Exposing Image Manipulation with Curved Surface Reflection

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Abstract

Objectives: One of the principal problem in image forensics is identifying if a particular image is manipulated or not. Nowadays powerful image editing software increases the difficulty in finding the authentic image. Our approach is to detect curved surface manipulated area inserted in the photograph by describing a geometrical technique. Methods/Statistical Analysis: This technique is combined with multiple image segmentation methodologies. The main objective of our work is to identify the manipulated area from the reflected images. Findings: Our contribution of this paper is to design a new geometrical relationship between the original and fake images. We use the new notations for this geometrical representation and combine these notations to the basic image segmentation methods. Finally we identify the fake reflected image using the different approaches and compare the results and produce the best performance of our work. Application/Improvements: The experimental result shows that our method achieves promising performance for tampering the curved surface reflections. The result of our work, we compared the 100 images and produce the best PSNR value and compression ratio.

Keywords: Curved Surface, Forgery Detection, Image Forensics, Reflection, Top-Hat

1. Introduction

Recently it is difficult to identify the image by the occurrence of more image editing software such as paint, Photoshop etc in the domain of image manipulation. The fake images created even make the court of justice to go wrong.

Figure 1 represents the original image along with its fake image. Above said image says, on seventh day of November in the year of 1999, the Soviet Union celebrated its second anniversary of the October revolution. Lenin is standing at the centre of the left figure wearing the soviet cap. Among the two standing at the left side of Lenin, Trotsky is the one wearing glass with a salute. Trotsky was supreme leader in the military council of Russia in the period of Lenin the above said figure was modified by removing Trotsky along with three peoples and published in the newspaper of Moscow at 1967.

Figure 1. The fake image (right) shows missing of some persons and its original one (left).
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Figure 2. The fake image (left) shows one person stand in front of the car and slightly moved backward and its original one (left).

Figure 2 represents instance for the altered image and its original one, the car is slightly moved backward and one person standing in front of the car in the left image and its original one in the right. This paper is organized as follows: section 2 describe about the existing work for image forgery detection, section 3 explains the geometrical representation, top-hat filtering, Gray scale reconstruction, morphological binary image analysis, thresholding segmentation and super pixel. Section 4 discusses about the result and performance of the forgery detection method with graphical representation followed by conclusion and future work provided in section 5.

2. Related Work

Recent years the various forgery methods and techniques were used to identify the fake image. Nowadays it is a critical to identify a altered image. To proposed a method Bit level key agreement to identify the forged region from suspicious region which can be effectively recognised if any image is a forged one from the suspicious region. It is also proposed another one approach by exploring the basic image manipulation which is used to find the digital image manipulations. The operations used here are re-sampling, contrast enhancement and histogram equalization.

In the field of image forgery localization presented a forensic algorithm to discriminate between original and forged region by evaluating the performance of a detector based on thresholding the likelihood map, considering different forensic scenario. The main motivation for this approach is to detect and localize a tampered area into a digital image in the presence of a JPEG recompression. To introduces a novel methodology based on Scale In-Variant Future Transform (SIFT).

The basic method used for manipulating a photo is joining more images into a single lossy compression methods like jpeg, is used often in many camera which allows more flexibility in compression. The light source direction can be calculated by performing three simple assumptions. First is, the surface of interest is lambertion. Second is , the surface has a constant reactance value and the third is , a point light source is used for surface illumination ; and the angle between the surface normal and the light direction is in the range 0 to 90. Modelling the edge image as a finite-state Markov Chain (MC) to capture its inter-pixel dependencies.

Quantization, P parameter calculates the quantization steps and this parameter used in discrete cosine transform for finding quantization steps. The P factor leads to good solution for higher values and false matches for lower values. To demonstrate the robustness performance of the technique, it has been tested under several attacks including: 1) JPEG compression, 2) image filtration and 3) noise attacks. In this new scheme, the entire image, even low contrast regions, is covered adaptively based on distinctiveness metric.

