add signatures to the data they produce
- Intrinsic: artefacts that are due to optical, electrical, or mechanical limitations of the device
- Extrinsic: generated by modulating the process parameters according to a specified pattern that may encode the serial number of the sensor or other information
- Forensic characterization: Identify characteristics of the device by observing the produced data



- Photo-response non-uniformity
- CCD/CMOS Sensors
- intrinsic property
- noise-like pattern
- Variations in quantum efficiency among pixels
- PRNU noise residual: PRNU extracted from a single image
- PRNU fingerprint: Averaged PRNU extracted from multiple images from same sensor



Subset name	Short name	Sensor	Resolution
CASIA-Iris-Interval	intv	CASIA close-up iris camera	320 × 280
CASIA-Iris-Lamp	lamp	OKI IRISPASS-h	640 × 480
CASIA-Iris-Twins	twin	OKI IRISPASS-h	640 × 480
CASIA-Iris-Distance	dist	CASIA long-range iris camera	2352 × 1728
CASIA-Iris-Thousand	thou	Irisking IKEMB-100	640 × 480



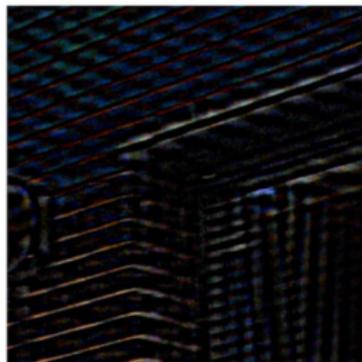
- Iris-Sensor Authentication using Camera PRNU Fingerprints [UH12]
- Distinction rate varies between 0.21 and 23.26% (EER)
- Do poor EERs for some sensors come from low variance in image content? → uncorrelated data [LZA14]
- Have all images in a data set been acquired with the same sensor? → forensic investigation [LA15]

- Proposed in [LA15]:
  - Sliding Window Fingerprinting (SWFP):  
Iteratively computes PRNU FPs from consecutive images and compares their similarity.
  - Device Identification on Dataset Partitions (DIODP):  
Partitions the dataset and performs source identification by assuming each partition is a different sensor.
- Blind Camera Fingerprinting and Image Clustering (BCFAIC) [G B08]:  
Agglomerative clustering of images by grouping images with similar PRNU together.

# PRNU Contaminations and Enhancement Techniques

- Undesired contaminations affect both PRNU fingerprints and noise residuals
- Sources:
  - Non-unique artifacts (NUAs)
  - Image content
- Degrade quality of the PRNU and decrease discriminative power of distinct sensors

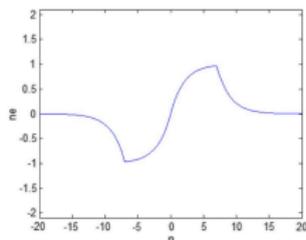
# Image content related contamination



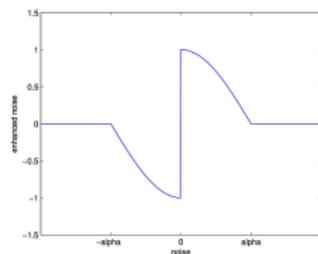
[Li10]

- Covers high-frequency components of the image
- Edges and textured image regions
- Correlated content among various images
- Hard to separate from the PRNU
- Visible in the extracted PRNU

- Image content contamination suppression using various attenuation models in DWT domain
  - Enhancement model Li [Li10]
  - Enhancement model Caldelli [R C+10]
- Idea: The larger a component in the PRNU, the more likely it is contaminated by the image content



