

FORENSICS OF FRONT CAMERA ACQUISITIONS

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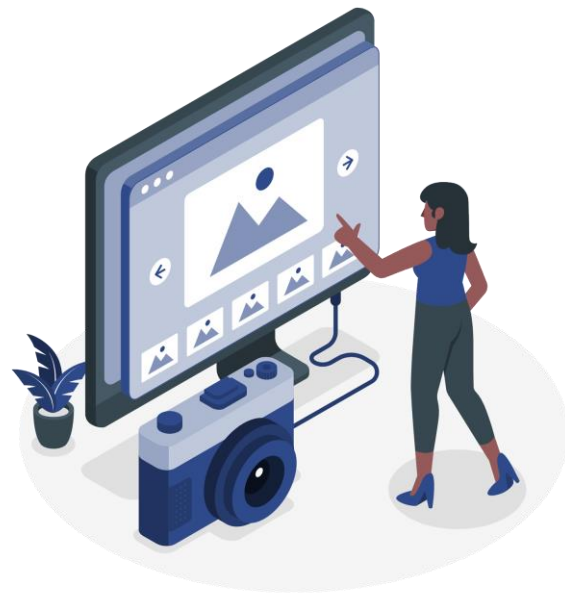




TABLE OF CONTENTS

01. Camera source
identification

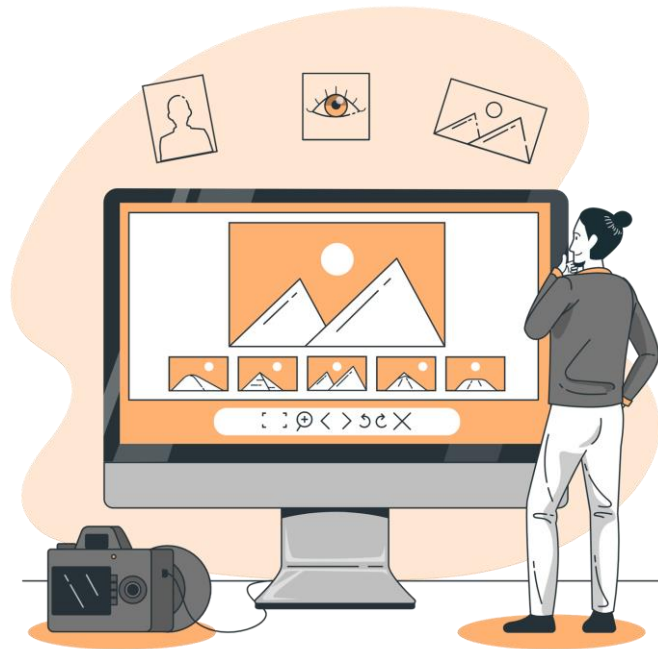
02. CNN-based fast source
device identification

03. Live demo

04. Outlook

01.

Camera source identification



Camera source identification

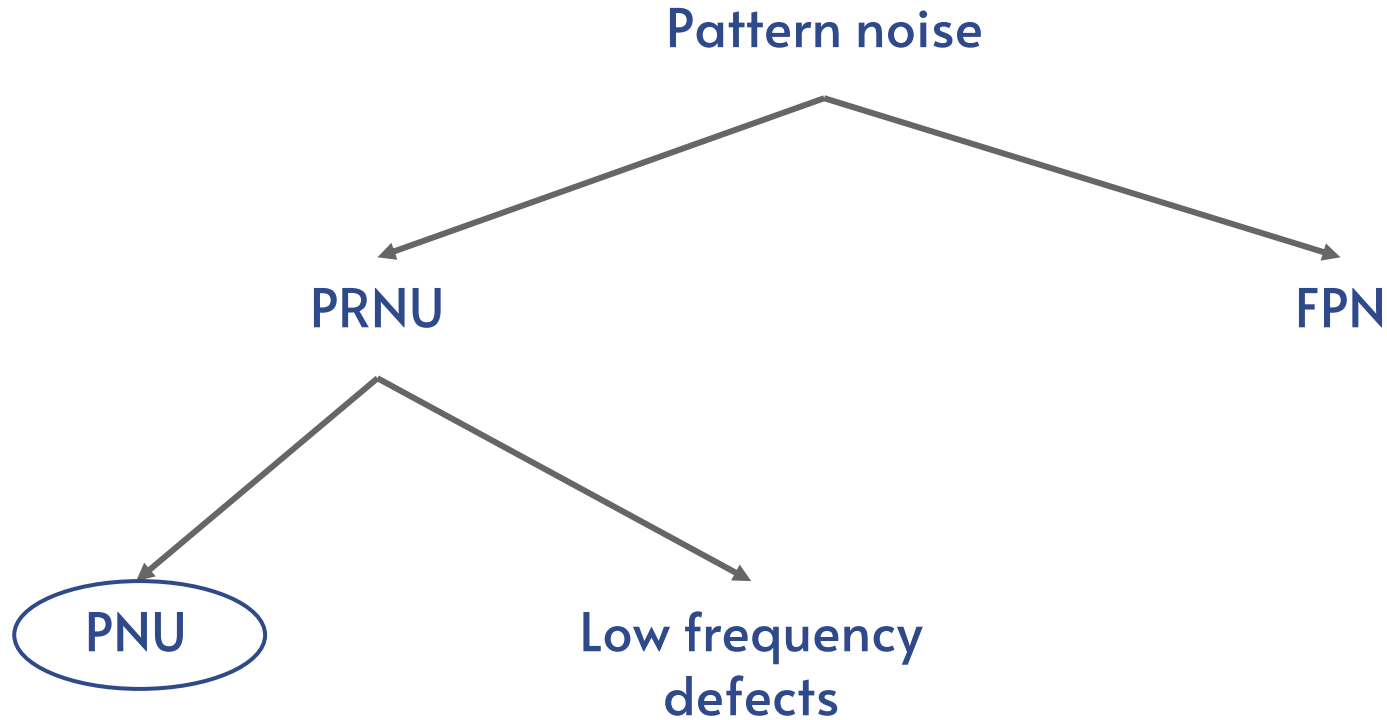
Source identification allows to trace back the origin of an image

It can be used to:

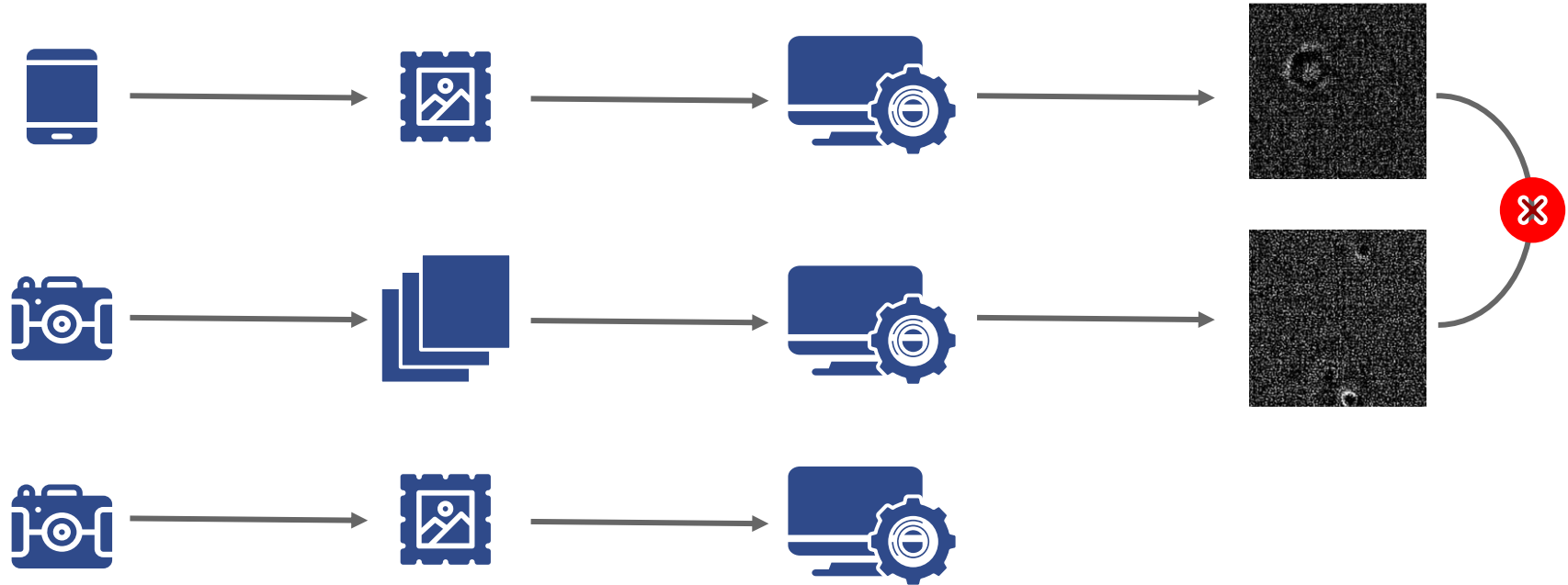
- *Claim intellectual property*
- *Reveal the authors of illicit materials.*



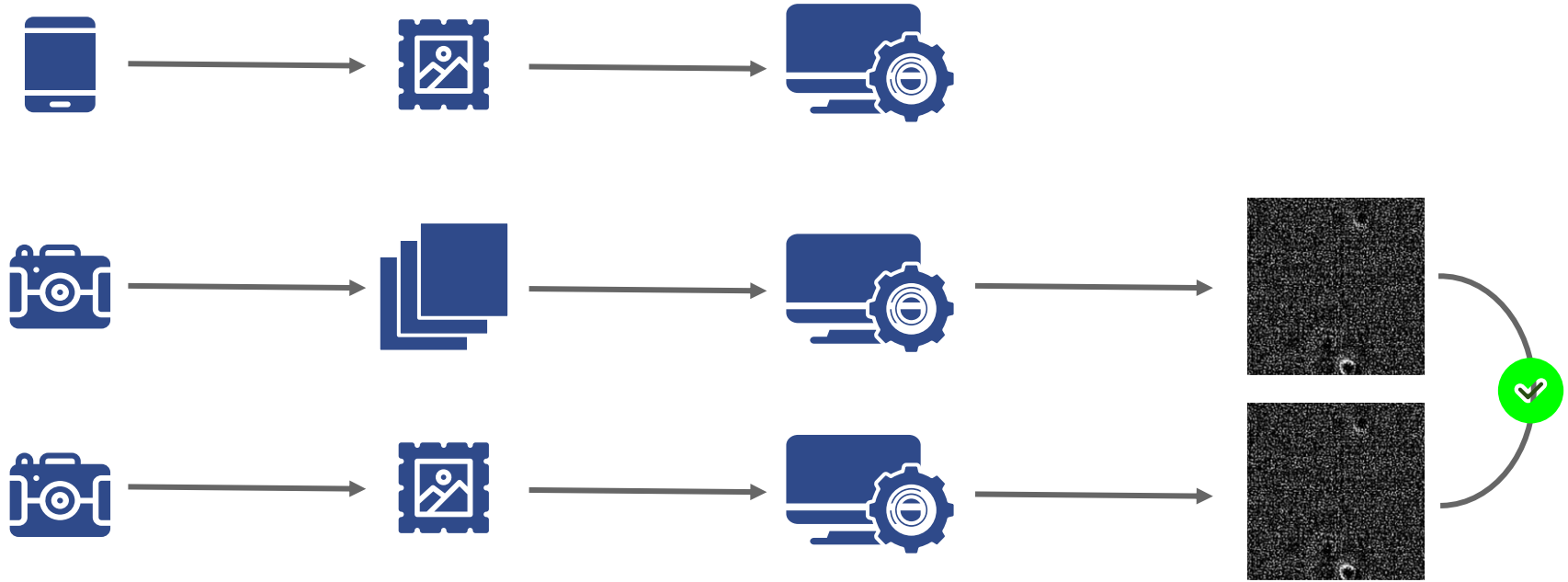
Digital camera identification from sensor pattern noise



Digital camera identification from sensor pattern noise



Digital camera identification from sensor pattern noise



Digital camera identification from sensor pattern noise

- PRNU extraction:

$$n^{(k)} = p^{(k)} - F(p^{(k)})$$

$$P_c = \frac{\sum_{k=0}^N n^{(k)}}{N}$$

- Noise residual of candidate image:

$$n^c = p^c - F(p^c)$$

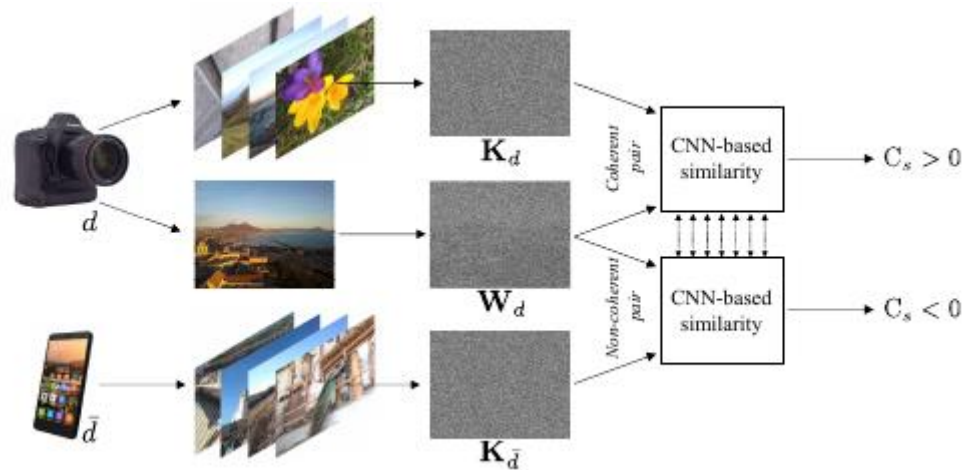
02.