To classify the forged images, we propose a method to identify the histogram features with the help of LBP code as well as three special classifiers like back propagation neural network, combined k-nearest neighbour and support vector machine. To detect forgeries, image is divided into overlapped blocks and feature vectors are generated for every block. Feature vectors are tips about copy move forgery. We need to explore colour, shape and texture features by combining the different statistics powered by different image descriptors. We locate a forgery which involves people, specifically the face of a person in an image.
We lexicographically sorted the feature matrix and after this step, similar image blocks are sequentially sorted. To identify the CFA pattern observed that the image re-interpolation is done with several CFA patterns and for each pattern mean square error is calculated between the input and the re-interpolated images. Physically based forensic method to identify the tampered image that is focused on the constraints of shading and shadows. A new copy-move forgery detection using Multiresolution Local Binary Patterns (MLBS). They focus not only detecting duplicated region but also determine the geometrical transformation applied in the forgery region and no need of watermarks, signature information or any metadata.

3. Methodology

In this paper, we propose forgery detection techniques like geometrical expressions combined with various image analysis methods. Using this technique we calculate the parameters and constrain among the original and fake images.

![Figure 3. This figure illustrates the geometrical relationship between the original and reflected images in an image formed with original image AB, reflected image ED and mirror M.](image)

3.1 Geometrical Representation

Let us assume an object which is placed at some distance from the mirror as represented in figure 3. A ray diagram is used to locate the object this diagram, consist of the ray from the light to the mirror and from the mirror to the light (reflection) the image will be at the intersection of the reflected rays, which follows the basic rules of intersection, we should find the intersection and where the image is present with the help of the reflected rays which diverges from the mirror.

Our objective is to find out the focal length of an image. The focal length \( f \) is given by,

\[
\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}
\]

(1)

Where \( d_o \) is the distance between mirror and object \( d_i \) is the distance between image and mirror. We find the \( d_i \) value as follows:

\[
\frac{1}{d_i} = \frac{1}{f} \cdot \frac{1}{d_o}
\]

(2)

\[
\frac{1}{d_i} = \frac{d_o f}{(n-1) \left( \frac{1}{R_1} - \frac{1}{R_2} + \frac{(n-1)d}{R_1 R_2} \right)}
\]

(3)

Where \( d \) is the thickness of mirror and \( n = \frac{c}{v} \), \( c \) is the velocity of light and \( v \) is the velocity of light in object. \( R_1 \) and \( R_2 \) are radius of curvature to find out the radius of curvature of the curved surface image.

Consider the parabolic equation and assume the parameter values,

\[
R = \frac{(1 + Y_1^2)^{\frac{3}{2}}}{Y_2}
\]

(5)

Where \( Y_1 = \frac{dY}{dx} \), \( Y_2 = \frac{d^2Y}{dx^2} \), consider the parabolic curve \( \chi^2 = -4ay \) and substitute in equation 5

We also find the magnification ratio which is given by,

\[
M = \frac{h_i}{h_o} = \frac{d_i}{d_o}
\]

(6)

Where \( h_o \) is the height of the object and \( h_i \) is the height of the reflected image.

3.2 Top-Hat Filtering

Compute the morphological opening of the image and substitute the result to the original image. In Nine-pixel Differencing and Modified LSB Substitution generalizing the top-hat filtering method, the method used here are, vertical order and demonstration. The first method determines the vector space and the second is used to rewrite the top hat based on increments and keeps track of the channels with the help of vectorial order. The pixel wise vector distance is then replaced by the standard top
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The top-hat filter produces gray scale images with the help of vectorial order and demonstration. The top-hat opening filter method can be expressed as follows:

$$T_W(f) = f - f \circ b$$

(7)

Where $f$ is the given function, $T_W(f)$ is the top-hat transformation of $f$, $b$ is the gray scale structure element and $\circ$ is the opening operation. In top-hat filtering method, top-hat transformation to identify the feature of images, concept of invariant pixels is introduced based on the binary structuring elements for XML based electronic retrieval system.

### 3.3 Gray scale Reconstruction

This process is able to segment or extract desired parts of gray scale images. First read the gray scale image by converting colour image and then apply edge detection function to generate gradient images. This technique FPGA and ASIC Implementation of Systolic Arrays for the Design of Optimized Median Filter, is not affected by lower contrast edges, due to noise that could produce local minima and produce erroneous results. The marker image and the mask image place a vital role in geodesic dilation. An elementary isotropic structuring element is used to dilating the marker image and the resultant image will be below the mask image and it acts as a limit for the dilated mask image. This can be defined as follows:

$$\delta(J) = J + B$$

(8)

Where, $J$ denoted marker image, $B$ denotes the isotropic structuring element. This method can be extended...
to the gray scale case where it turns out to be extremely useful for several image analysis tasks and provide gray scale reconstruction.