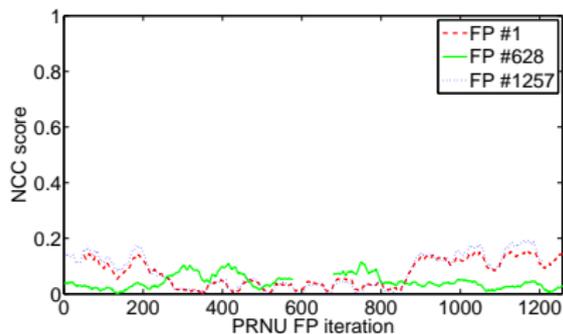
Attenuation function Li



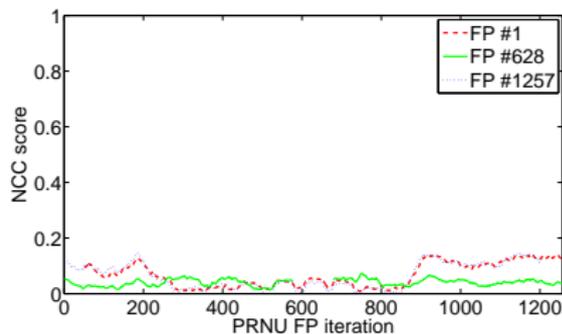
Attenuation function Caldelli

# Results and Conclusion

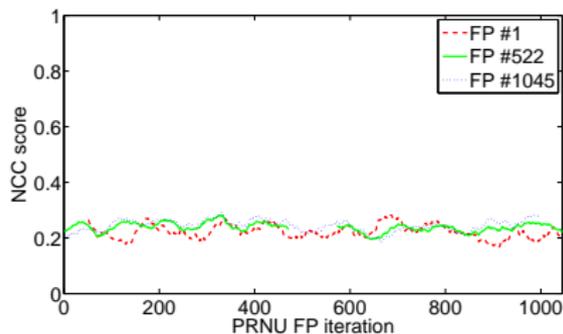
# Results: Sliding Window Fingerprinting



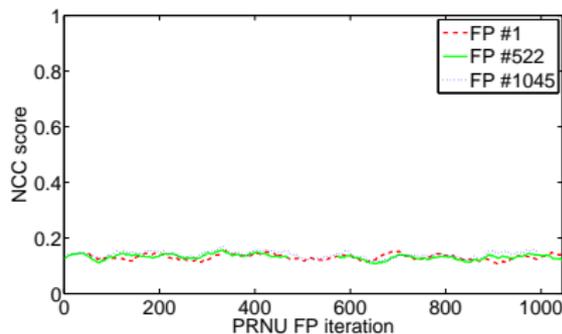
*intv - Li*



*intv - Caldelli*

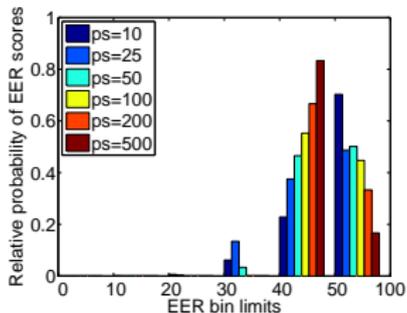


*twin - Li*

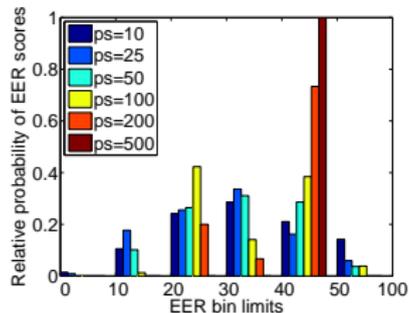


*twin - Caldelli*

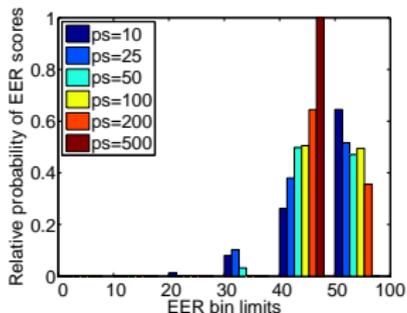
# Results: Device Identification on Dataset Partitions



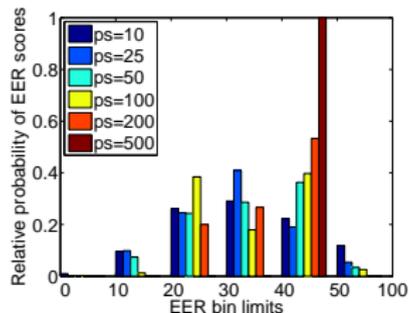
*thou - Li*



*intv - Li*



*thou - Caldelli*



*intv - Caldelli*

# Results Blind Camera Fingerprinting and Image Clustering

<i>EnhLi3</i>	<i>intv</i>	<i>lamp</i>	<i>twin</i>	<i>dist</i>	<i>thou</i>
# P	11	15	3	1	2
P > 100	4	5	1	1	1
P < 10	3	5	1	0	0
Unass. IMGs	0	0	0	0	0

<i>EnhCald</i>	<i>intv</i>	<i>lamp</i>	<i>twin</i>	<i>dist</i>	<i>thou</i>
# P	17	20	6	1	4
P > 100	4	7	1	1	2
P < 10	5	4	3	0	1
Unass. IMGs	0	0	0	0	0

- Results of applied PRNU enhancements comparable to previous results without enhancement
- Overall correlation scores show a slight offset (decrease)
- Results for CASIA-Iris V4 datasets indicate:
  - Single sensor: *dist, twin, thou, lamp*
  - Multiple sensors: *intv*
- Intra-set correlation scores mostly low, which indicate low quality PRNU extraction
- Unknown factors that lower PRNU quality



G. Bloy. “Blind Camera Fingerprinting and Image Clustering”. In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* (2008).



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Thank you!