Synopsis of

Application of Image Blobs and Illumination Component In Image Tamper Detection Techniques

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By

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1 Introduction

Image tampering is a malicious act of adding, removing, or changing some major regions of a digital image. The main purpose of image tampering is to mislead the viewers or public opinion. History shows that the earliest known surviving photograph made in a camera, was taken by Joseph Nicéphore Niépce in 1826 [1, 3], but around 1860 photographs were already being manipulated [3]. Since then, with the digital era, the manipulation of photographs has been made simpler and much easier by computer tools. Since engineer Steven Sasson [4] invented the first self-contained (portable) digital camera back in 1975, the digital revolution has basically changed the way how images are created, consumed and perceived. In 1987 the photo editing computer program for personal computers known as Adobe Photoshop was released. Today, it is so popular that the term "photoshop" refers to digital image editing and manipulation. Around 95 million photos are uploaded daily on the social media platform "Instagram", and since its creation in 2010, more than 40 billion photos have been shared [5]. Around 350 million photos per day are uploaded to the social media platform "Facebook" [2]. Now, with the gigantic amount of photographs on social media, the questions arise like in [11], how many of the photographs can we trust on social media? How to tell the authentic from the tampered? The field of *Digital Image Forensics* (DIF) has emerged to help restore some trust to digital images. DIF aims at validating the authenticity of images by identifying the imaging device that captured the image or detecting the traces of forgeries [16].

Generally, DIF categorizes the digital image tampering detection algorithms into two categories: *active detection algorithm* which embeds digital watermark or digital signature in the image; and *passive or blind detection algorithm* which does not consider any prior information to be embedded beforehand [16]. The passive detection approach has attracted more attention since most of today's digital images on social media, internet and other fields don't have digital watermarking or signature embedded. The two common types of digital image tampering include **copy-move forgery or Cloning** in which a part of an image is copied and pasted to another part of the same image[15], and **image splicing or image composition** which involves the composition of two or more regions/images from different sources in a single image [10].

2 Problem Statement, Aim and Objectives

2.1 Problem Statement

Today's computer technology has made the process to create the *copy-move forgery* and the *image splicing forgery* simple and effortless. Various image tamper detection techniques have been proposed to combat the above-mentioned forgeries. However, they exhibit numerous limitations that need to be addressed. Image tamper detection tools that are robust, effective, and efficient need to be developed.

2.2 Aim

To provide digital image tamper detection techniques using blind image forensics to tackle the limitations of the existing copy-move forgery detection techniques and image splicing forgery detection techniques.

2.3 Objectives

1. Identify the limitations of the existing copy-move forgery detection techniques and image splicing forgery detection techniques.

2. Study of different image characteristics and efficient features that can be used to reveal the clues of image tampering.

3. Develop detection methods for each of the above-identified limitations.

4. Testing the behavior and performance of the developed methods on standard benchmark datasets.

3 Literature Survey

3.1 Copy-move forgery detection

Various copy-move forgery detection (*CMFD*) techniques have been proposed to deal with different forms of image copy-move forgeries *(CMF)*. These techniques are generally divided into the following major categories: *Block-based*, *Keypoint-based* and *Segments-based* approaches.

In the block-based approach, image is divided into small overlapping or non- overlapping blocks, the blocks or block features are matched against each other to determine blocks or features that are similar [17].

In the keypoint-based approach, keypoints are detected in the image without any image subdivision. Then, each keypoint is described by a feature vector of a certain size. Finally, the feature vectors are compared to find similar features [6].

Some recent techniques have adopted image segments as alternatives to image blocks in CMFD [7]. Image is divided into non-overlapping regions called segments or superpixels [8]. Features are extracted from each segment and these features are matched to find similar segments.

3.2 Image splicing forgery detection

Most recent techniques to detect the image splicing forgery are based on machine learning [12, 18]. They consider the image splicing problem as a binary classification task with two phases:

1. Phase 1: classify images as authentic or tampered(forged) based on extracted features.
2. Phase 2: localize the doctored regions in the spliced image.

3.3 Limitations of existing techniques

- Copy-move forgery detection
  - The main limitations of block-based CMFD techniques include the difficulty of finding the appropriate size of the block, small blocks increase the computational cost of matching and also do not give robust features. Large blocks cannot be used to detect small forged areas, and uniform areas such as background regions can be detected as duplicates.
  - The main limitations of keypoints-based CMFD techniques include the large number of keypoints to match, a large number of false positives and the need for filtering techniques such as Random Sample Consensus (RANSAC) to remove or reduce the false positives.