**Figure 6.** (a) Authentic binary image; (b) Authentic morphological image; (c) Fake binary image; (d) Fake morphological image.

### 3.4 Morphological Binary Image Analysis

To avoid higher intensity values on an image, we go for skeletonization, in which we use gradient and watershed to find out the real image. For image segmentation threshold is used to discriminate for the ground from the background.

The simplified version of algorithm is which can calculate centroid of several white contours in a binary image. If there is only one white contour, coordinates $X_c$ and $Y_c$ of the contour centre are expressed as follows:

$$X_c = \frac{1}{M} \sum_{i=1}^{n} x_i \ m_i$$

$$\sum_{i=1}^{n} x_i \ m_i$$

$$Y_c = \frac{1}{M} \sum_{j=1}^{n} y_j \ m_j$$

Where $M$ is the sum of intense, $m_i$ is the pixel intense value, $x_i$ and $y_j$ are pixel location on the image, $n$ is the total number of pixels.
3.5 Thresholding Segmentation

is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. Threshold techniques can be categorized into two classes: global threshold\(^{25}\) and local (adaptive) threshold. In the global threshold, a single threshold value is used in the whole image\(^{26}\). This technique can be written as:

\[
T_s = T_s[a, b, p(a, b), f(a, b)]
\]  \hspace{1cm} (11)

Where \(T_s\) is the threshold value, \(a, b\) are the coordinates of the threshold value point, \(p(a, b), f(a, b)\) are points the gray level image pixels.

3.6 Super Pixel Segmentation

In this proposed super pixel algorithm, to make the image we use a regular grid of super pixels which consist of a number of properties. The topological constrains gives good performance when compared with similar algorithms and also gives good measure of super pixels, which can be defined as:
\[ R^2 = \frac{\sum_i (x_i - \mu)^2}{\sum_i (x_i - \mu_i)^2} \]  \hspace{1cm} (12)

Where we sum over i pixels, \( x_i \) is the actual pixel value, \( \mu \) is the global pixel mean and \( \mu_i \) is the mean value of the pixels assigned to the super pixel that contains \( x_i \).

**4. Experimental Result**

We have discussed the result of the proposed system in this section. Figure 4 shows the analysis of top-hat image from the input image. We construct the gray scale segmentation showed in Figure 5. After we analyse the binary image segmentation and morphological process as represented in Figure 6. Finally thresholding the image to get the segmented image as mentioned in Figure 7 followed by super pixel segmentation in Figure 8.

The image editing software like paint, Adobe Photoshop etc is been used to produce the false images. Hundred fake images are involved in testing and the result is found better than the existing system. Figure.9 shows the graphical representation of the various methodology discussed in section 3 and the performance is discussed in the Table 1.

| Image         | Input image size | Encode process time(sec) | Bit per pixel | Compression ratio | PSNR  |
|---------------|------------------|--------------------------|---------------|------------------|-------|
| Authentic image | 150*200*3        | 1.04060                  | 0.2954        | 27.0854          | 7.2140|
| Fake image    | 150*200*3        | 111.1680                 | 0.2995        | 26.7080          | 4.4725|
| Detection ratio | 0.00            | -0.762                   | -0.0041       | 0.3374           | 2.7415|
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5. Conclusion and Future Work

In this paper, a new geometrical way of representation has been proposed. The method is based on the process of image segmentation. The main objective of this forensic technique is to identify the fake curved surface reflected images. The proposed approach is more efficient because of segmentation with geometrical representation rather than the previous methods. A key step in applying our method is to analyze the image using segmentation process such as top-hat filtering, gray scale reconstruction, morphological binary image analysis and thresholding techniques followed by super pixel segmentation.

The curved surface shadows has been developed with the similar methods in the future .the images with irregular shapes like mountains, cooking vessels, crushed materials can be used in further development. In the future we will try to integrate some other technique to solve these curved surface reflection problems and increases the performance of the experimental results.

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