CNN-based fast
source device
identification



CNN-based fast source device identification

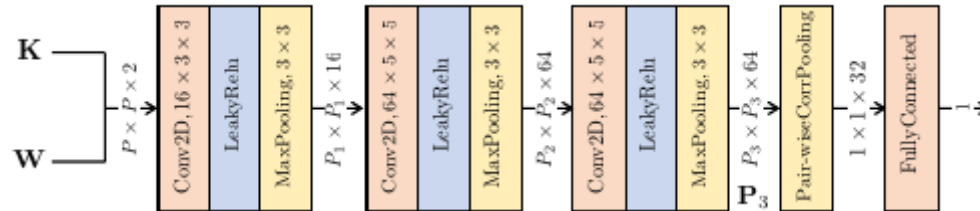
The authors proposed a 2-channel-based *CNN* that learns a way of comparing camera fingerprint and image noise at patch level



CNN-based fast source device identification

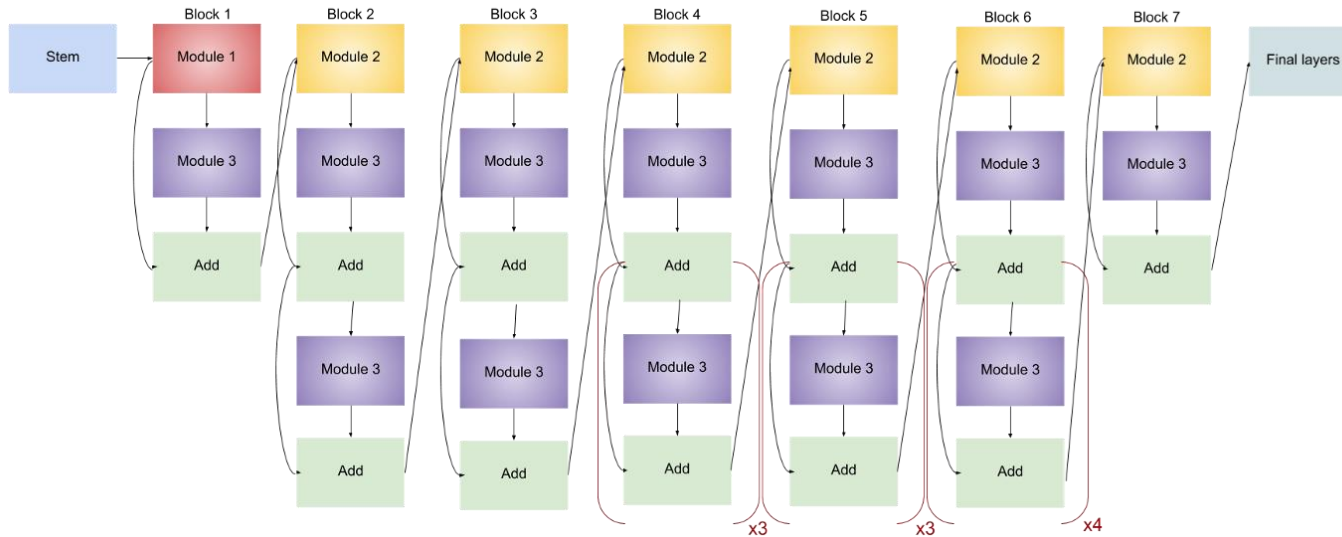
PCN

The architecture is drawn using 3 convolutional layers. Then, a pair-wise correlation pooling layer and a fully connected layer follow to obtain a single score C_s



CNN-based fast source device identification

EFFB2



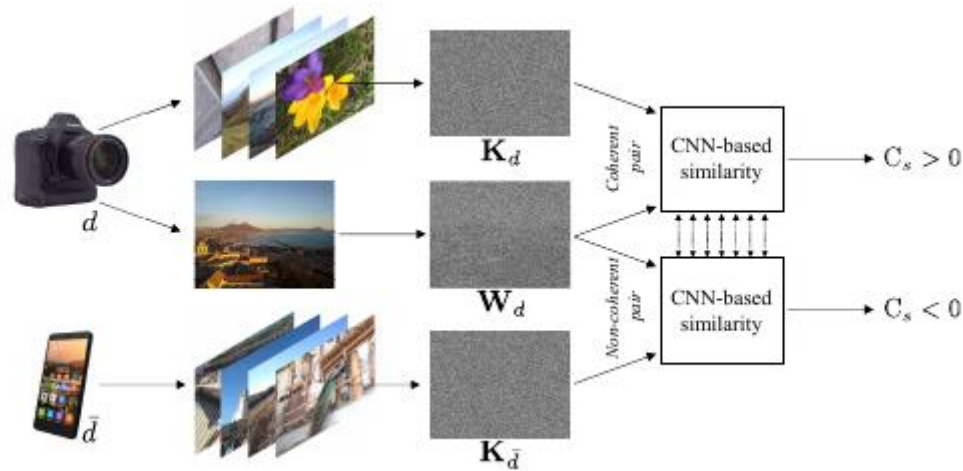
CNN-based fast source device identification

Network training

Batch size = $2 * D$

1 residual noise for each device

Paired with coherent PRNU and non-coherent PRNU



CNN-based fast source device identification

Tests

BACKBONE



PCN and EfficientNet

DATASET



VISION and Frontal
camera acquisitions
of personal devices

BASELINE



Peak to correlation
energy (PCE)

