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## Source camera identification using Photo Response Non-Uniformity on WhatsApp

Christiaan Meij, Zeno Geradts\*

Netherlands Forensic Institute, The Netherlands

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## ABSTRACT

The Photo Response Non-Uniformity pattern can be a method for identification for an individual camera and is often present in digital footage. Therefore, the PRNU-pattern is also called the fingerprint of the camera. This pattern can be extracted and used to identify the source camera with a high likelihood ratio. This can be useful in cases such as child abuse or child pornography. In this research a 2nd order (FSTV) based method is used to extract the PRNU-patterns from videos of ten different mobile phone cameras. By calculating the Peak to Correlation Energy the PRNU-patterns of the natural videos are compared to the PRNU-patterns of the reference flat field videos of each camera to identify the source camera. This has been done for the original videos and the transmitted videos by WhatsApp for Android and IOS to determine if source camera identification by using PRNU is possible when videos are transmitted by WhatsApp. Also the PRNU-patterns of the natural videos are compared to each other to determine the possibility to find out if videos originate from the same source. With most cameras tested the method provides a high likelihood ratio, however for each case a validation of the method is necessary with reference cameras of the same model and type if used in casework. With videos transmitted by the IOS version of Whatsapp the source camera identification was not possible anymore.

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## Introduction

A Swedish woman was being sexual abused for hours by three armed men. The abuse was broadcasted on Facebook Live and was being watched by almost two hundred people. At first the viewers thought it was a joke but later on one of the viewers called the police. The police arrested the three abusers what also was shown on the live stream (Daileymail, 2017). Recently crime-related footage is more common broadcasted live.

When digital footage is crime-related it can be useful to identify the source camera. In the above example the suspects were caught in the act. But when for example a suspect denies that footage of child pornography, which was found on his computer, is manufactured by him, the only charge against him could be the procession of child pornography. When the camera of the suspect can be identified with a high likelihood ratio as the source camera of the video, the suspect can also be charged for manufacture of child pornography.

To identify the source of the digital footage the Photo Response Non-Uniformity (PRNU) pattern can be extracted from the footage and needs to be compared with the PRNU-pattern of the disputed camera. The PRNU-pattern is originating from the camera sensor and therefor always present in footage taken with that camera. The PRNU-pattern is often unique for a specific camera and therefore also called the fingerprint of a camera (Scheelen and van der Lelie, 2012) At the Netherlands Forensic Institute validation of PRNU in casework is conducted by using a same model and type camera to determine how identifying the pattern is (Nederlands Forensisch Instituut, 2010; Houten and Geradts, 2009).

With the popularity of social media a lot of digital footage is being uploaded with these social media. To relieve the network and increase the uploading or sending speed, social media often compresses the digital footage. Due to lossy compression the quality of the footage will drop what will affect the PRNU-pattern. Therefore research is needed to see if it is still possible to link a video to his source when it was uploaded on social media. In this paper we will take a look at WhatsApp. The main goal is to determine if it is still possible to identify the source of videos that are transmitted by WhatsApp. Also the possibility to determine if videos originate

\* Corresponding author.

E-mail address: [geradts@uva.nl](mailto:geradts@uva.nl) (Z. Geradts).

from the same source after they are transmitted by WhatsApp will be investigated.

## Material and methods

### Cameras

In this research videos of 10 different cameras are used. Most of the videos have a resolution of  $1920 \times 1080$  pixels. Only the videos of the Samsung Galaxy Grand Prime are taken with a resolution of  $1280 \times 720$  pixels. The used cameras are shown in Table 1.

For each camera three videos are used. Two natural videos (one from an outside situation and one from an inside situation) and one reference flat field video from a grey surface. All videos were taken with the rear camera in portrait mode.

