A Novel Detection Algorithm for Image Copy Move Forgery

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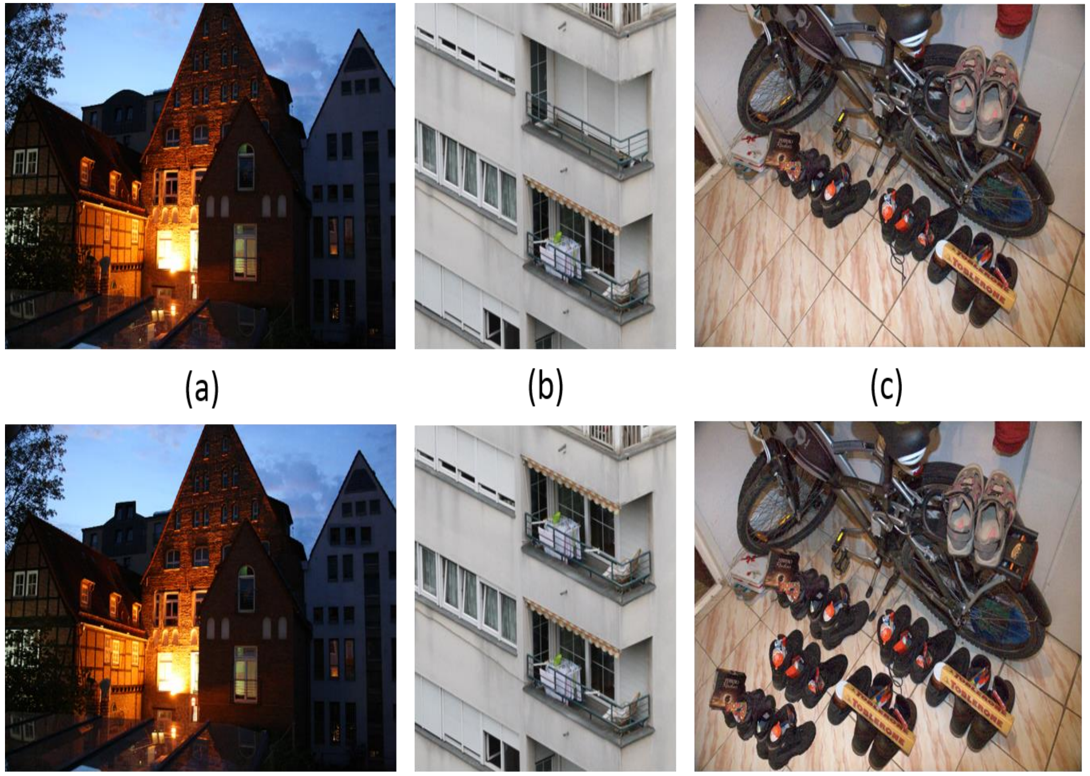
Introduction

- Images have been a powerful media of delivering and communicating information ever since their inception.
- The act of distorting and changing images has been around for a long time.
- Detecting these image forgeries has become and important problem.
  - Even more so now that we have entered the digital age.
- This paper produces a way of detecting these falsified images.

History of Image Forgeries

- People have been doing image manipulation since the beginning and these forgeries have been put to many uses. Such as
  - Journalists who want to make up their own stories
  - Photojournalists who want dramatic scenes
  - Scientists who forge or repeat images in academic papers



(a) (b) (c) (d) (e) (f)

History of Image Forgeries

- There are 4 manipulation techniques that are used on images.
  - Deletion of details: removing scene elements
  - Insertion of detail: adding scene elements
  - Photomontage: combining multiple images
  - False Captioning: misrepresenting image content.
- Copy-move is the most common operation for generating a digital image forgery
  - as a part of the image itself is copied and pasted into another part of the same image to conceal an important object or sometimes to show more than one object.
- We present an effective and robust image copy-move forgery detection algorithm based on Histogram of Orientated Gradients (HOG)

Histogram of Orientated Gradients

- HOG is a robust feature descriptor for object detection, proving highly effective in the detection of pedestrians.
- HOG is a vector-space model, where perceptual similarity is approximated by Euclidian (or cosine) distance between two HOG vectors.
- HOG appears to be a reasonably good model of perceptual similarity:
  - Intensity gradients rather than intensity directly
  - Sensitive to local but not global contrast
  - HOG is very fast to compute.

