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Tampering Localization in Double Compressed Images by Investigating Noise Quantization

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ABSTRACT

Noise is uniformly distributed throughout an untampered image. Tampering operations destroy this uniformity and introduce inconsistency in the tampered region. Hence, noise discrepancy is often investigated in forensic analysis of uncompressed digital images. However, noise in compressed images has got very little attention from the forensic experts. The JPEG compression process itself introduces uniform quantization noise throughout an image, making this investigation difficult. In this paper, the authors have proposed a new noise compression discrepancy model, which blindly estimates this discrepancy in the compressed images. Considering the smaller tampered region, SVM classifier was trained using noise features of test sub-images and its nonaligned recompressed versions. Each of the test sub-images was further classified using this classifier. Experimental results show that in some cases, the proposed approach can achieve better performance compared with other JPEG artefact based techniques.

KEYWORDS

Double Compression, Image Forensic, JPEG Artifacts, Noise Discrepancy, Quantization

1. INTRODUCTION

The digital image is one of the strongest tools for communication, publicity and authenticity. Piracy of the sophisticated image processing software has made image capturing, editing and distribution quicker and simpler. With these tools, even a novice user can create convincing tampering, causing a potential threat to the society. As people believe what they perceive, validation of these images is very necessary. During image tampering, an image segment is copied and pasted to it. The pasted region often undergoes pre-processing operations such as upscaling, downscaling, rotation, light adjustment and contrast stretching, etc. These pre-processing operations make tampered region fingerprint inconsistent with the untampered regions (Piva, 2013). This inconsistency can be used to locate the tampered region, but the compression process dilutes these fingerprints. Most of these fingerprints are visible in frequency domain and has a limitation for JPEG images (Cuong & Stefan, 2012).

When a foreign image segment is pasted into a single compressed image and resultant image is again saved in JPEG format, double compression artifacts get introduced in an image. Figure 1 shows an example, where an image of vase was copied from single compressed source image (a) and pasted

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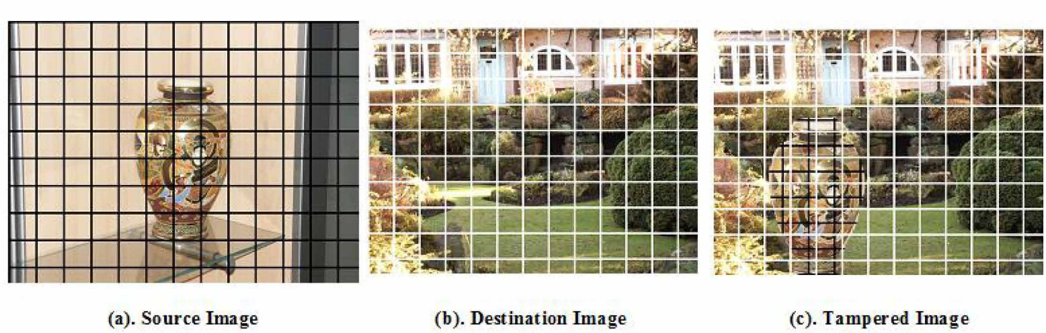
into another single compressed destination image (b). The black and white grids shown in these images represents 8×8 DCT grids used for the compression. The resultant image (c) was compressed once again by aligning 8×8 DCT grid with the upper left most corner of an image. Due to this, the primary (black) and secondary (white) compression grids of the tampered region (pasted vase) do not overlap with each other and it shows Non Aligned Double JPEG (NADJPEG) compression artefacts. As primary (white) and secondary (white) compression grids of the untampered region still overlap, it shows Aligned Double JPEG (ADJPEG) compression artefacts. It is difficult to create the visually indistinguishable tampering by aligning DCT grid of the tampered region. Hence, ADJPEG compression artefacts will always remain missing in the tampered region. Resampling operations further destroy the primary DCT grid structure and it cannot be localized using resampling detection techniques (Mahdian & Saic, 2008). However, due to the absence of ADJPEG artefacts, JPEG fingerprint based techniques are able to localize it (Mire A. V., Dhok, Mistry, & Porey, 2015).

Farid (2009) found that the difference between the double compressed image and its recompressed versions appears minimum when the recompression quality is same as that of the primary compression quality, called as a ghost effect. As this approach involves manual investigation of various difference images, Garcia-Ordas, Robles, Alegre, Garcia-Ordas, & Garcia-Olalla (2013) further extended it for automated ghost localization. Lin, He, Tang, & Tang (2009) recognized the periodicity in the histogram of double quantized DCT coefficients and utilized it for double compression detection. Wang, Liew, Li, Zhang, & Li (2014) also used the distribution of DCT coefficient histogram for differentiating the NADJPEG compressed region from single compressed region. Wu, Kong, Wang, & Shang (2013) used difference of pixels inside and at the edges of the 8×8 blocks to identify the double compression. They trained SVM classifier with features retrieved from these differences. Li, Zhao, Liao, Shih, & Shi (2012) trained SVM classifier using First Digit Probability Distribution (FDPD) of single compressed images and their aligned double compressed counterparts. They assumed that FDPD of NADJPEG compressed region will be similar to the single compressed region. Amerini, Becarelli, Caldelli, & Mastio (2014) showed that FDPD of first digits '2','5' and '7' is sufficient to locate the tampering. However, the probabilities of first digit '1' and '2' gives better localization than the probabilities of first digits '2', '5' and '7'. Nevertheless, both the approaches cannot give better localization compared to the probabilities of all nine first digits (Mire A. V., Dhok, Mistry, & Porey, 2016). Yang & Zhu (2011) proposed double maxima in the DCT coefficient factor histogram of the double compressed image, which can also be used to locate tampering (Mire A. V., Dhok, Mistry, & Porey, 2015).

As the tampered and untampered region have different origins, noise statistics differs in it. Mostly noise discrimination has been investigated for uncompressed images using RGB or gray color domain. Popescu & Farid (2004) assumed scale invariant kurtosis for noise in natural images and computed

Figure 1. DCT compression grid non alignment



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