CNN-based fast source device identification

Tests | Datasets

VISION

35 different cameras
1750 flat images
1400 natural images



CNN-based fast source device identification

Tests | Datasets

VISION

35 different cameras
1750 flat images
1400 natural images



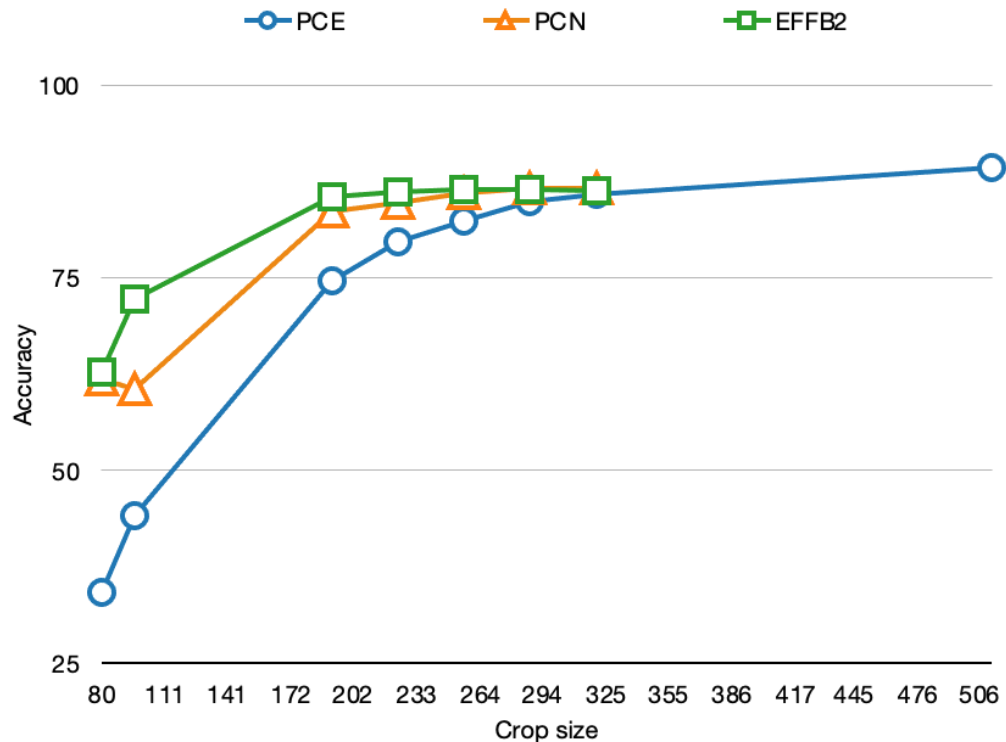
FRONT CAMERA

11 different cameras
550 flat images
440 natural images



CNN-based fast source device identification

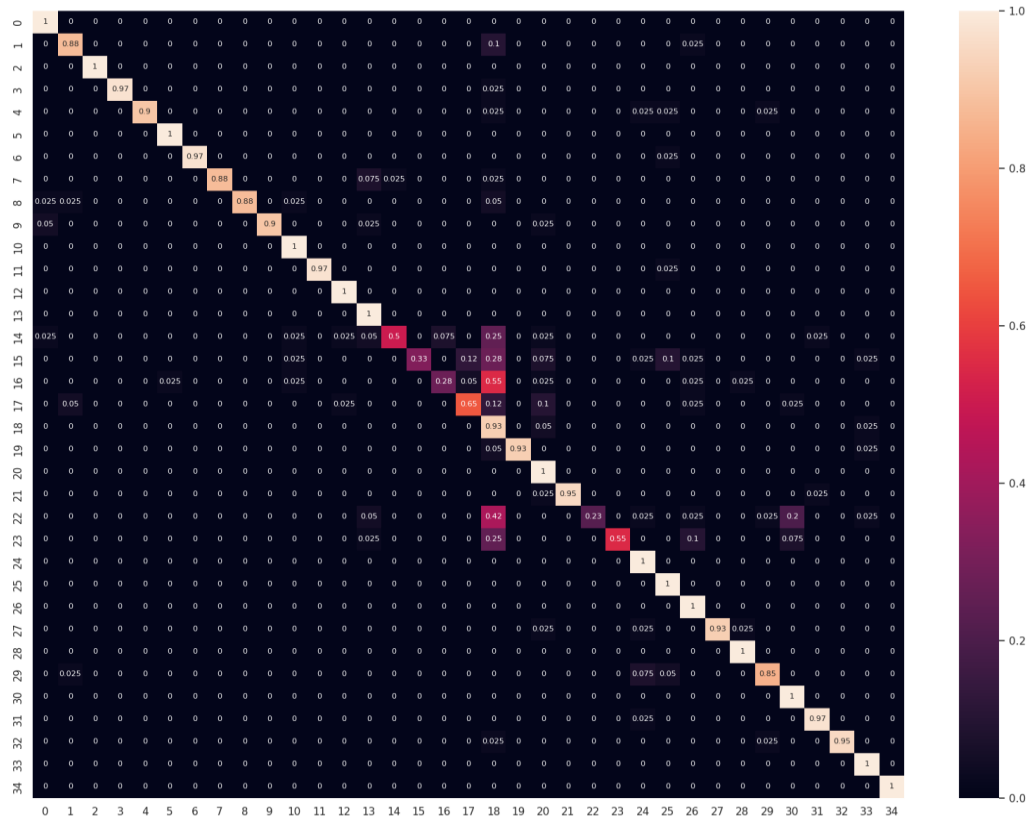
Results - VISION



Heatmap visualization of the correlation matrix for 34 variables. The color scale ranges from 0.0 (dark purple) to 1.0 (dark red). The matrix is symmetric, with the diagonal elements all equal to 1.0. The variables are numbered 0 to 34 on the x-axis and y-axis. The color bar on the right indicates the correlation values from 0.0 to 1.0.

CNN-based fast source device identification

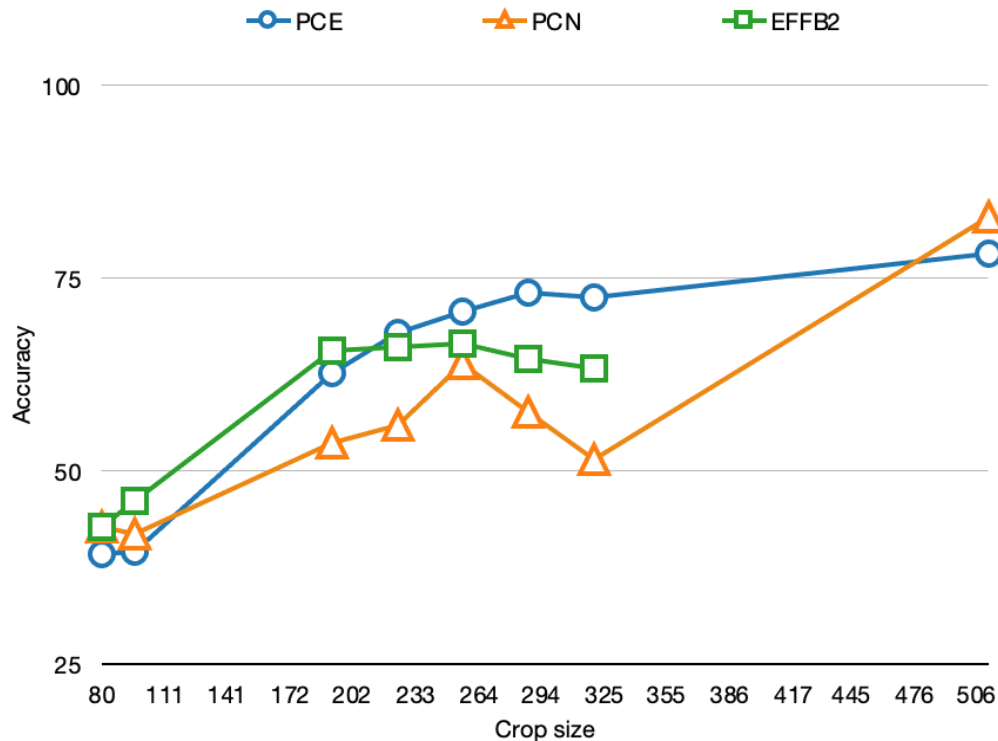
Results - VISION - PCN



Heatmap visualization of the correlation matrix for 34 variables. The color scale ranges from 0.0 (dark purple) to 1.0 (light yellow). The diagonal elements are all 1.0. The matrix is symmetric. The variables are numbered 1 to 34 on the x-axis and y-axis. The heatmap shows a block-like structure with some high correlations (yellow) and many low correlations (dark purple).

