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Analysis of Image Forgery Detection Technique

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ABSTRACT: Image forgery is the manipulation or alteration of an image. Image forensic is an emerging field since digital images are used in legal proceedings. Image forgery raised the demand to assure the truthfulness of digital image. Popularity of many editing software's lead to manipulation of an images in different ways which cannot be recognized by the naked eye. Therefore, image forgery detection techniques play an important role. Image splicing and copy-move forgery are the most widely used image forgery tools. This paper, will give an analysis of various active and passive methods of an image forgery detection. Passive techniques of forgery detection do not require any pre-embedded information about the image. Previous research studies shown that Convolutional Neural Networks can achieve the art of state performance in some visual problems. Thus deep learning-based CNN models are preferred for forgery detection in digital images. In this paper a novel method is proposed to classify forged image and original image via Error Level Analysis (ELA) is applied on CNN model which analyses this compression ratio of original image and forged image.

KEYWORDS: Image forgery, image forgery detection, Convolutional Neural Networks, Deep learning, Error level analysis

I. INTRODUCTION

The main objective of this paper is to present various methods of image forgery detection. Several active and passive methods are available to detect a forged image. Digital images play a crucial role in field like criminal investigation, forensic, medical imaging etc. Due to the advancement in digital technology images can be easily processed using various advanced tools like Corel, Adobe Photoshop, etc. Images are exploited in a large range of use cases where determining their integrity and origin may have high consequences. Alteration of an image using different tools is considered as image forgery. Some of the most commonly used forgery techniques are copy move, image splicing and image retouching This emphasized the importance of authenticity of an image. As a result, image forgery detection techniques are gaining concern and importance in the society.

Image forensic is a field of digital forensic that deals with image forgery detection and validation. It is an emerging field that seeks to establish the origin and validity of digital media. It works for the detection of the originality of images or videos so that major ramifications on a national and worldwide level due to forgery can be controlled. [1]

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II. LITERATURE REVIEW

Classification of Image Forgery Techniques:



Fig.1. Classification of Image Forgery Techniques

Digital image forgery detection techniques are classified into two categories such as active approach and passive approach. In the active approach, certain information is embedded inside an image during the creation in form of digital watermark or digital

signature. Active approaches were used traditionally by employing data hiding (watermarking) or digital signatures. In the passive approach, there is no pre-embedded information inside an image during the creation. This method works purely by analyzing the binary information of an image. [2]

1.Active approach

An active forgery detection method needs pre-extracted or pre-embedded data. In active approach, the digital image requires some kind of pre-processing such as watermark embedded or signatures are generated at the time of creating the image. [3] Active approaches are used in limited application since pre-processing is required. A Digital signature and Digital watermarking [4,5] are commonly known methods used in active approach [6].

A. Digital watermarking

In an active approach, the first phase consists of pre-processing technique that is watermark injecting. Watermarking is also used for image forgery detection. These watermarks are designed to be undetectable, or to blend in with natural camera or scanner noise. Watermarking involves injecting a special pattern into the owner (source) image so that piece of information gets authorized. This special pattern can be further used to notify the user either the image is tampered or not. Visible watermarks also exist. In addition to this, a visually undetectable watermarking schema is also available which can sense the modification in single pixels and it can find wherever the modification occurs [7]. Active techniques have some disadvantages because they required some human involvement or specially equipped cameras. Also large portion of the imaging application does not contain any watermarking or mark module. To overcome this drawback a passive authentication has been proposed.

The least significant bit (LSB) algorithm is the common and simplest algorithm applied in spatial watermarking schemes [8], Discrete cosine transform (DCT), discrete wavelet transform (DWT), discrete sine transform (DST), and singular value decomposition (SVD) [9] are common transforms applied in frequency domain watermarking. In recent years, these transforms are still applied widely in the watermarking field. Rasti et al. [10] proposed a robust color video



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watermarking scheme based on QR decomposition and entropy analysis, embedding the watermark into the block selected by entropy analysis. The selected block is performed by DWT, Chirp-Z transform (CZT), QR decomposition, and SVD for watermark embedding. Luo et al. [11] presented an adaptive robust watermarking scheme based on discrete Fourier transform (DFT) and SIFT to deal with the synchronization errors.

B. Digital signature

Digital signature is one of the active methods used for detecting image forgery or tampering. This one is mathematical approach applied to confirm the integrity and authenticity. Representing the authenticity of digital document using a kind of mathematical format is named as digital signature. In digital signature a robust bit is extracted from the original image. An image is partitioned of into blocks of 16*16 pixels. A secret key k is employed to get N random matrices with entries uniformly distributed in interval [0, 1]. A low pass filter is applied on every random matrix frequently to obtained N random smooth pattern [12]. System produce digital signature by applying signing process on digital image.

