가보 필터를 이용한 이미지 위조 검출 기법

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Image Forgery Detection Using Gabor Filter

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Abstract

Due to the availability of easy-to-use and powerful image editing tools, the authentication of digital images cannot be taken for granted and it gives rise to non-intrusive forgery detection problem because all imaging devices do not embed watermark. Forgery detection plays an important role in this case. In this paper, an effective framework for passive-blind method for copy-move image forgery detection is proposed, based on Gabor filter which is robust to illumination, rotation invariant, robust to scale. For the detection, the suspicious image is selected and Gabor wavelet is applied from whole scale space and whole direction space. We will extract the mean and the standard deviation as the texture features and feature vectors. Finally, a distance is calculated between two textures feature vectors to determine the forgery, and the decision will be made based on that result.

1. Introduction

Digital visual information in the form of digital images and videos is becoming popular and important as broadband infrastructure and digital technology are growing. As such, how individuals perceive visual media is of importance and could play an important role in shaping their society; as a result, the need for digital image forgery detection has been arisen. Copy-move forgery (CMF) is the most common type of image forgery; in this case one region is copied from one place and pasted to another place of the same image in order to conceal important information. In another similar kind of forgery, a part is copied from one image and is pasted to a different image. This type of forgery is called image splicing.

Image forensics can be divided into active forensics and passive forensics [1, 2]. The active forensic approach is a non-blind approach. Image watermarking [3-4] is a popular technique among the non-blind approaches. Image watermarking embeds a watermark at the recording time and extracts hidden message later to verify the image authenticity. The passive forensic approach is a blind approach. No supplementary information is used in the passive forensic approaches, such as copy-move forgery detection [5] and tampering detection of composite images [1, 2, 5]. Therefore, the passive forensic approaches are more realistic than the active forensic approaches.

Discrete cosine transform (DCT), Gabor transform and discrete wavelet transform (DWT), have been adopted successfully to solve the image annotation problem in some other models separately in [1]. Inspired to investigate the performance of the visual feature extraction method for image annotation based on the distribution of feature vectors, these three famous transform methods are investigated to extract feature vectors which can be taken as texture features of the image [6].

In this paper, we proposed effective image forgery detection by using Gabor filter which is able to capture the texture features at various orientations and frequencies as well as it can achieve the optimal localization in spatial and frequency domain. Hence we choose use the mean and the standard deviation instead of energy as feature vectors to make the method more efficient. Besides the method is robust against illumination, rotation invariance and robust to scale.

The paper is organized as follows: Section II has the texture descriptor of Gabor filter. Section III explains the proposed method. And lastly, Section V gives a conclusion.

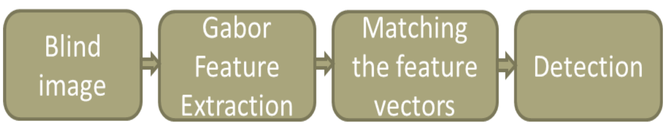
2. Texture Descriptor: Gabor Filter

Many texture features have been widely used in object recognition, image content analysis and many others. Texture feature extraction aims to extract proper features to distinguish different textures.

As to the feature extraction method, much work has been done and many methods have been proposed [10]. Generally, visual features in an image may include color, texture, shape, color layout, etc.

Gabor filter

Gabor filter has emerged as one of the most popular ones. Gabor filter-based feature extractor is in fact a Gabor filter bank defined by its parameters including frequencies, orientations and smooth parameters of Gaussian envelope [8].



(Figure 1) Scheme of our method

Because of its excellent spatial locality and orientation selectivity, it can extract spatial frequencies and local structural characteristics within the local area of the images at multiple directions ' and also have certain tolerance on the changes in displacement, deformation, rotation, scaling and illumination [7].