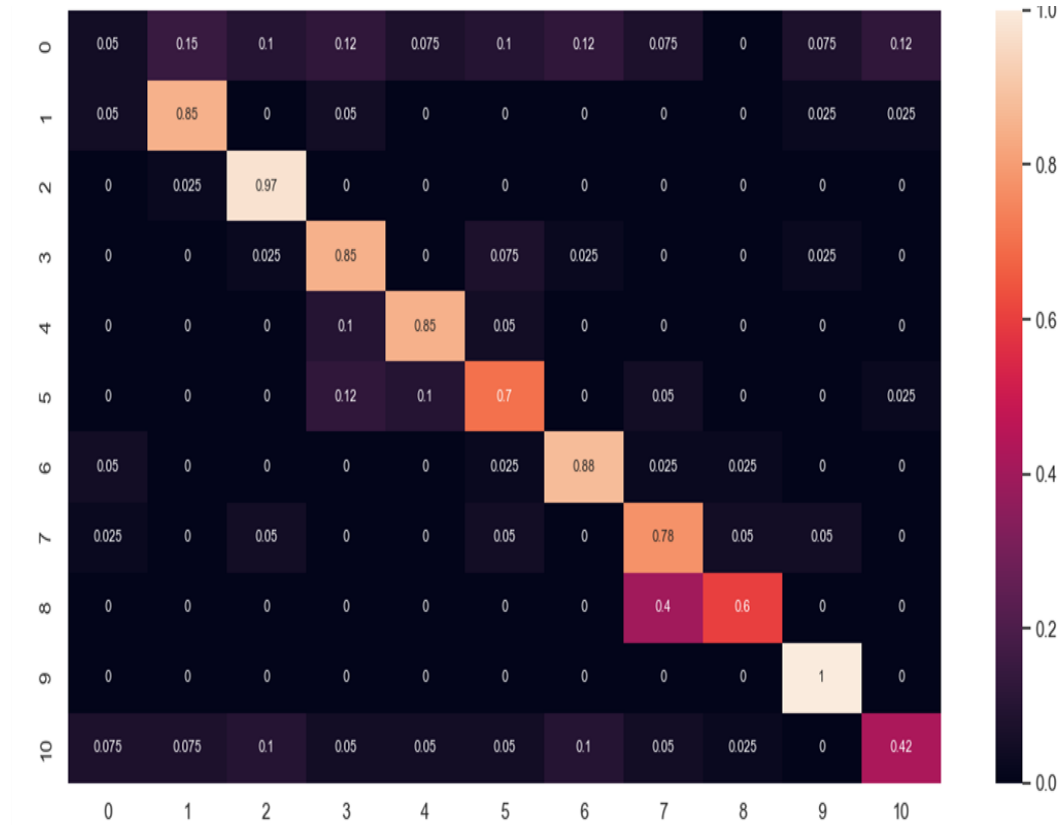
CNN-based fast source device identification

Results - Frontal Camera



CNN-based fast source device identification

Results - Frontal Camera - PCE



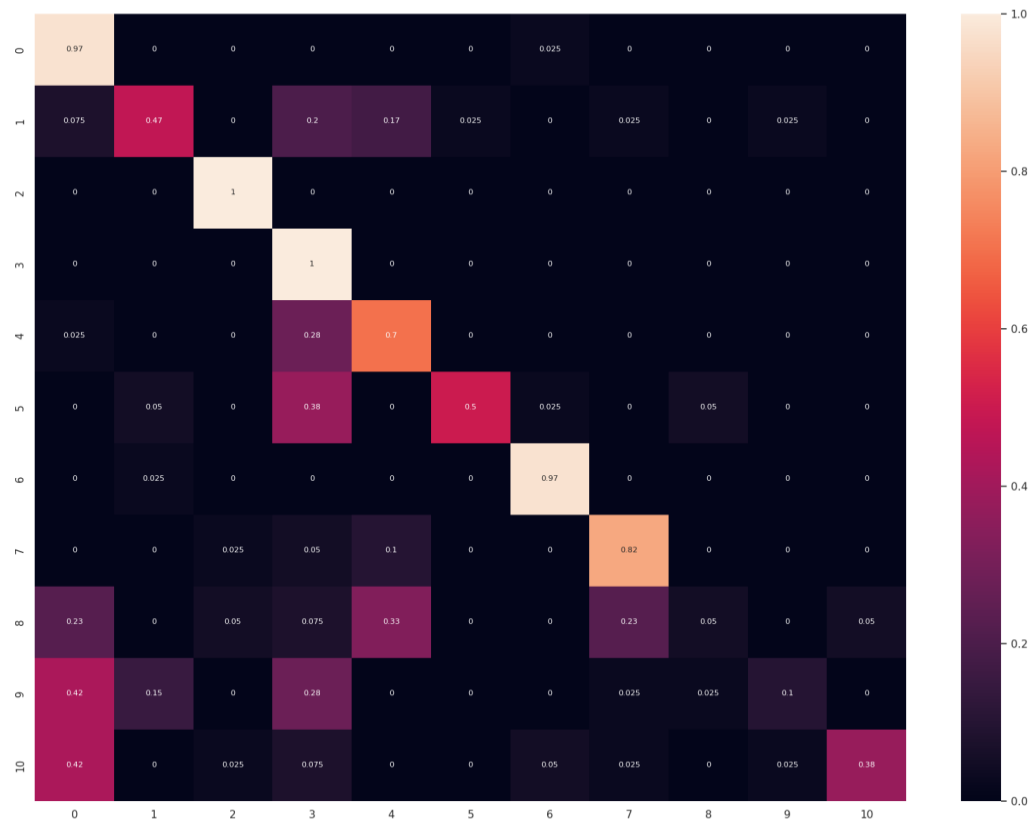
CNN-based fast source device identification

