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Image Splicing Forgery Detection using Local Binary Pattern and Discrete Wavelet Transform

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***Abstract*—A common way of tampering in digital images is known as splicing, Where a selected region from an image is pasted into another or same image. In this paper we propose a method to detect image manipulation. Firstly the algorithm converts input RGB image into YCbCr color channel, afterwards chrominance component is divided into non-overlapping blocks. Secondly Local Binary Pattern (LBP) operator is performed, and wavelet transform is applied in all blocks. Finally, Principal Component Analysis (PCA) is used for all blocks and the output is fed to Support Vector Machine (SVM) classifier as features. Experimental results demonstrate the efficiency of proposed method in exposing image splicing forgeries.**

Keywords*—*Image splicing, chrominance, LBP, wavelet, PCA, SVM

I. Introduction

Today lots of digital images are produced by tampering original images and distributed by information channels like newspapers, websites and television. Low cost digital cameras, powerful photo editing softwares and image processing have made it easy to forge images for different purposes. One of the most common and simple methods of image forgery is splicing. Image splicing is act of cropping regions of an image and pasting it into the same or a different image to create a new forged photo. So deciding about authenticity of an image has become increasingly difficult. Thus the significance of trusting the integrity of an image has made image forensics a very critical research issue. Based on these reasons, we need a reliable and objective way to verify the authenticity of images. Many researches have been conducted regarding image splicing. In [1], Zhen Hua Qu, Guoping Qiu, and Jiwu Huang introduced an automatic image splicing detection using sharp splicing boundaries. The contribution of this method to splicing detection is the usage of an OSF-based edge sharpness measure, which can detect spliced image with the help of a visual saliency-guided feature extraction method and hierarchical classifier,. In [2], H. R. Chennammahas adopted an image device to correlate the portions of the image. Such correlations are then distributed in spliced images. Johnson and Farid In [3] offered exploitation of specular highlights in the eyes to detect spliced images. The drawback of the proposed method is on the fact that people's eyes must be visible and available in high resolution which constricts its applicability. In [4], Chennamma & Lalitha suggested a detection method based on the spherical lens which introduced radial distortions. In [5], Feng and Chang mentioned the integrity analysis of camera characteristics is considered among different portions of an image. The discrete wavelet transform which is proposed in [11] can only be usable in the same spliced image. The contribution of our paper is using LBP, wavelet transform and PCA simultaneously which as will be shown, increases the efficiency of proposed detection method compared to the others. The rest of the paper is organized as follows: The main issue is discussed in section II, the suggested algorithm is described in section III, in section IV; we display the result of our method. Finally conclusion is given in section V.

II. Image Splicing

As previously mentioned, splicing is one type of tampering that combines different regions of same or separate sources to create a composite fake image. Sometimes it is not possible to decide about authenticity of a photo by naked eyes, so we need an applicable method to detect spliced photos. Fig. 1 shows one of the examples of image splicing process [6].

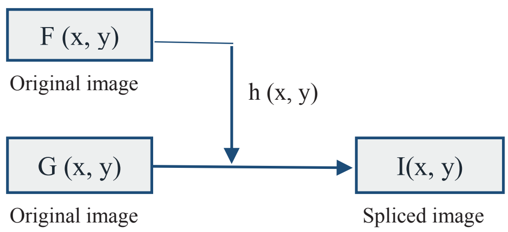

Fig. 1. The steps of image splicing, f(x, y) and g(x, y) are original images, h(x, y) is a part of f(x, y) which is insert into g(x, y) and generate spliced image I(x, y). Perhaps f(x, y) and g(x, y) is the same image.

Fig. 2 shows an example of image splicing forgery.

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a) Original image b) Spliced image

Fig 2. Image Splicing Forgery example

III. Proposed Algorithm

In our proposed method we apply LBP, wavelet transform and PCA which each one is briefly described below:

A. *Local Binary Pattern*

LBP is a powerful feature for texture classification which has been widely used in papers such as [9, 10].
LBP defines a code for each pixel of image. It is computed as bellow:

$$LBP_{p,r} = \sum_{i=1}^{p-1} S(p_i - p_c).2^i \tag{1}$$

$$S(p_i - p_c) = \begin{cases} 1, & p_i - p_c \geq 0 \\ 0, & p_i - p_c < 0 \end{cases} \tag{2}$$

Where p is the number of neighborhood pixels and r is radius of neighborhood. p_c Denotes the central pixel's value.
This operator computes the LBP code by thresholding value of 8 neighbors. If the neighbor's pixel value is less than the center, it will hold binary digit '0' otherwise '1'. Then neighbors' binary digits are put together to build a binary code. The LBP code will be the decimal value of that binary code [9]. Figure 3 shows the LBP code computation process.

5	9	1
4	4	6
7	2	3

Thresholding →

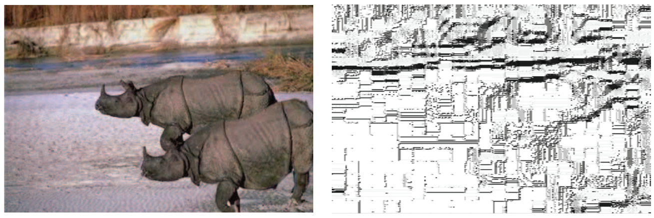
1	1	0
1		1
1	0	0

Binary: 11010011

Decimal: 211

Fig. 3. LBP code computation process.

