Detection of Doctored Image Using Variant of Color Filter Array

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Abstract

Discrimination of computer generated images from real images is becoming more and more important. In this paper, we propose the use of new features to distinguish computer generated images from real images. The proposed features are based on the differences in the acquisition process of images. More specifically variant of color filter array. The basic idea is that the correlation between bit planes of an image will be different in doctored image compared to real image.

Keywords

Digital Image Forensics, Image Processing, Classification, Demosicing.

I. Introduction

The advances in digital technologies have given birth to very sophisticated and low-cost tools that are integral parts of information processing. The trend brought with it new challenges concerning the integrity and authenticity of digital documents, in particular images. The most challenging is that images can be edited and manipulated easily without leaving any obvious trace on having been modified. As a consequence, one can no longer take the authenticity of image for granted, especially when it comes to legal photographic evidence. Today, there is a severe lack of techniques and methodologies for addressing this sort of a problem. In this context, digital forensics is concerned with determing the original and potential authenticity of a digital image. Digital water marking can serve in a scheme to authenticate images. However, presently the overwhelming majority of images that circulate in the media and Internet do not contain a digital watermark. Hence in the absence of widespread adoption of digital watermarks or concurrently with it, we believe it is necessary to develop image forensics techniques. We define image forensics as the art of reconstructing the set of processing operations, calls overall doctoring that the image has been subjected to. In prior schemes of differentiating doctored images from original images was based on training a classifier based on certain image quality features, called also " generalized moments". Scaling, rotation, brightness adjustment, blurring, enhancement etc. or some particular combinations of them are typical examples of doctoring. A frequent image manipulation involves the pasting of another image, skillfully manipulated so to avoid any suspicion. Since the image manipulation can be very subtle to eschew detection, the discriminating features can be easily overwhelmed by variation in the image content. It is thus very desirable to obtain features that remain independent of the image content, so that they would only reflect the pressence, if any, of image manipulations.

II. Decription Of Features

We assume that altering an image changes the correlation between and within bit planes. Therefore the quantal-spatial correlation between the bit planes of the original image will differ from that of the bit planes of the doctored images. Consequently certain statistical features extracted from the bit planes of image can be instrumental in revealing the presence of image manipulations.

Features used are:

Let Sc(x, y) be the image intensity of color channel c at spatial location (x, y) and c 2 {R,G,B} and ¥ k,c represent the set of color filter array locations of channel c for a type of CFA pattern denoted by k. The color filter mask for a particular channel is defined as:

$$M_{k,c}(x, y) = \begin{cases} 1, (x, y) \text{ belongs to } ¥_{k,c} & [1] \\ 0, \text{otherwise} \end{cases}$$

Assuming 4 × 4 CFA conuration, there are 36 different filter arrangements. In this paper, we restrict the maximum value of k with 4 since most digital cameras use the Bayer CFA pattern in which the green color filters are placed on the diagonal. Denoting I' c (x, y) as the output of CCD sensors for three different channels and f as the demosaicking function, the interpolated image I before post processing operations is defined as:

$I = f(I', M_k)$, and $I'_c (x, y) = Sc(x, y) . M_{k,c} (x, y)$.[1]

In the proposed method is that if a given image, that has been initially interpolated with a Bayer demosaicing filter, is reinterpolated with a different kind of CFA, the right CFA pattern should yield significantly smaller mean squared error than others patterns. Therefore, If an image is not acquired with Bayer sampling or heavily distorted with compression than we would expect that all re-interpoation MSE values for different CFA patterns should represent a uniform distribution.

Algorithm steps involved:

To estimate the presence of Bayer interpolation, the image is divided into D × D sub-blocks. CFA pattern detection method is based on the mean square error (MSE) variations depending on different kind of demosaicking methods so mean square error is calcuated. The non smooth blocks whose high freq. Components energy (pixel values' standard deviation) is above a certain threshold are used solely. We choose the demosaicing algorithm, f, to be bilinear interpolation. We denoted each non-smooth block with B_i, where i =1, ...,N. N is the number of non smooth blocks in a given image. The corresponding re-interpolated blocks, using filter k, is denoted with $\hat{B}_{i,k}$. Essentially, $\hat{B}_{i,k}$ is computed as a convolution between the bilinear kernel and the re-sampled block Bi with the kth CFA pattern Mk. Denoted by

$\hat{B}_{i,k} = f(B_i,M_k)$, and k = 1, ..., 4.[1]

The MSE error between the blocks B and ˆB is computed in non smooth regions all over the image as:

$$E_i(k, c) = \frac{1}{D \times D} \sum_{x=1}^{D} \sum_{y=1}^{D} (B_i(x, y, c) - \hat{B}_{i,k}(x, y, c))^2$$