2. Passive Approach

Passive image forensics is usually a great challenge in image processing techniques. There is not a particular method that can treat all these cases, but many methods each can detect a special forgery in its own way. The stream of passive tampering detection deals with analyzing the raw image based on various statistics and semantics of image content to localize tampering of image. Neither construct is embedded in the image and nor associated with it for security, as like active approaches and hence this method is also known as raw image analysis. The localization of tampering is solely based on image feature statistics. Hence, algorithms and methods of detection and localization of image based on passive tampering vary depending upon the type of security construct used. Nevertheless, passive tampering detection typically aims for localization of tampering on raw image.

A. Image splicing:

This is a manipulation technique that copies one or many regions of an image and pastes them onto another image. It can be used for the purpose of adding an additional element to a scene. Image Splicing is a process of making a composite picture by cutting some object from image and adding it to some other image. This technique for making forgery images is more aggressive than image retouching. Image splicing is fundamentally simple process and can be done as crops and pastes regions from the same or separate sources. This method refers to a paste-up produced by sticking together images using digital tools available such as Photoshop. In Image Splicing technique there is composition of two or more images, which are combined to create a fake image. Examples include several infamous news reporting cases involving the use of faked images. Below shows how to create forge Image; by copying a spliced portion from the source image into a target image, it is a composite picture of scenery which is forge image [13].



(i) Authentic images

(ii) Spliced image

Fig.2.Example of Image splicing type image forgery

B. Copy-move forgery:

Copy Move forgery is a process of making a composite picture by cutting some object from image and adding it to the same image. It can be used for the purpose of adding false information or hiding information. It is one of the most common image tampering techniques, and it's also one of the most difficult to spot because the cloned image is taken from the same image. A section of an image is copied and pasted to another part of the same picture in Copy-Move image forgery. The copy move forgery is popular as one of the difficult and most commonly used kind of image



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tampering technique. In this technique, one needs to cover a part of the image in order to add or remove information. In the Copy-Move image, manipulation technique a part of the same image is copied and pasted into another part of that image itself. In a copy-move attack, the intention is to hide something in the original image with some other part of the same image [14]. The example of Copy-Move type is as shown in figure 3.



(a) The original images

(b) The copy-move forged images

Fig.3.Example of copy-move type image forgery

Lu S. [15] proposed a new scheme that makes use of the circular domain coverage (ECDC) algorithm. The proposed scheme combines forgery detection methods based on blocks and key points. First, from an entire image, speed-up robust features(SURF) in log-polar space and scale-invariant feature transform (SIFT) are extracted. Second, generalized two nearest neighbors (g2NN) are used to generate a large number of matched pairs. To detect tampered regions Popescu et al. [16] worked upon principal components analysis (PCA) as a feature.

Yao et al. [17] proposed method to detect copy-move forgery using non-negative matrix Factorization. Non-negative matrix factorization (NMF) coefficients are extracted from a list of all blocks after the image is partitioned into fixed-size overlapped blocks. It is worth mentioning that all of the coefficients are quantized before matching, which means that a sub-image can be interpreted with a small amount of data. Rani et al. [18]. This research proposes a pixel-based forgery detection framework for copy-move and splicing-based forgeries. Initially, image data is pre-processed to improve the textural information. For the identification of bogus picture regions, the suggested method estimates multiple attributes using augmented SURF and template matching. Kanget al. [19] proposed a method to detect copy-move forgery in digital image in2010. In which firstly image is divided in sub-blocks then applied improved SVD on each blocks.

Sr. No.	Title of the paper	Method used	Type of forgery detection	Pros/cons	Publishing year
1	Detection of copy-move forgery in digital image[20]	DCT	Copy-move region is detected	Will not work in noisy image	2003
2	Robust detection of region duplication in digital image[21] A new approach for detecting	Similarity matching DWT	Copy-move region detected in noisy conditions Exact copy-move	Time complexity is reduced Works well in noisy	2006 2008
	copy-move forgery detection in digital image[22]		region is detected	and compressed image	
4	Fast, automatic and fine- grained tempered JPEG image detection via DCT coefficient analysis[23]	Double Quantization DCT	Tampered region is detected accurately	Works only in JPEG Format	2009



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5	Detecting copy-paste	Transform-	Copy-paste forgery	Difficult detection in	2011
	forgeries using transform-	invariant	detection	case of blurred image	
	invariant features [24]	features			
6	A fast image copy-move	Phase	Copy move region	Valid in detecting the	2012
	forgery detection method	correlation C	detected	image region	
	using phase correlation[25]			Duplication and quite	
				robust to additive noise	
				and blurring	
7	Copy-move forgery detection	2D- Fourier	Copy-move region	This work detects	2013
	in imagesvia2D-fourier	transform	detected accurately	multiple copy move	
	transform [26]			forgery and it also	
				robust to jpeg	
				Compression attacks	
				hence highly accurate	
8	A scheme for copy-move	2D-DWT	Copy- move region is	Works well in noisy	2014
	forgery detection in digital		detected	and compressed image	
	images based on2D-DWT[27]			_	

Table1: Comparative study on existing copy-move image forgery detection methods

C. Image Retouching:

Image Retouching is considered as less harmful kind of digital image forgery than other types present. In case of image retouching original image does not significantly change, but there is enhancement or reduces certain feature of original image. This technique is popular among magazine photo editors they employ this technique to enhance certain features of an image so that it is more attractive. Actually, the fact is that such enhancement is ethically wrong. Image retouching is adding or removing something from the image for enhancing features of an image. This technique is applicable for used for aesthetic, commercial users and it degrades the image features. Generally, it is popular among magazine photo editors, where they try to make an image more attractive by enhancing some features. Compared to all available forgery techniques Image Retouching is considered as less harmful. Removing blemishes on a picture of a model would be a great example of image Retouching.



