CNN-BASED DETECTION OF GENERIC CONTRAST ADJUSTMENT WITH JPEG POST-PROCESSING

Department of Information Engineering and Mathematics, University of Siena, Italy.

Mauro Barni, barni@diism.unisi.it
Adrea Costanzo, andreacos82@gmail.com
Ehsan Nowroozi, ehsan.nowroozi@student.unisi.it
Benedetta Tondi, benedettatondi@gmail.com

Detection of contrast adjustments in the presence of JPEG post-processing is known to be a challenging task. JPEG post-processing is often applied invisibly, as JPEG is the most common image format, or it may correspond to a laundering attack, when it is purposely applied to erase the traces of manipulation. In this paper, we propose a CNN-based detector for generic contrast adjustment, which is robust to JPEG compression. The proposed system relies on a patch-based Convolutional Neural Network (CNN), trained to distinguish pristine images from contrast adjusted images, for some selected adjustment operators of different nature. Robustness to JPEG compression is achieved by training a JPEG-aware version of the CNN, i.e., feeding the CNN with JPEG examples, compressed over a range of Quality Factors (QFs). Experimental results show that the detector works very well under a wide range of QFs and scales well with respect to the adjustment type, yielding very good performance under a large variety of unseen tonal adjustments.

GOAL OF PROPOSED SYSTEM

- **PROBLEM**
  - Poor resilience to post-processing, in particular to JPEG compression is a problem common to most contrast enhancement detection tools.
  - Most available tools are thought to detect one very specific kind of manipulation. [1-2]

- **DETECTION TASK**
  - We look for a generic detector of contrast adjustment, that is, a detector which generalizes well to a wide variety of tonal adjustments.
  - The detector should survive weak to moderate JPEG compression.

- **GOAL**
  - We proposed a JPEG-aware CNN-based approach to detect contrast adjusted images in the presence of JPEG-material.

JPG-AWARE TRAINING FOR GENERIC CE DETECTION

We proposed a JPEG-aware CNN-based approach to detect generic contrast adjustments in the presence of JPEG-post-processing. JPEG-aware CNN training is achieved in two steps:

- **Unaware case**, the network is trained to distinguish between pristine and contrast-adjusted images.
- **Aware case**, the network is trained to distinguish between pristine and contrast-adjusted images.

METHODOLOGY

- **Algorithms used for training**
  - Adjustment operators work on the luminance channel only (RGB to HSV).
  - Applied enhancement to the luminance channel (V-channel)
  - HSV to RGB.

- **Algorithms used for testing**
  - Parameter matching and mismatching.
  - Software mismatch.

- **Asses the performance under software mismatch**
  - AutoContrast, AutoColor and Auto Tone: algorithms which operate differently on the three color channels.
  - Gamma correction: a hand-crafted smooth S-curve is applied to enhance the contrast in the midtones.
  - Brightness and Contrast: generic tools of Photoshop for enhancing and reducing brightness and contrast.
  - Histogram Equalization (HistEq).

RESULTS (I)

- **Dataset**, uncompressed, camera-native images are taken from the RASENK image database.
- **Images are divided into 64x64 patches**.
- **3106 patches per class were selected to train the CNN**.
- **2*10^5 patches were used for testing**.

The overall performance of the detector on full images is reported in the following table in terms of AUC, for both matched and mismatched processing parameters.

- **AUC for CLAHE manipulation is above 98% for QF<=95**.
- **Gamma correction works very well under a wide range of QFs and generalizes well to unseen tonal adjustments**.

RESULTS (II)

- **Software Mismatch**
  - For generating mismatched test images, we considered different operators by processing the images with adjustment tools provided by Photoshop.

EXAMPLES OF TRAINING IMAGES

- Pristine
- Gamma Corr 1.5
- Curve_S

EXAMPLES OF TESTING IMAGES – SOFTWARE MISMATCH

- Brightness +50
- Brightness +50
- Curve_S

CONCLUSIONS

We proposed a JPEG-aware CNN-based approach for detecting the contrast adjusted images in the presence of JPEG post-processing. To accomplish this task, and build a detector which works well for generic contrast adjustment, we trained the CNN with a three-class of tonal adjustments of different nature. Results show that our detector achieves good performance over a wide range of QFs and generalizes well to unseen tonal adjustments.

As further research, it would be interesting to see if the performance with respect to the most difficult cases can be improved by refining the composition of the training, i.e., the types of contrast adjustments considered and their proportions, and also the strategy adopted to fuse the results obtained on the 64x64 patches.