  - Segments-based CMFD techniques split the CMF regions (original region and its duplicate) into several segments (oversegmentation). Uniform areas such as background regions can be detected as duplicates.

- Image splicing tamper detection

  - The existing methods with high detection accuracy are computationally expensive. Majority of them are based on complex deep learning models. They are expensive to train and require a large amount of data to perform better. They also run on expensive GPUs (Graphics Processing Unit).
  - There is no known standard mechanism to localize the spliced forged regions.

4 Proposed Contents of the Thesis

This thesis consists of 7 chapters. Chapter 1 includes an introduction to image forgery and digital image forensics. It also provides the motivation and necessary background for the work reported in this thesis. It concludes by providing the scope of the thesis. Chapter 2 discusses the literature survey in the area of image tampering detection. Chapter 3, 4, 5, and 6, cover our contributions and published works in the field. Finally, Chapter 7 draws conclusions and direction for future work.

The content of each of these chapters are summarized below:

4.1 Chapter 1: Introduction

This chapter introduces the field of digital image forensics, copy-move forgery, and image splicing forgery. It also provides motivation and describes the scope of the thesis.

4.2 Chapter 2: Related Work

Chapter 2 describes an overview of the state-of-the-art methods in copy-move forgery and image splicing detection methods. The limitations and drawbacks of existing techniques are discussed.

4.3 Chapter 3: Copy-move forgery detection using DoG and ORB

The utilization of image blobs to tackle the limitations of existing CMFD methods is presented. Image blobs are regions detected in scale-space, they present more advantages over image blocks and image segments in copy-move forgery detection. This chapter discusses the use of DoG (Difference of Gaussian) blob detector [14] and rotation invariant feature detector called ORB (Oriented Fast and Rotated Brief)[9] to detect copy-move regions.

4.4 Chapter 4: Copy-move forgery detection using image blobs and BRISK feature

This chapter discusses CMFD technique which uses image blobs and BRISK (Binary Robust Invariant Scalable Keypoints) [13]. This method reduces the number of keypoints to match by almost 50% and reduces the false positives without using a filter algorithm.

4.5 Chapter 5: Geometric transformation parameters estimation from copy-move forgery using image blobs and features:AKAZE, BRISK, ORB, SIFT and SURF

This chapter presents a method that can detect the copy-move forgery and estimates the geometric transformation parameters between the CMF regions (original region and its duplicate) using image blobs and various features including AKAZE, BRISK, ORB, SIFT and SURF. A blob post-process operation followed by a 2D affine transformation are used to estimate the geometric transformation parameters.

4.6 Chapter 6: Image splicing detection technique based on illumination component and LBP

The chapter presents the use of illumination and chrominance features to detect the image splicing forgery. Images taken from different cameras with different lighting conditions introduce illumination inconsistencies in the spliced image. Thus, illumination component is a good feature for splicing detection. Image splicing perturbs the spatial arrangement (texture information) of color or intensity in the image. Thus, LBP (Local Binary Patterns) is used to capture texture information. Then illumination component and LBP are used as features to detect image splicing using different classifiers (e.g., Support Vector Machine and Linear Discriminant Analysis).

4.7 Chapter 7: Conclusion and Future Work

We summarize the work reported in the thesis and outlines future directions. The following research directions are suggested for future:

- Study needs to be done to determine which is the authentic region and which is the tampered region in copy-move forgery. This will enable to recover the original image from the tampered image.
- Study needs to be carried out using illumination component and deep learning models like shallow convolution neural network to enable the model to automatically learn low-level features (e.g., edges and boundaries) to increase the detection performance.

5 List of Publications

1. Niyishaka Patrick and Chakravarthy Bhagvati. **Digital Image Forensics Technique for Copy-Move Forgery Detection Using DoG and ORB.** ICCVG 2018, Warsaw, Poland, September 17-19, 2018, Proceedings. 10.1007/978 − 3 − 030 − 00692 − 1_41.

2. Niyishaka Patrick and Chakravarthy Bhagvati. **Copy-Move forgery detection using image blobs and BRISK feature**. *Multimedia Tools and Applications (MTAP)*, https://doi.org/10.1007/s11042-020-09225-6.

3. Niyishaka Patrick and Chakravarthy Bhagvati. **Geometric transformation estimation from copy-move forgery using image blobs features and keypoints**. *Multimedia Tools and Applications (MTAP)*, Communicated.

4. Niyishaka Patrick and Chakravarthy Bhagvati. **Image splicing detection technique based on illumination component and LBP**. *Multimedia Tools and Applications (MTAP)*, https://doi.org/10.1007/s11042-020-09707-7.

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