Results - Frontal Camera - PCN



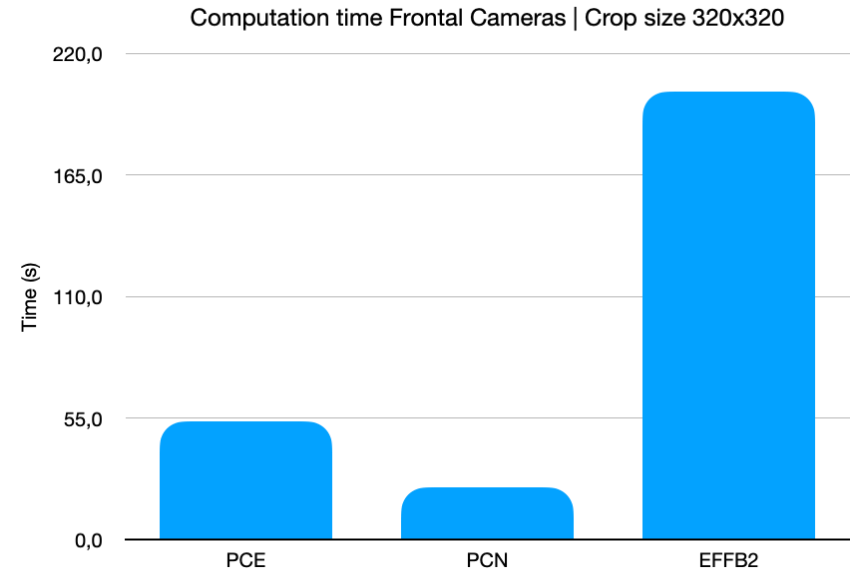
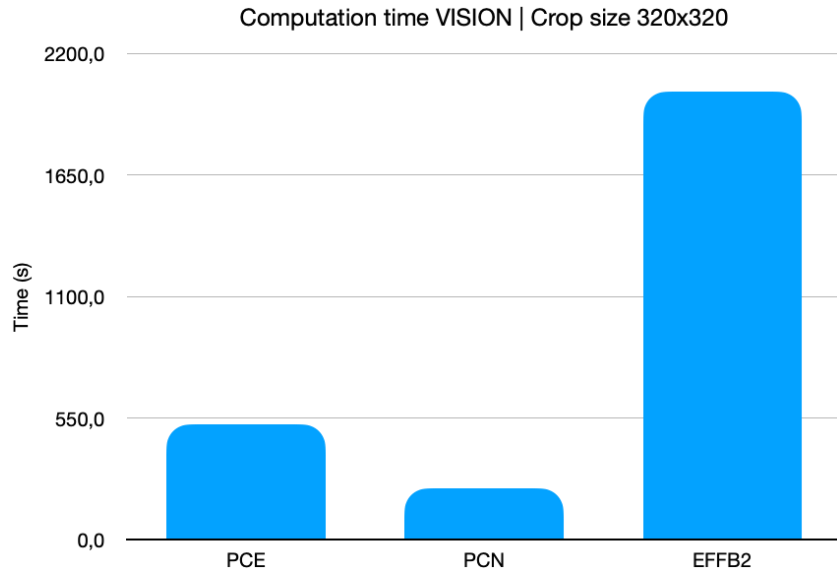
CNN-based fast source device identification

Results - Frontal Camera - EFFB2



CNN-based fast source device identification

Results - Computation time



03.

Live demo



04.

