**COMBINING IMAGE SECURITY AND AUTHENTICATION USING SIFT AND ZERNIKE MOMENTS**

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**ABSTRACT**

In this paper, we propose a system that protects and authenticates digital image by applying Data Hiding schemes in Cipher text images. Image features are extracted using Global Zernike moments and Local SIFT features which acts as embedded data and used for authentication purposes. The image is preprocessed by employing a Histogram shrink operation and then Encrypted using Paillier cryptosystems. To this cipher text image, features extracted are embedded using Multilayer Wet Paper coding. At the receiver side, the image is decrypted and original image along with embedded data are recovered. To this received image Global Zernike moment’s features and Local SIFT features are extracted and compared with the received features data to verify the authenticity of the image. The proposed system simultaneously authenticates and provides security for the digital image.

1. **INTRODUCTION**

In recent days, digital images have widespread use in multimedia data. With the enormous image editing application the security and integrity of images are greatly challenged. The images may also be vulnerable to many attacks during transmission over public or wireless channels. Such attacks in image data could change the decision when digital images are used as evidence in criminal investigation, medical images, forensic sciences, notary documents etc.

To ensure image authenticity, content based authentication greatly reduces the computation than strict authentication. The content of the image is represented as a small code called Hash code [1]. Hash code can be generated by extracting local and global features [2], Watermarking methods [3] [4], Transform co-efficient [5] [6], and much more. In recent work combining two or more hashed techniques to generate the hash code is also most common to take advantage of different hashing techniques [7]. The main drawback of representation of image by its content is the possibility of having some feature vector for different images [7]. This vulnerability can be removed decisively, but can be avoided by generating features based on local and global image features. Thus for ensuring authenticity of image hash code based on feature of image can better be used.

Global features are describing the image as a whole to generalize the entire object whereas in local features focusing and extracting the key points from an image. Moments are set of values used to describe the information content in the image. A proper subset of moments is always the best choice that describes the exact content of image. Zernike moments have an orthogonal basis functions and are used as Global image features in most authentication system [2]. Lv et al. [12] explained about local feature points and shape context by using SIFT as feature extraction method. SIFT is used to select the most stable key points from the image and it is embedded to generate image hash.

In spite of using all approaches to extract the features from an image, but still at the receiver side encounters some additive noise or blurring [11]. Therefore, Zhao et al. [10] combined global and local feature extraction methods to construct image hash.

The most traditional way of providing security to any type of data in cryptosystem. Image encryption is used in many applications for providing security. Paillier cryptosystem algorithm [8] is used for Image encryption. To take advantage of Protection and authentication the proposed system embeds the hash code with the encrypted image. For embedding, the data into the cipher text image multilayer wet paper coding is used.

The remainder of the paper is organized as follows: Section II Paillier cryptosystem, Section III Zernike Moments, Section IV SIFT, Section V Overview of wet paper coding, Section VI Implementation of the proposed system, Section VII Experimental Results and Section VIII Concludes the paper.

1. **PAILLIER CRYPTOSYSTEM**

Select two large prime numbers p and q and calculate n = p.q such that ‍λ = lcm (p-1, q-1) where lcm means the Least common multiple and gcd (n, (p-1) . (q-1)) = 1 where gcd means the Greatest common divisor. The pair <n,g> in act as public key and the pair <λλλλ , µ> act as private key where

**µ = (L(gλ mod n2))-1 mod n** where **L(x) =**

Cipher text

**C(i , j) = .] mod**

where r(i , j) is a random integer in

Plain text

**m(i , j) = mod**

1. **ZERNIKE MOMENTS**

The Complex Zernike moments of order n with repetition m for a continuous image function f(x,y) for X Y image plane are defined as

**Anm = n+1/π ∫∫x2+y2<=1 f(x, y) Vnm\* (P,) dx dy**

**Anm = n+1/π ∫02 π ∫01f (P,) Rnm\* (P) exp (-jmo) P.dP.d**

Where n is either positive integer of 0.m takes positive and negative integer with the constants n-|m|= even and |m|<=n, P is the length of the vector from the origin to the pixel at (X, Y) and is the angle between vector P and the X-Axis is the counter clockwise direction.

The Zernike Polynomial is given as

**Vnm(x, Y) = Vnm (P sin, P cos) = Rnm (P) exp (jm)**

It refers complex conjugate.The features of invariance under image rotation makes Zernike function of the most important moments.

1. **SIFT**

SIFT [13] has been widely applied where object recognition plays a vital role in Image Processing. Since its key-points are invariant to image scaling and rotation, and are shown to provide Robust matching across a substantial range of affine distortion, change in 3D viewpoint and change in illumination.

*Scale-space extreme value detection:* the scale space of an image I(x , y) is defined as:

Where \* is the Convolution operation,

**G(x,y,**

is a variable scale Gaussian function, is the scale. To efficiently detect stable key-point locations in scale space, the difference of Gaussian (DoG) is defined as the difference of two nearby scales separated by a constant multiplication factor .

)

The maxima and minima of the DoG can be found by comparing a pixel to its neighbors in 3 x 3 regions at the current and adjacent scales. These extreme values are referred to as candidate key points.