Gabor-wavelet transform can be regarded as the wavelet transform whose mother wavelet is Gabor function [9]. Assume that an image is represented by f (x, y) of size M×N. Then its discrete Gabor wavelet transform can be expressed as follows:

$$G_{pq}\left(x,y\right)=\sum_s \sum_t f\left(x-s,y-t\right)\Psi*_{pq}\left(s,t\right) \quad (1)$$

Here ***s*** and t are the filter mask size variables, and ***p*** and ***q*** are the scale and direction values, respectively. Also $\psi*_{pq}$ is the complex conjugate of ψ_{pq}, which is a self-similar function generated from the dilation and rotation of the mother wavelet 'ψ'.

$$\Psi*_{pq}\left(x,y\right) = \alpha^{-p}\left(x?\ y\right) \quad (2)$$

Here α is the factor of scale and greater than 1.
Also p = 0, 1… ***P-1*** and $q = 0$, 1… ***Q-1***, respectively, where ***P*** and ***Q*** are the total number of scales and directions
And x' = α^{-p} (x cos θ + y sin θ) and
y'= α^{-p} (-x sin θ + y cos θ),
Where θ = qπ/ Q.

$$\psi(x,y)=(\frac{1}{2\pi\sigma_x\sigma_y})\exp(-\frac{1}{2}(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}))\exp(2\pi jWx) \quad (3)$$

Here W defines the frequency bandwidth of Gabor filter. It has been found in neurophysiology that ***W*** = 0.5 is completely consistent with visual system of human. σ_x and σ_y are constants of Gaussian envelope along ***x*** and ***y*** axles in time domain respectively.

Gabor-wavelet transform is used for the scale ***p*** and direction ***q*** of image ***f (x, y).*** Then the energy information can be represented as follows.

$$E(p,q)=\sum_x\sum_y\left|G_{pq}\left(x,y\right)\right| \quad (4)$$

The representative ***N*** images are selected from X_i. If the energy of each image in scale ***p*** and direction ***q*** is denoted as $E_{pq}(x)$, the energy of X_i in scale ***p*** and direction ***q*** can be denoted as follows.

$$E_{pq}\left(X_i\right)=\sum_x E_{pq}\left(x\right)/N \quad (5)$$

The energy of X_i in each scale and each direction is computed in whole scale space and whole direction space. If the maximum of the energy of X_i in scale ***p*** and direction ***q*** is denoted as max ($E_{pq}(X_i)$), the dominance of X_i in scale ***p*** and direction ***q*** is measured as follows.

$$W_{pq}\left(X_i\right)=E_{pq}(X_i)/\max\left(E_{pq}\left(X_i\right)\right) \quad (6)$$

The amount of representative images selected from X_i (that is ***N***) is changed, and the above process is repeated ***M*** times. Based on the results of ***M*** tests, the dominant multi-scale and multi-direction fuzzy set consists of scales and directions with the most dominance and relative stabilization.

3. Proposed method

Texture features extraction

As the scheme of our method is Figure 1. The detection is doing as follows: The first step is to take an image ***f(x, y)*** of ***M×N*** size. Apply on the image the Gabor filter by using equation ***(1)*** and ***(2)*** respectively, by doing that we will obtain an image with different orientation at different scale.

To improve performance of the method, the mean and standard deviation are usually selected as texture features instead of energy. Suppose if the size of each image is ***M×N*** and its mean and standard deviation computed from scale ***p*** and direction ***q*** are denoted as $\mu_{pq}(x)$ and $\delta_{pq}(x)$ respectively, the $\mu_{pq}(x)$ and $\delta_{pq}(x)$ can be denoted as follows respectively.

$$\mu_{pq}\left(x\right)=\frac{E_{pq}\left(x\right)}{MN} \quad (7)$$

$$\delta_{pq}\left(x\right)=\sqrt{\frac{\sum_x\sum_y\left(\left|G_{pq}\left(x,y\right)\right|-\mu_{pq}\right)^2}{MN}} \quad (8)$$

Feature vectors and matching

A feature vector ***V*** is created using $\mu_{pq}(x)$ and $\delta_{pq}(x)$.
V= (μ_{00} , δ_{00}, μ_{01} , δ_{01}, μ_{01}, …).

When tampering is done, the original texture of the image is distorted. One of the efficient method to detect forgeries is to compute the difference between the textures.

Let us assume that the scale p=3 and set a threshold β.A and B are feature vectors.

If $A-B\succ\beta=0.5$
Then the image is authentic.
If $A-B\leq\beta$
Then the image is forged.

4. Conclusion and discussion

Many texture features have been proposed but most of them are neither rotation invariant nor robust against scale and other variations.

In this paper we proposed, a method based on Gabor filter which revealed to be robust illumination and rotation. Furthermore the method detects as well the forgery inside image. For future work, we will continue with this method to see all the performance it can gives in other different areas.

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