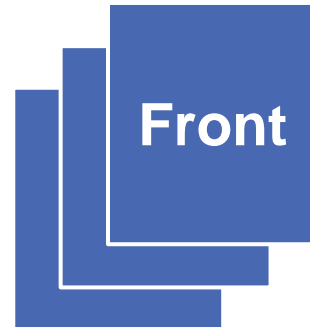
Outlook



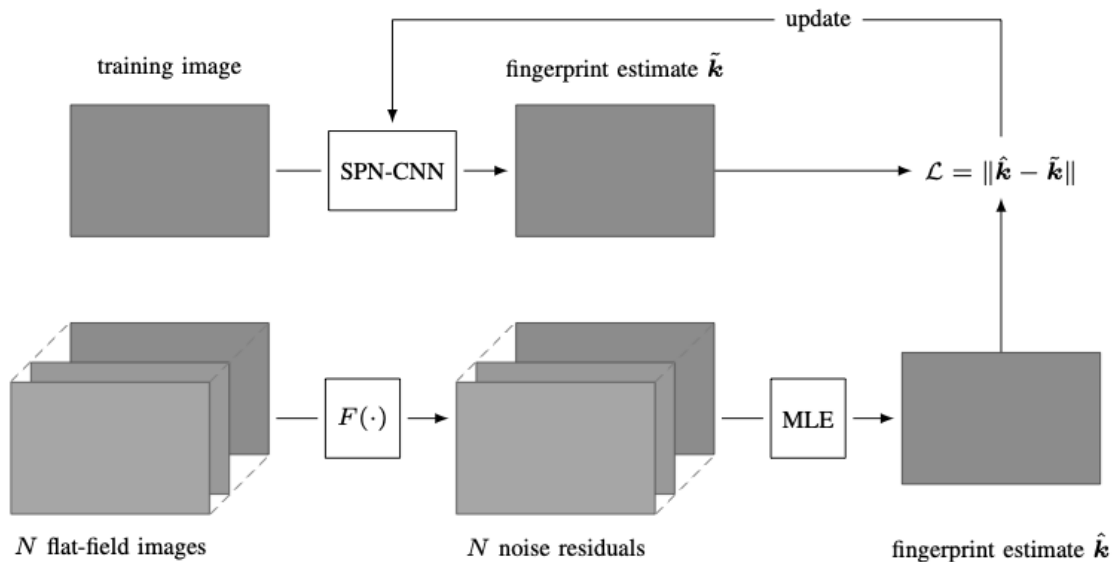
Outlook



+



Outlook



Outlook

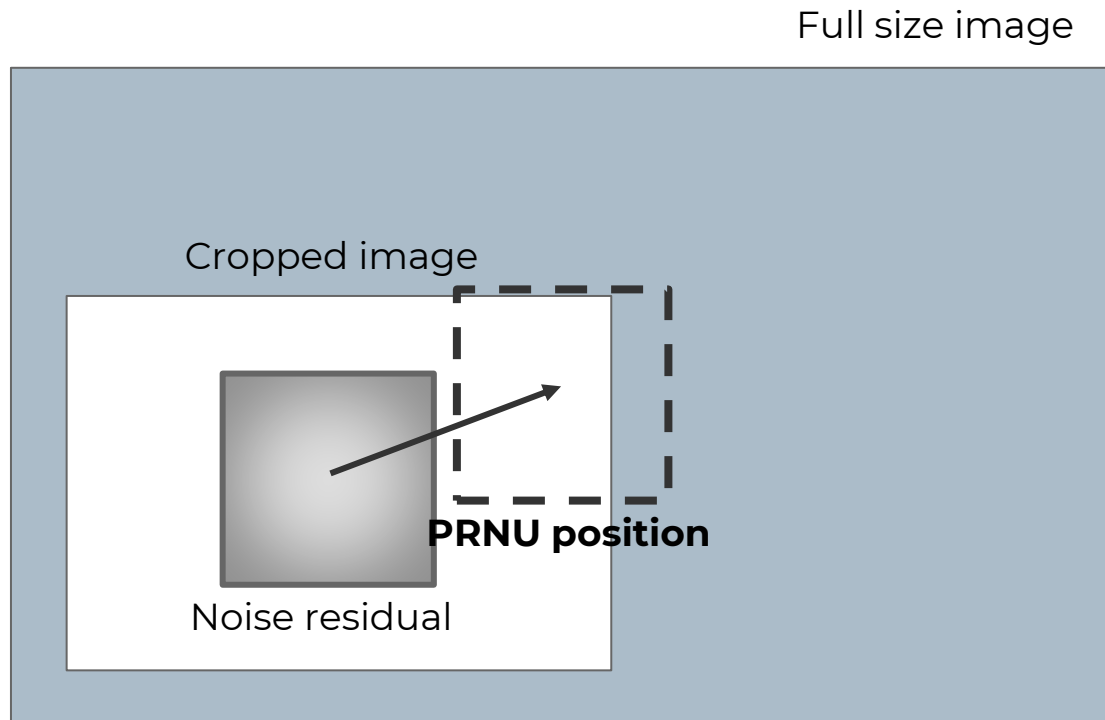
Full size image

Cropped image



Noise residual

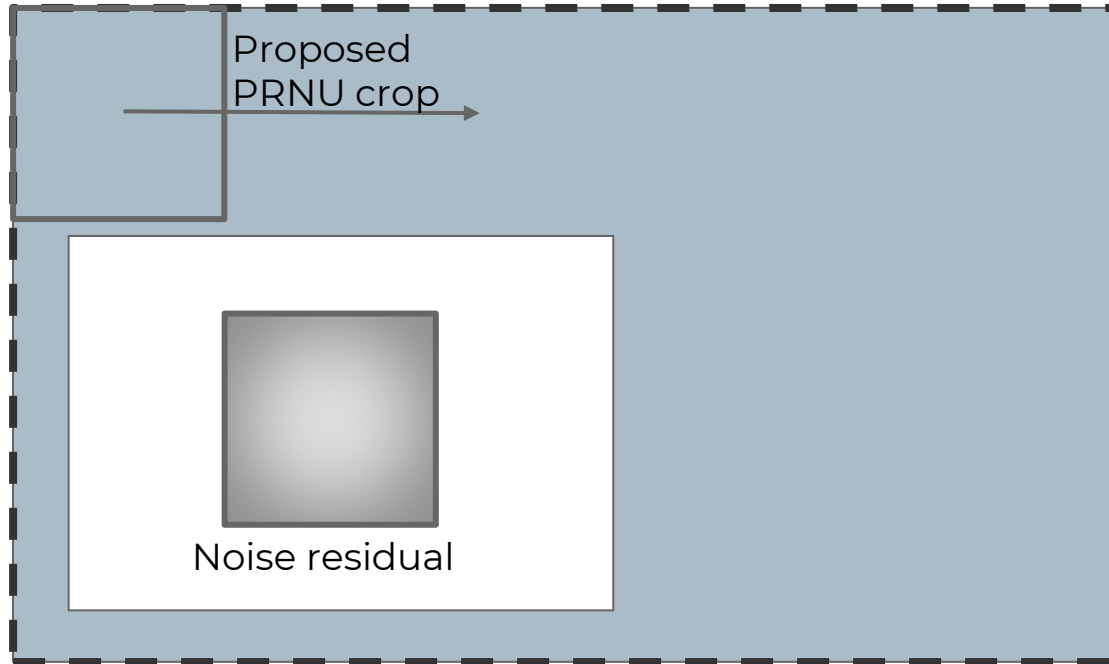
Outlook



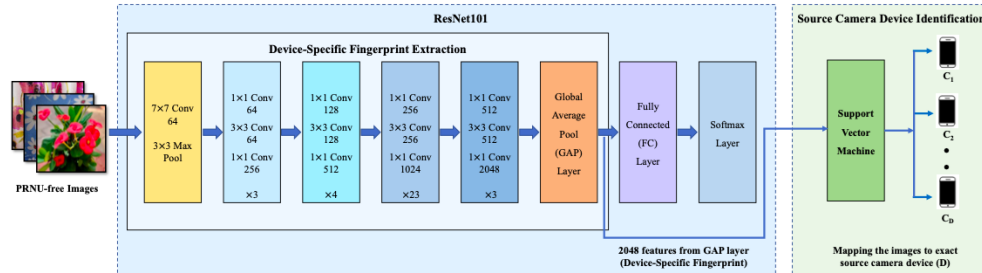
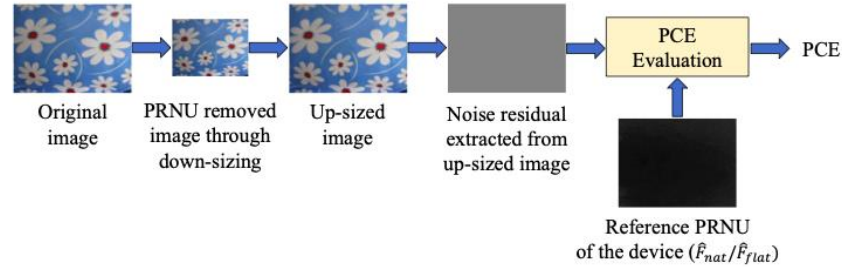
Outlook

Full size PRNU

Full size image



Outlook





THANK YOU

Alberto Casagrande
Alessio Belli
Joy Battocchio
Davide Guidolin



APPENDIX

VISION

```
0 Apple_iPad2_0
1 Apple_iPadMini_0
2 Apple_iPhone4_0
3 Apple_iPhone4s_0
4 Apple_iPhone4s_1
5 Apple_iPhone5_0
6 Apple_iPhone5_1
7 Apple_iPhone5c_0
8 Apple_iPhone5c_1
9 Apple_iPhone5c_2
10 Apple_iPhone6Plus_0
11 Apple_iPhone6_0
12 Apple_iPhone6_1
13 Asus_Zenfone2Laser_0
14 Huawei_Ascend_0
15 Huawei_Honor5c_0
16 Huawei_P8_0
17 Huawei_P9Lite_0
18 Huawei_P9_0
19 LG_D290_0
20 Lenovo_P70A_0
21 Microsoft_Lumia640LTE_0
22 OnePlus_A3000_0
23 OnePlus_A3003_0
24 Samsung_GalaxyS3Mini_0
25 Samsung_GalaxyS3Mini_1
26 Samsung_GalaxyS3_0
27 Samsung_GalaxyS4Mini_0
28 Samsung_GalaxyS5_0
29 Samsung_GalaxyTab3_0
30 Samsung_GalaxyTabA_0
31 Samsung_GalaxyTrendPlus_0
32 Sony_XperiaZ1Compact_0
33 Wiko_Ridge4G_0
34 Xiaomi_RedmiNote3_0
```