Figure 4 shows an original image and an image after applying LBP.



a. An original image b. LBP applied image

Fig. 4. Shows an of LBP operator. Fig. 3. a shows the original image and Fig. 3. b shows the same image after applying LBP.

B. *Wavelet transform*

Due to the fact that wavelets allow the simultaneous analysis of both frequency and time, wavelet transforms have started to play a more significant role in image compression [11, 16]. They are now being regarded as the most powerful signal representation tool applied in processing of signals and images, compression of data, detecting features in images, removing noise and so on. In this paper, Haar wavelet is performed to reduce the dimension of the images.

C. *Principal Component Analysis*

PCA is a great useful filter in image processing. It is the most common and popular linear dimension reduction approach [18]. It has been used for years because of its conceptual simplicity and computation efficiency. It maps a dataset of n dimensions to a linear subspace with d dimensions, where d < n, and attempts to maintain most of the variability in the mapped dimensions [19]. In the proposed approach, PCA is employed for feature extraction and also decrement of data dimension [12] while the efficiency is well preserved.

As we see in the diagram in Fig. 5, in the first step of our proposed method we transform input image into YCbCr color space, because recent researches [7, 8, 9] have proved that using chromatic channel in forgery detection methods improves the performance. As mentioned in [9] Human vision perceives the luminance component in a better way than the chrominance component.

Therefore, most of the tampering traces, which could not be detected by naked eyes, are hidden in the chromatic channel. In the second step, we divide chrominance component into 16*16 non-overlapping blocks which our experiments has shown is an optimal number of blocks, because increasing the number of blocks will raise the time of detection, On the other hand decrement of blocks although will be time consuming, but will affect the detection accuracy. The third step is about feature extraction, which consists of 3 levels as listed below:

A. LBP operator in all blocks
B. wavelet transform
C. PCA

After the completion of the three levels, the output is fed into the SVM classifier as features. Now SVM should detect whether an image is fake or original.

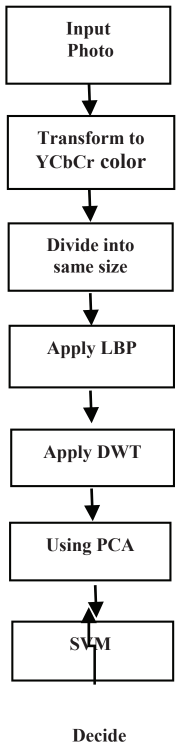


Fig. 5. Diagram of the proposed method

IV. Experiments And Results

In this section the database which has been used to evaluate the proposed method is introduced and also numerical results are discussed.

A. Database

CASIA Tampered Image Detection Evaluation Database Version 1.0 (CASIA TIDE v1.0) [13] and Columbia Uncompressed Image Splicing Detection Evaluation Dataset [16] are our database which have been widely used for image splicing detection. In table 1 some of the important characteristics of these databases has been summarized.

TABLE 1. DESCRIPTION OF THE EVALUATED DATASET

Dataset	Image Type	Image Size	Number of Images		
			Authentic	*Tampered*	*Total*
CASIA1	jpg	384*256 256*384	800	921	1721
Columbia	tiff bmp	757x568 To 1152x768	183	180	363

B. Numerical result

First the comparison between YCbCr color space and other color spaces such as RGB and HSV are done. Detection results for RGB and HSV for CASIAI database are 81.3 and 84.9 respectively. Similarly the results for Columbia database will be 81.22 and 80.9. In YCbCr, for chrominance object the results for CASIAI and Columbia are 97.21 and 95.12 respectively which has improved the results dramatically compared to the other methods.

So detection algorithm is continued with conversion to YCbCr color space and receipt of chromatic channel of images. As shown in [9] for parameters of LBP operator, the selection of r = 1 and p = 8 will lead us to better results. For instance if we consider p = 24, the detection results will decreased to 92. So the simulation is continued by selecting r = 1 and p = 8 as neighborhood radios and neighborhood pixels.

The combination of LBP and DCT for CASIAI and Columbia database, results in 94.20 and 92.1 respectively. But when we combine LBP with wavelet, the results improved to 97.21 and 95.12. So the wavelet transform was chosen. In order to decrease the amount of data and also the complexity of the problem, PCA was employed which increased the speed and efficiency of proposed algorithm. In the last stage, the KNN and SVM were candidated for classification which SVM had better results. The accuracy of our detection algorithm is summarized in table 2.

TABLE 2. THE PERFORMANCE ON DIFFERENT DATASETS.

Dataset	Accuracy (%)
CASIA 1	97.21
Columbia	95.13

In table 3 the proposed method is compared with other methods.

TABLE 3. RESULTS OF THE COMPARISON BETWEEN THE PROPOSED AND OTHER METHODS.

Dataset	Accuracy (%)			
	Proposed method	***Method 17***	***Method 16***	***Method 15***
CASIA 1	97.21	95.2	-	93.33
Columbia	95.13	-	93.55	-

As seen, the proposed method, leads us to better results in comparison to other methods.

V. CONCLUSION

This paper introduces an image splicing forgery detection based on LBP, wavelet transform and PCA which finally, all extracted features are fed to a SVM classifier. We applied our method on CASIA Tampered Image Detection Evaluation Database (CASIA TIDE v1.0) and Columbia Uncompressed Image Splicing Detection Evaluation Dataset. The test results show that our proposed algorithm is effective in detecting spliced photos and its accuracy is acceptable compared to the other methods.

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