*Accurate key-point localization and Orientation assignment:* To enhance the matching stability, some candidate key points with low contrast and poor localization along an edge are rejected. An 2x2 Hessian matrix is used to compute the principal curvatures and to remove unstable points. To make key point rotation invariant, each key point is assigned the dominant direction of the local gradient by computing the gradient magnitude m(x,y) and orientation :

After the key point detection is completed, a vector ( is used to represent each key point

1. **MULTILAYER WET PAPER CODING**

In encrypted image, cipher text pixels are divided into two sets. Set A including C(i , j) with odd values of (i + j). Set B including C(i , j) with even values of (i + j).

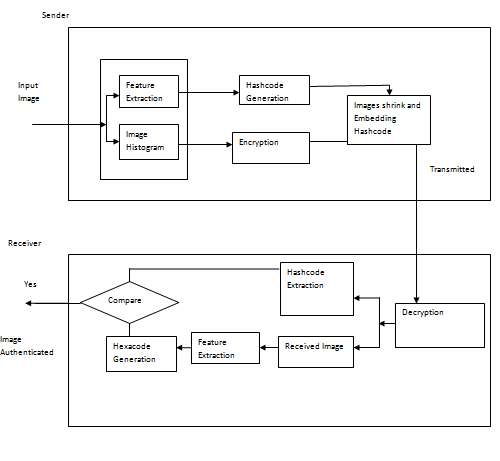
Without any loss in data, the pixel number in Set A is . It employs Error correction codes to expand the additional data as a bit sequence with length , and maps the bits in the coded bit sequence to the cipher text pixel in Set A in a one to one manner.

When Paillier Cryptosystem is used, if the bit is 0 the corresponding cipher text pixel is modified as

**w**here r’ (i , j) is a randomly selected integer in . If the bit is 1, the corresponding cipher text pixel is modified as

**.**

This way an encrypted image containing additional data is produced. Additional data are embedded into Set A. Set B will be used for data extraction since the pixel values in Set A are difficult to be precisely obtained on receiver side. It leads to possible errors in directly extracted data.



**Figure 1-Architecture diagram**

Therefore, the error correction coding mechanism is employed here to ensure successful data extraction and perfect image recovery.

1. **IMPLEMENTATION**

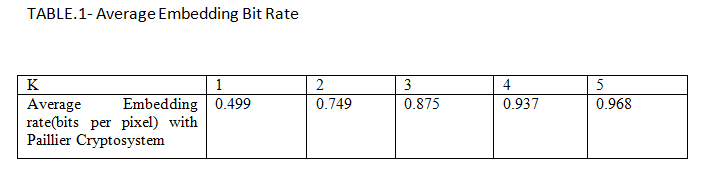
The architecture of the proposed system is as shown in figure. In the sender side the input image undergoes a preprocessing stage. In the Preprocessing the input image of size 512 X 512 is converted to grayscale image. For this grayscale image Zernike moments of order n = 10 is calculated and for the same gray scale image SIFT is used to obtain local features .A set of ‘V’ interest points are noted and for each point 4 set of values (x,y,,) are calculated where x,y is the co-ordinates of interest points , is the scale with different directions is calculated . From a set of V’ points ‘K’ set of points are calculated based on by arranging them in descending order repetition can be avoided. From this SIFT and Zernike moment values, hash code [HS]is generated. The same grayscale image is then converted to Image Histogram and encrypted using Paillier cryptosystem. To this cipher text hash code is embedded using Multilayer wet paper coding algorithm and is transmitted.

In the receiver side, the received image is decrypted and the hash code [HS] and image is extracted. To this extracted image again Zernike Moments of order n = 10 and SIFT values are calculated and hash code is generated [HR]. Now HS and HR is compared using Correlation co-efficient and authenticated if it is above certain threshold τ.

1. **EXPERIMENTAL RESULTS**

The size of the image is taken as 512 X 512. A median filter is applied to eliminate noise and is converted to grayscale image. For this grayscale image Zernike moments ‘Z’ of order n = 10 is extracted and is normalized using a random vector R using ZM = [Z + R mod 256]. The SIFT interest point features are calculated as SIP={P1,P2,P3……PK} where each Pi has the following 4 set of values (x,y,,). The hash code Hs= [ZM SIP]. This Hs now becomes the code to be embedded. The grayscale image converted to Image Histogram and is encrypted using Paillier Cryptosystem. The obtained cipher text is then divided into two set A and B and the set is shrinked to half to embed the hash code Hs in bit 0 and bit 1 of each pixel. A and B is combined to get transmitted image.

Table-1 list the average value of embedding rates when K - LSB planes are used for carrying the additional data in 50 encrypted images.



The performance of the system is measured using peak signal to noise ratio for various embedding rates. For an image of size M x N the MSE and PSNR are given as

1. **CONCLUSION**

This paper proposes a system that integrates image protection and security. Due to the compatibility of data embedding and encryption, the required performance of the system is 100% achievable. However on the receiver side there is slight distortion introduced in decrypted image due to the presence of additional data embedded in the cipher text image during the transmission.

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