### PRNUCompare 2.2

To extract and compare the PRNU-patterns the software PRNUCompare version 2.2 is used. This software is developed by the Netherlands Forensic Institute and is used for source camera identification (Nederlands Forensisch instituut, 2010). Four different filters can be chosen to extract the PRNU-pattern: 4th order extraction filter, wavelet (daubechies), wavelet (coiflet) and the 2nd order (FSTV) extraction filter. In this research the 2nd order (FSTV) extraction filter is used, since it provides better results for video (Brouwers and Mousa, 2017) compared to the other methods. The “frame averaging” is another parameter that can be set before extracting the PRNU-pattern.

### Original videos

To determine if it is still possible to identify the source camera of a video after being transmitted by WhatsApp 2.17.79 (Android) and 2.17.20 (IOS), we first need to know if it is possible to identify the source camera of the original videos of the investigated cameras. Therefore the PRNU-patterns of the two natural videos and the flat field video of each camera are extracted. The comparison between the two natural videos of camera A and the flat field video of the same camera A delivers the PCE of the two matches. The comparison between the two natural videos of camera A and the other flat field videos not from camera A will deliver the PCE of the multiple mismatches. Only the highest mismatch will be shown in the results.

After the source camera identification the possibility to determine if videos originate from the same source before they are transmitted by WhatsApp 2.17.79 (Android) and 2.17.20 (IOS) is investigated. The PRNU-patterns of all the original natural indoor videos 1 (NA1) are compared with all the original outdoor natural videos 2 (NA2). The comparison between the original natural video 1 (NA1) from a camera and the original natural video 2 (NA2) from

the same camera will deliver the PCE of the match for each camera. The comparison of the original natural video 1 from a camera and the original natural videos 2 of the other cameras will deliver the PCE of the multiple mismatches. Only the highest mismatch will be shown in the results.

Of the used cameras it is determined that the PRNU is individualizing for the individual camera of brand and model, since we have reference images of same brand and model and different cameras.

### WhatsApp

#### Compression WhatsApp

In this research two different versions of WhatsApp are used: “WhatsApp version 2.17.79 for android and WhatsApp version 2.17.20 for IOS”. The following methodology will be executed for both WhatsApp versions. At first we will take a look at the influence of the compression on the videos by sending them with WhatsApp. This will be done by sending three videos from different cameras with different resolution, extension and frame rate. The natural videos 1 (NA 1) from the Samsung galaxy grand prime, Microsoft Lumia 950 and the Apple iPhone 6 are used. To exclude the influence of the transmitting method, the videos are transmitted in all the different ways that are possible. In Table 2 below, the different methods of sending are shown.

The videos will be transmitted using the mobile phones and WhatsApp versions showed in Table 3 below.

Also the influence of the WhatsApp version of the mobile phone that receive and forward the videos will be investigated. Therefore every video is transmitted as following:

- IOS to IOS
- IOS to Android
- Android to Android
- Android to IOS

Every action will be executed in three fold to exclude the variability within one method of sending.

After the research on the compression, all the videos are being transmitted using the sending method that delivers different compression. If resolution changes the original flat field videos will

**Table 2**  
Methods to transmit and forward a video with WhatsApp.

Transmit	Share from save location with WhatsApp Add a file to the chat with WhatsApp
Forward	Share from save location with WhatsApp Add a file to the chat with WhatsApp Share the received video with WhatsApp (only possible for WhatsApp 2.17.79 for Android) Forward the received video with WhatsApp

**Table 1**  
Used cameras.

Camera	Model	Resolution	Frame rate (FPS)	Extension
01	Samsung Galaxy S5 Active	$1920 \times 1080$	29	MP4
02	Samsung Galaxy Grand Prime	$1280 \times 720$	29	MP4
03	Samsung Galaxy S6 edge	$1920 \times 1080$	29	MP4
04	Huawei P8 lite	$1920 \times 1080$	29	MP4
05	Huawei G8	$1920 \times 1080$	29	MP4
06	Microsoft Lumia 950	$1920 \times 1080$	30	MP4
07	HTC One A9	$1920 \times 1080$	30	MP4
08	Sony Xperia Z5 Premium	$1920 \times 1080$	29	MP4
09	LG G4	$1920 \times 1080$	30	MP4
10	Apple iPhone 6	$1920 \times 1080$	29	MOV

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