(a) Original Image

(b) Retouched Image

Fig.4.Example image retouching type of image forgery

Xing et al. [28] describe a new algorithm based on an 8-neighborhood quick sweeping technique. The experimental result shows that there is a significant increase in the rate of the image in painting while maintaining quality effect. Kumar et al. [29] examined different pixel- and physics-based counterfeit detection algorithms, as well as a comparative examination of these techniques. Furthermore, imaging devices and processing procedures, no matter how varied they are, contain a constant pattern in the image that, if interfered with, will introduce a departure from the original pattern. This divergence allows one to detect image counterfeiting. It has more accurate forgery detection and has more homogeneous lit surfaces.



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D. Deep learning models:

In recent years, machine learning and neural networks, such as convolutional neural networks(CNNs), have shown to be capable of extracting complex statistical features and to efficiently learn their representations, allowing to generalize well across a wide variety of computer vision tasks, including image recognition and classification and so on [30,31]. The extensive use of such networks in many areas has motivated and led the multimedia forensics community to comprehend if such technological solutions can be employed to exploit source identification[32]

One approach to image forgery detection using deep learning is to train a convolutional neural network (CNN) on a dataset of both genuine and forged images. The CNN can then be used to classify new images as either genuine or forged based on the features it has learned to recognize [33]. This paper presents a deep learning-based approach to image forgery detection, specifically using Error Level Analysis (ELA) with Convolutional Neural Networks (CNNs) and a pre-trained VGG-16 model. The study compares the performance of the two models and provides an in-depth analysis of the results. The experiments show that the ELA CNN model achieves a remarkable accuracy rate of 99.87% and correctly identifies 99% of invisible images, while the VGG16 model achieves a lower accuracy rate of 97.93% and a 75.87% validation rate. The research highlights the significance of using deep learning techniques in image forgery detection and explores the implications of the findings. [34] A primary method in image forgery detection is the Error Level Analysis (ELA), a technique that quantifies the compression levels across an image Error Level Analysis (ELA), a passive method for finding fake images, assesses how consistently different levels of compression are used throughout an image. The compression levels of the edited area in an image are frequently different from the surrounding portions. ELA draws attention to these discrepancies, which makes it simpler to spot forgeries [35].

Sudiatmika, I.B.K. and Rahman et al [36] using DL to solve the statement of discriminate between original images and forged images. Proposed a system of the combination of Error Level Analysis (ELA) and used the transfer learning model called Visual Geometry Group (VGG). With 100 epochs, results showed the 92.2% and 88.46% of training and validation accuracy respectively.

The basic image recognition neural network called convolution neural network (CNN) [37], has been used. Images as input is given and significant features from an image is taken out. It is a multi-layered neural network, hence at each layer it extracts certain features. As move deeper into network, it can identify even complex features. One of the advantage of using CNN is that the features are extracted directly from the image dataset. The principal advantage of these CNN based approaches is that they are capable of learning classification features directly from image data.

Sr.	Title of the paper	Method used	Pros/cons	Publishing
1	A Kuznetsov. [38]	VGG convolutional	Highly accurate	2019
		neurar network.	Accuracy.97.870	
2	Image Forgery Detection using Deep Learning: A Survey [39]	Convolutional Neural Network (CNN).	Deep-learning techniques are more efficient than traditional techniques. Deep Learning methods require a huge set of training and testing data for the algorithm to work efficiently.	2020
3	Image forgery detection using error level analysis and deep learning [40]	combination Error Level Analysis and Convolutional Neural Network	The result of our experiment is that we get the best accuracy of training 92.2% and 88.46% validation by going through 100 epoch.	2018

Table1: Comparative study on deep learning based detection methods

III.CONCLUSION

The main objective of this paper is to present various aspect of image forgery detection. Various active and passive image forgery detection methods are highlighted in this paper. From the literature survey, we observed that the Active method needs an information to be incorporated inside an image. Digital watermark and digital signature are widely used active methods. In the passive approach, there is no need to incorporate information inside an image during the creation. In this

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paper we presented a step forward into adopting convolutional neural networks for the task of detecting splicing forgery. We began to explore CNN capabilities to classify and localize uncompressed, single and double compressed patches of images. First, the choice of the CNN architecture can lead to very different performance as it was seen on the object classification task where deep architectures are used. The ELA-CNN model successfully incorporated the benefits of Convolutional Neural Networks and Error Level Analysis preprocessing, obtaining a remarkable validation accuracy.

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