Chapter 7
Large Feature Mining With Ensemble Learning for Image Forgery Detection

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ABSTRACT

The detection of different types of forgery manipulation including seam-carving in JPEG images is a hot spot in image forensics. Seam carving was originally designed for content-aware image resizing. It is also being used for forgery manipulation. It is still very challenging to effectively identify the seam carving forgery under recompression. To address the highly challenging detection problems, this chapter introduces an effective approach with large feature mining. Ensemble learning is used to deal with the high dimensionality and to avoid overfitting that may occur with some traditional learning classifier for the detection. The experimental results validate the efficacy of proposed approach to detecting JPEG double compression and exposing the seam-carving forgery while the JPEG recompression is proceeded at the same quality and a lower quality, which is generally much harder for traditional detection methods. The methodology introduced in this chapter provides a strategy and realistic approach to resolve the highly challenging problems in image forensics.

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INTRODUCTION

JPEG is a commonly used method of lossy compression for digital images. The detection of the forgery manipulations in JPEG images has been well studied (Amerini et al. 2011; Bianchi and Piva 2012; Liu and Chen 2015; Pun, Yuan and Bi 2015). For example, double JPEG compression may be involved on JPEG image tampering, the detection of double JPEG compression was actively conducted (Chen and Hsu 2011). While the detection is very effective if the second compression quality is higher than the first compression quality, it is not so strong if the second compression quality is lower than the first compression quality. A forgery maker may exploit the weakness of the current detection arts, manipulate the images, and produce the forgery at the same or at a lower quality level, to evade from being detected.

Seam carving, known as liquid rescaling, was originally designed for content-aware image resizing (Avidan and Shamir 2007). It establishes several seams (paths of least importance) in an image and then automatically removes seams to reduce image size or inserts seams to extend it. Seam carving allows manually defining areas in which pixels may not be modified and features the ability to remove whole objects from photographs. Seam carving has been implemented in Adobe Photoshop and other popular computer graphic applications including GIMP, digiKam, ImageMagic, and iResizer. While it is widely used in computer vision and multimedia processing for legitimate applications, it has been adopted for forgery manipulation. The proliferation of seam carving raises a serious challenge in image forensics.

In detecting seam carving–based image forgery, Sarkar et al. (2009) utilized a steganalysis detector, which was originally developed to detect JPEG-based steganograms. Fillion and Sharma (2010) detected seam-carved images including benign image reduction, benign image enlargement, and deliberate image reduction. They tested their method over a set of images consisting of 1484 uncompressed images. Unfortunately, the approach was not validated in JPEG images with seam carving manipulation. Liu and Chen (2015) made use of neighboring joint density that was designed in steganalysis to detect seam carving-based forgery in JPEG images. Chang et al. (2013) proposed a method to detect seam carving in JPEG images based on the symmetrical property of blocking artifact characteristics matrix (BCAM) and the extension. Wei et al. (2014) developed a patch analysis method to detect seam carving. Ryu and Lee (2014) discriminated seam carving from intact by energy bias and noise features. Wattanachote et al. (2015) presented a method to detect the JPEG seam-carving image based on the extended Markov feature. Yin et al. (2015) exposed seam carving forgery by combining half-seam features, energy bias and noise-based feature together from the local binary pattern. Sheng and Gao (2016) introduced a method based on Benford law. Zhang et al. (2017) implemented a blind detection approach for seam carved image with low scaling