Assignment 2: Photo Response Non Uniformity (PRNU) estimation

Step 1: estimate PRNU fingerprint of Camera A

Gather a set of N≥15 uncompressed images (PNG, TIFF, TIF or BMP formats) that have been acquired with a known Camera A. Note that:

- Images should be *flat-field*, i.e. their visual content should have a low variance. This is the case, for example, of blank walls or cloudless sky. However images must not contain too many saturated pixels (i.e., whose value is 255)
- For sake of simplicity, all the images should have the same size. If this is not true, make sure to work on a portion of image whose size is common to all the data set (for example, consider 1024x1024 sub-images cropped by starting from the top-left corner)

Use the above images to estimate the true fingerprint of camera A. Within a loop:

- Read each image (*imread*) and convert it to grayscale (*rgb2gray*)
- Convert each grayscale image to double precision (*double)*
- Compute each image's residuals by means of a denoising filter (for example Wienner2 filter). Feel free to look for more accurate filters **(optional bonus)**:

$$W_I = I - F(I) \tag{1}$$

Use the residuals and the image to compute its contribution to the PRNU fingerprint:

$$\frac{W^{(i)} I^{(i)}}{(I^{(i)})^2} \tag{2}$$

Accumulate each contribution to obtain the final estimate of the PRNU fingerprint

$$\hat{K} = \frac{\sum_{i=1}^{N} W^{(i)} I^{(i)}}{\sum_{i=1}^{N} (I^{(i)})^2} \tag{3}$$

Save the PRNU fingerprint matrix

Step 2: perform source camera identification

Gather a set of M≥15 JPEG compressed images that have been acquired by the Camera A, that is the same camera that was used in Step 1 to estimate the PRNU fingerprint.

- Images do not need to be flat-field. On the contrary, they should depict natural scenes, such as landscapes, buildings, people or objects
- JPEG compression should be very high quality, e.g. not less than 90
- Images must not undergo any kind of processing (filtering, enhancement, etc.)

Gather K≥5 images from another camera, say Camera B. It would be interesting to consider images that have been acquired with a camera that is the same model of Camera A (two Iphones, for example)

- For sake of simplicity, consider images of the same size of those used to estimate Camera A's fingerprint in Step 1. If images were cropped to 1024x1024 in Step 1, crop these images in the same way

Gather K≥5 high quality JPEG images from unknown cameras from the Web

- For sake of simplicity, download images of the same size of those used to estimate Camera A's fingerprint in Step 1. If images were cropped to 1024x1024 in Step 1, crop these images in the same way

Within a for loop, compute the residual of all the above images as in Step 1 (same denoising filter)

Compute the correlation between each image and the PRNU fingerprint estimation (e.g., corr2). In other words, perform the attribution test:

$$\rho = corr(W_J, \hat{K}J) \tag{4}$$

Gather all these values into an array.

Plot all the correlation values and verify whether:

- Correlations between PRNU fingerprint estimation and images acquired with Camera A are high
- Correlations between PRNU fingerprint estimation and images acquired with Camera B are low
- Correlations between PRNU fingerprint estimation and images downloaded from the Web (unknown source) are low.

If needed use images from 2024_DF_Lab2_Supplements_Dataset.zip (*_train for Step 1; *_test for Step 2).

Complete all results into report and submit it (together with your code) to "Digital forensics" course moodle.