Proposed Detection Scheme

- The image is divided into overlapping blocks of a fixed-size.
- Features of each block are extracted using HOG descriptors.
- Matching similar block pairs.
- A map of duplicated regions in created.

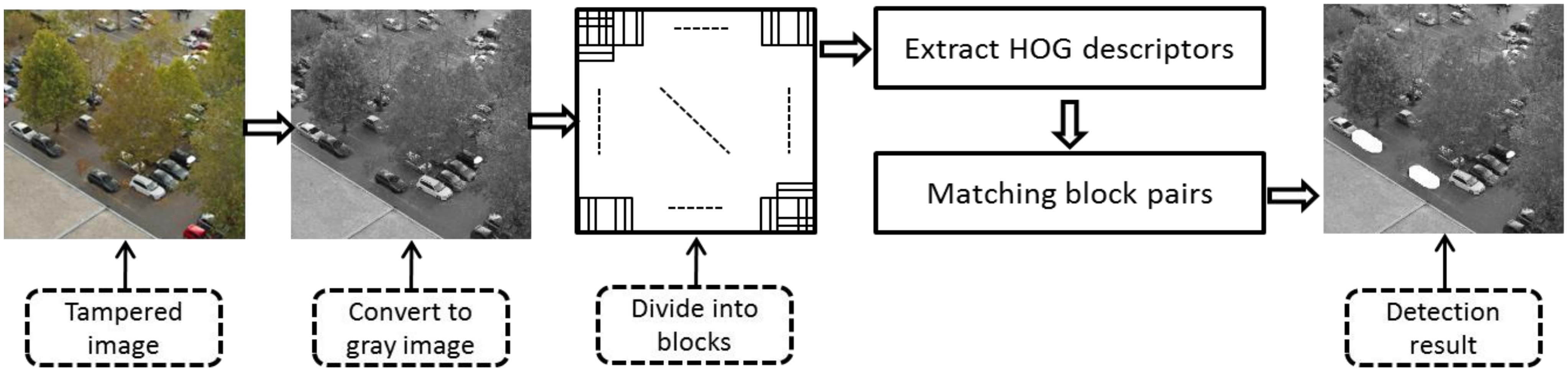


Image is Divided into Overlapping Blocks of a Fixed-Size

- RGB image is transformed into grayscale image I, according to the following formula:
  - $I = 0.299R + 0.587G + 0.114B$ (luminance component)
- To identify forged regions, the image is divided into overlapping square sub-blocks.
  - The grayscale image I of $M \times N$ is first divided into overlapping sub-blocks of $L \times L$ for the calculation of HOG descriptors. The image is then divided into $(M - L + 1) \times (N - L + 1)$ overlapping blocks.

