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Asymmetric Distortion Function for JPEG Steganography Using Block Artifact Compensation

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ABSTRACT

This article describes how the existing distortion functions for JPEG steganography allot same cost for ± 1 embedding changes. Because of the correlation of natural image, however, changes with different polarities make different influences on image. Therefore, the embedding costs for ± 1 embedding changes should not be equivalent. This article proposes a general method to distinguish the embedding costs for different polarities of embedding changes for JPEG images with the help of reference images constructed by block artifact compensation. The original JPEG image is decompressed into spatial domain firstly, and then the block artifact is compensated by smoothing filtering implemented on border pixels of each 8×8 block. After that, the compensated image which is more similar to the original uncompressed image is recompressed into DCT domain and adopted as side information to guide the adjusting of the given distortion function. Experiment results show that after the proposed method is employed, the security performance of current popular JPEG steganographic methods is observably increased.

KEYWORDS

Distortion Function, JPEG Images, Polarity, Steganography

INTRODUCTION

Steganography aims to transmit data secretly through digital media without drawing suspicion by slightly modifying cover data (Zhang, 2016). The early steganographic methods try to increase the undetectability by decreasing the quantity of embedding changes (Fridrich & Soukal, 2006; Zhang & Wang, 2006; Zhang, Zhang & Wang, 2008), or by maintaining a kind of statistical model (Westfeld, 2001; Phil, 2003; Fridrich, Pevný & Kodovský, 2007). But these methods cannot achieve

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satisfactory undetectability due to the lack of consideration about image content. With the emergence of the syndrome trellis coding (STC) (Filler, Judas & Fridrich, 2011) which can minimize additive distortion between the cover and the stego image under a user-defined distortion function with a given payload, the security performance of steganography has been greatly improved and the direction of steganography is turn to the design of distortion function.

A distortion function allots an embedding cost for each cover element and the embedding cost quantifies the effect for modifying the cover element. The distortion between cover and the corresponding stego object is expressed as a sum of costs of modified elements. There are a mountain of excellent distortion functions for spatial images (Pevný, Filler & Bas, 2010; Holub & Fridrich, 2012, Holub & Fridrich, 2013; Li, Wang, Huang & Li, 2014, Sedighi, Fridrich & Cogranne, 2015) or JPEG images (Holub & Fridrich, 2013; Guo, Ni & Shi, 2014; Guo, Ni, Su, Tang & Shi, 2015; Wang, Zhang & Yin, 2016). Most of these distortion functions allot a same embedding cost for ± 1 embedding changes. But because of the correlation of natural images, changes with different polarities make different influences on an image. Therefore, the embedding cost for ± 1 embedding changes should not be equivalent. So, these existing distortion functions can be optimized by distinguish the embedding costs for ± 1 embedding changes.

A general method to distinguish the embedding costs for different polarities of embedding changes for spatial images is proposed in (Wang, Lv, Wei & Zhang, 2016). Both the fluctuation after pixels being +1 or -1 and the texture of cover image are employed to adjust a given distortion function. This approach makes the fluctuation around modified pixels become more similar to that of their neighbourhoods. Thus, less detectable artifacts achieved. As JPEG is widely used, it is meaningful to design asymmetric distortion function for JPEG steganography. Some schemes are designed for distinguish the embedding cost for different polarities of embedding changes for JPEG steganography with the help of additional information such as spatial precover (Denemark & Fridrich, 2015) or multiple JPEG images of the same scene (Denemark & Fridrich, 2017). However, the need of additional information makes these schemes impracticable in real world. Up to now, there is no asymmetric JPEG distortion function without any help of additional information.

This paper firstly proposes a general method to distinguish the embedding costs for different polarities of embedding changes for JPEG images by compensating the block artifact. The original JPEG image is decompressed into spatial domain, and then the block artifact caused by JPEG compression is compensated. After that, the image is recompressed into DCT domain and adopted as side information to adjust the given distortion function. Note that the side information is produced from the given JPEG image, not from any additional information.

PROPOSED METHOD

The sketch of the proposed method is shown in Figure 1. The original JPEG image is decompressed into spatial domain firstly, and then the block artifact is compensated by smoothing filtering implemented

Figure 1. Sketch of the proposed method