Identifying Image Forgeries Using Change Point Detection

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ABSTRACT

This paper addresses the verification of the integrity of digital images and detecting the traces of tampering without using any protecting pre–extracted or pre–embedded information which have become an important research field of image processing.

This paper provides a novel and efficient approach for detecting the suspicious and modified regions of the image (the regions that have been tampered with). The presented approach is completely blind and uses only the image function. An interesting contribution of the paper is the employment of change point detection theory for image forgery detection. Change point detection theory is a well-developed research field and proposes a number of effective methods for detecting local non-homogenities.

Change point detection methods have been, for example, successfully applied in identification of the point in a time series at which some change occurs. In this paper we will show that a similar approach can also be applied for detecting and localizing image forgeries. To this end, we will detect those parts of the image that are not homogenous with respect to a set of homogeneity conditions. To this end, we employ a probabilistic change point detection framework.

Generally, the core of the approach consists in transforming the digital image data to a set of one-dimensional statistics and measuring a distance from homogeneity. Typically, when dealing with change point detection, there are two problems associated with this task: detecting the change and making inferences about the change point. Both these problems will be described and analyzed in details in the final version of the paper. In the employed probabilistic detection framework, we consider a sequence of random variables $X_1,\ldots,X_n$, that take value in R^d. The key assumption is that some properties of the X_i changes at some unkown pixels $t_1,\ldots,t_k$. Here, k is the unknown number of change points. There are several approaches to solve the change point detection task like sequential methods or local methods. In this work, we will employ a global approach, where all the change points are simultaneously detected.

After the first probabilistic detection part, we also use a verification step in which the number of possible false positives detections is minimized.

Our homogeneity features and conditions are based on JPEG quantization artifacts (double quantization artifacts) and image noise levels. In JPEG algorithm, the quantization step is performed in conjunction with a 64–element quantization matrix. If some parts of the image have been replaced by a foreign region with another former JPEG properties, then this part of the image may leave some non-consistencies compared to rest of the image. Our change point detection framework models these inconsistencies and detect them. The core features of this part are formed using the discrete cosine transform (DCT) coefficients of the JPEG image.

Furthermore, a commonly used tool to conceal the traces of tampering is the addition of locally random noise to the altered image regions. The noise degradation is the main cause of failure of many active or passive image forgery detection methods. Adding locally random noise may cause inconsistencies in the image's noise levels. Therefore, estimates of image noise levels form the basis of our second input to the applied change detection framework.

Results so far obtained show that the main advantage of the proposed approach is in its simplicity and relative ease with which it can be applied to several types of features and homogeneity conditions.

Besides analytical description of the approach, the final version of paper will also contain several illustrative experimental results as well as a comprehensive quantitative measure of the efficiency of the proposed approach.

The final version of the paper will mainly consist of the following parts:

1. Abstract
2. Introduction
3. Related Work
4. Homogeneity features and conditions
5. Change Point Detection Framework
6. Experimental Results
7. Discussion

Related Work

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