Obtaining HOG Descriptors of the Same Size

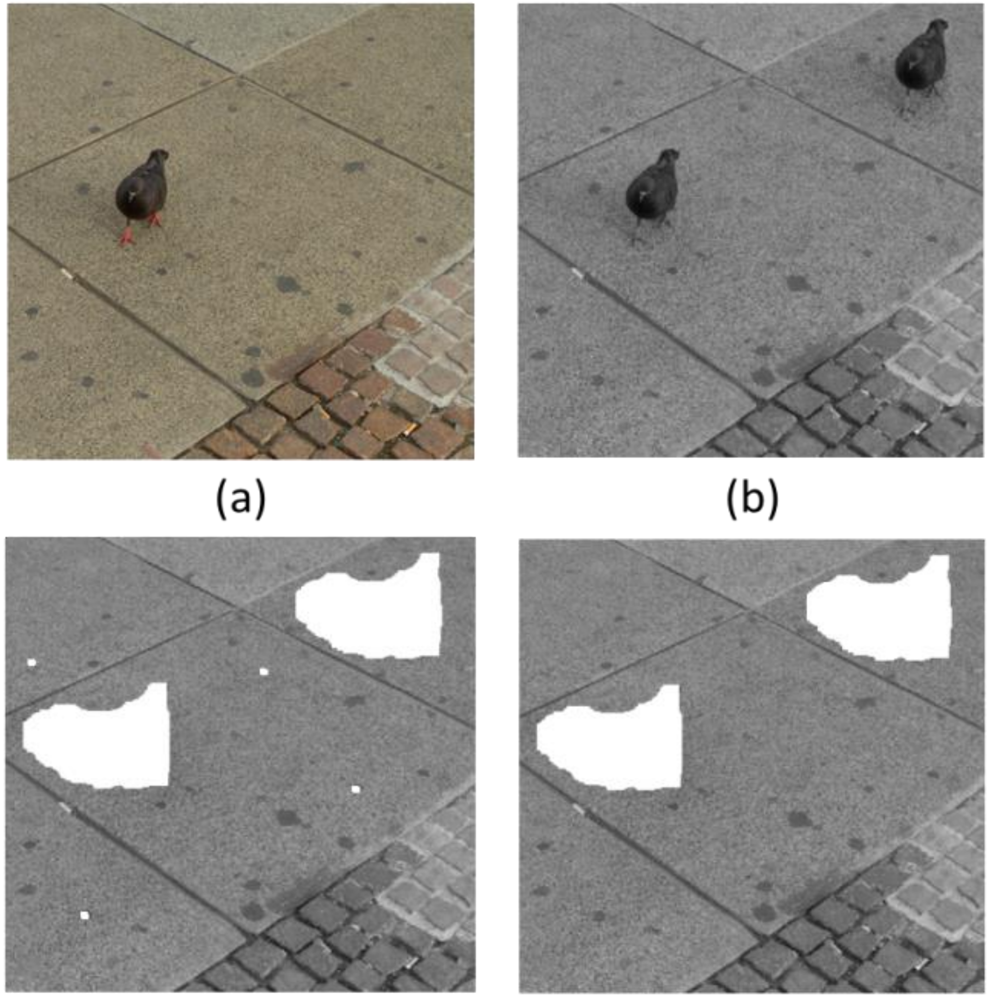
- An $L \times L$ block is represented by a 1×4 feature vector $v_L = (x_1, x_2, x_3, x_4)$. The feature dimensions of this vector are lower.
- For an image of size $M \times N$, matrix A would include $(M - L + 1) \times (N - L + 1)$ rows and 4 columns, where four represents the number of features.
- After applying HOG to each block, an HOG descriptor matrix the same size as the block is assembled to represent each corresponding block.
- The resulting cell histograms are then combined into a descriptor vector for each block, such that 4 features can be used to represent each block.

Match these HOG Features Each Other

- The similar feature vectors will be stored into the neighbor rows by lexicographical sorting.
- We search for the corresponding blocks by estimating the Euclidean distances of the feature vectors.

Post-processing of the Detection Result

- This study designed a detector to remove them as follows.
  - Suppose that the marked image is divided into n non-overlapping blocks with size 16×16.
  - If the number of "white" pixels in the block is less than 64, then all pixels in the block are regarded as belonging to the original image. Otherwise, keep the number of the white pixels and do nothing.



(a) (b) (c) (d)