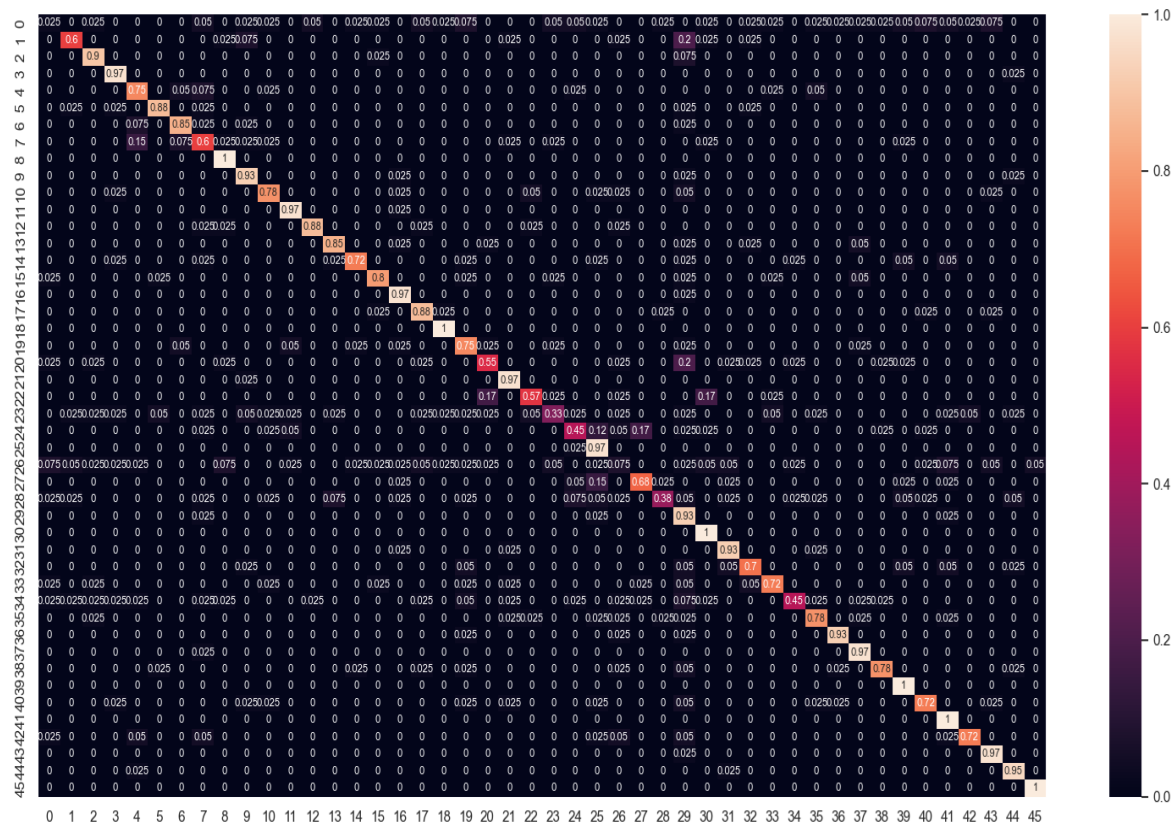
FRONTAL CAMERA

```
0 Acer_AspireE5_0
1 Apple_MacBookAir2018_0
2 Apple_MacBookAir_0
3 Apple_iPadAir3_0
4 Apple_iPhone11_0
5 Apple_iPhone13_0
6 Apple_iPhoneX_0
7 Asus_VivoBookPro_0
8 HP_Laptop15_0
9 Huawei_P20Lite_0
10 Redmi_Note7_0
```

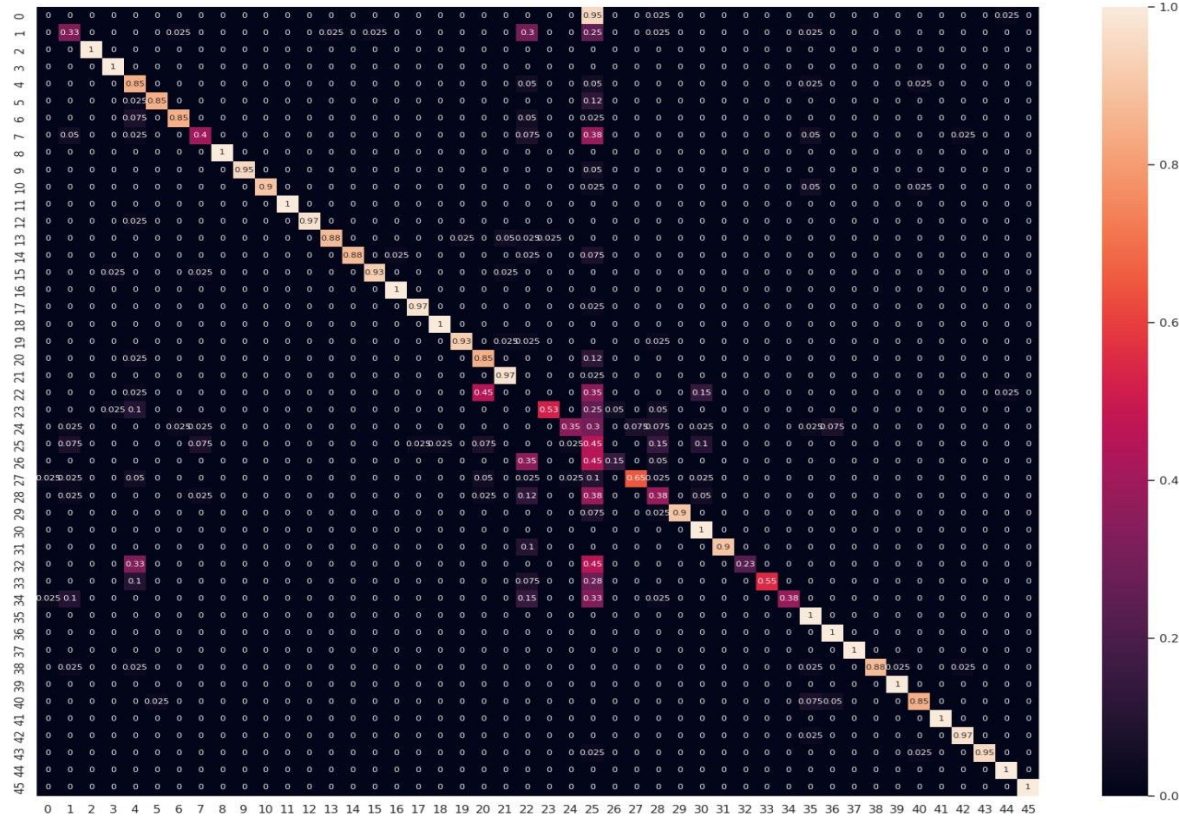
CNN-based fast source device identification

Results - Frontal Camera + VISION - PCE

Crop size → 256x256
Accuracy → 77.4



Crop size → 256x256
Accuracy → 78.2



CNN-based fast source device identification

Results - Frontal Camera + VISION - EFFB2

Crop size → 256x256
Accuracy → 79.1