To detect the relative error distances between color channels, a new error matrix $E_i(2)$ is created by normalizing all the rows of the Ei, as

$$E_i^{(2)}(k, c) = 100 \times \frac{E_i(k, c)}{\sum_{l=1} E_i(k, l)} \quad , c = 1, ..., 3. \ [1]$$

Due to the higher presence of green channel elements, most significant MSE variations due to different CFA patterns are observed in green channels. Therefore, the green channel column of the normalized error Ei , Vi(k), is used in extraction of some features which are directly correlated with CFA demosaicing operation. From Vi(k) vector, it is possible to get the index of CFA pattern which yields the minimum MSE, as P1(i) = argmink Vi(k). The pattern number which yields the second minimum MSE in the error matrix is stored in a separate P2 vector as well.
Thus, another feature can be derived to capture the uniformity of Vi vector such as

$$P_3(i) = \sum_{l=1}^{4} | V_i(l) - 25 | \quad [1]$$

P1(i), P2(i), and P3(i) values are computed for all non smooth blocks. If the given image is interpolated with any demosaicking algorithm, histograms of P1, P2, and P3 should concentrate in particular values which can be consequently used to detect demosaicing operation. We have changed the threshold value which results in change in output of the result i.e we get more accurate portion of doctored area.

III. Experiments

The Bayer features described above are expected to take relatively high values if the given image is obtained through a Bayer color filater array.

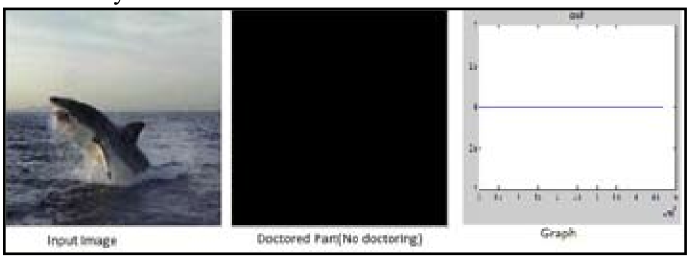

Fig. 1: Real Image result with graph

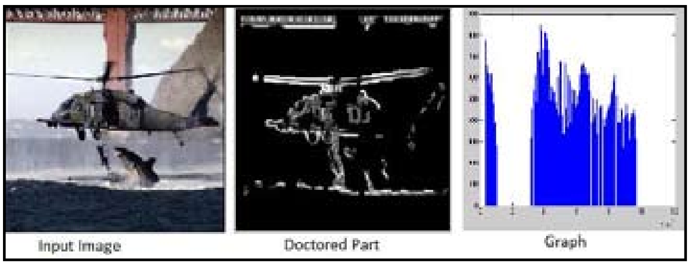

Fig. 2: Doctored Image result with graph. (Highlighted part is doctored)

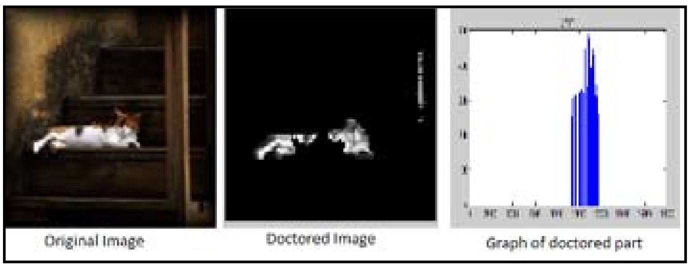

Fig 1. Doctored Image along with the graph of doctoring portion

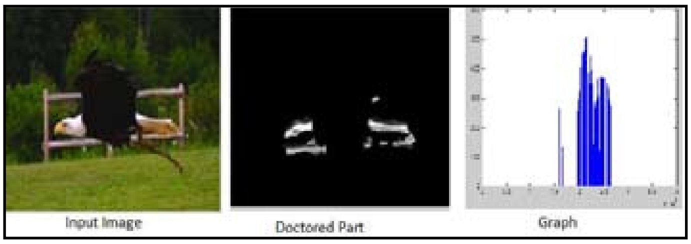

Fig. 4: Doctored Image result with graph. (Highlighted part is doctored)

Fig. 5: Doctored Image result with graph. (Highlighted part is doctored)

The graph in the above figures 1,2,3,4 and 5 show the portion of doctoring in an image with x –axis representing no. of pixels and y-axis representing pixel values. By looking into the graph we get to know the amount of doctoring in an image. The straight line in the graph in fig 1. shows that there is no doctoring done for that image.

IV. Conclusion

There are many methods to detect doctored images but the method which we have proposed i.e Detection of Doctored Image using variant of color filter array is the good method which gives better result when compared to other methods. Hence the results obtained are shown above. We have already tested for about 100 images, results are also obtained for the same and are saved in database.

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