Experiment Results

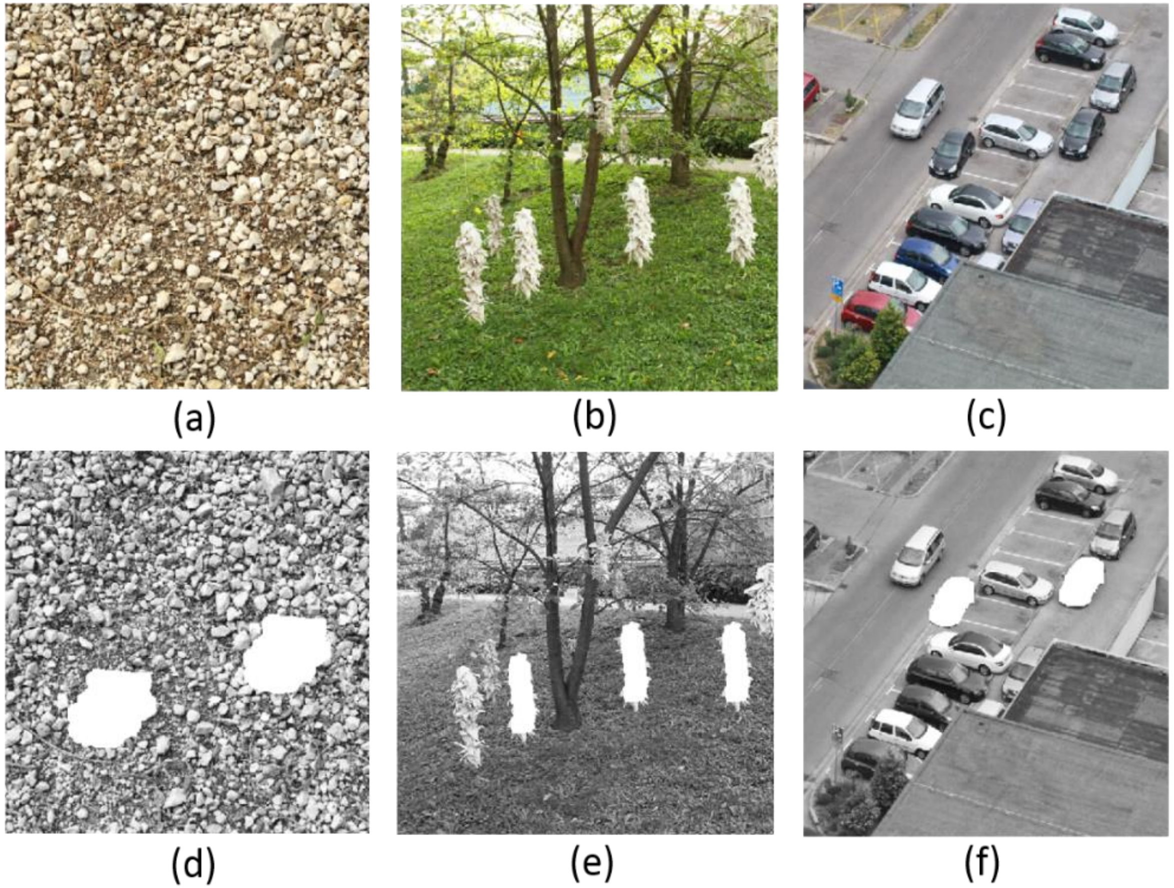
- CoMoFoD database
  - These forgery images consist of 200 png images with a resolution of 512×512 in small image category.
  - http://www.vcl.fer.hr/comofod
- Image Manipulation Dataset
  - These forgery images all have high resolution images (about 800×500 to 3200×2400 pixels) included 48 base images.
  - http://www5.cs.fau.de/research/data/image-manipulation/

Performance Evaluation

- Two evaluation criteria
  - Correct detection ratio (CDR)
    - To indicate the performance of the algorithm in correctly locating the pixels of copy-move regions in the tampered image
    - $$Fc = \frac{|\mu \cap \mu^c| + |\omega \cap \omega^c|}{|\mu| + |\omega|}$$
  - False detection ratio (FDR)
    - To reflect the percentage of pixels that the pixels detected using the proposed method did not include duplicate blocks
    - $$F_f = \frac{|\mu^c - \mu| + |\omega^c - \omega|}{|\mu^c| + |\omega^c|}$$

Effectiveness and Accuracy Test

- CoMoFoD database(all the doctored images in this experiment are without any attacks).
- The accuracy rate CDR is generally greater than 0.95 and the false positive rate FDR equals to 0.



(a) (b) (c) (d) (e) (f)

Analysis of Robustness Against Post-processing Attacks

- There are many different types of post-processing attacks, such as **translation**, **rotation**, **blurring**, **adjustment of brightness**, and **color reduction**.

Attacks		CDR	FDR
Image rotation		0.814	0.232
Images blurred (filter size)	3*3	0.994	0.003
	5*5	0.976	0.012
	7*7	0.946	0.092
color reduction (levels)	32	0.981	0.041
	64	0.986	0.029
	128	0.992	0.014
adjustment of brightness (ranges)	[0.01, 0.95]	0.995	0.006
	[0.01, 0.9]	0.992	0.011
	[0.01, 0.8]	0.983	0.025

Conclusion

- This paper proposes an effective method for detecting duplicated regions based on the histogram of orientated gradients.
- Experiment results demonstrate that the proposed algorithm is highly robust against different attacks, such as translation, rotation, blurring, adjustment of brightness, and color reduction.
- Future work should concentrate on copy-move forensics following the application of complex operations (such as rotation, scaling, JPEG compression, or a combination of them) involving multiple stages of manipulation.