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A Novel Visual Cryptographic Scheme using RGB Plane Slicing

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Abstract: The paper models a novel visual cryptographic algorithm using image RGB plane slicing. The technique employed in this article is a keyless scheme with a minimal computational load. The approach generates two shares of images from the original secret image. The shares are generated by RGB slicing such that no individual share reveals any information only when the shares are overlapped the secret image is exposed. The main demerit of visual cryptography is the quality of the decrypted image decreases. In the method described, the original image could be formed by copying the pixel value of the shares on the RGB planes without any degradation of image quality.At such the originality, accuracy, secrecy and confidentiality of the secret image is maintained while sharing over a medium.

Key Words: Visual cryptography; RGB Image; shares; keyless; image; computational complexity, accuracy; secrecy; algorithm

I. INTRODUCTION

With the exponential increase in technology, the internet has become a prominent medium for sharing of multimedia information over the network. Most of the medium of work has been digitized over the decade. At such most people depends on weak password systems and servers for their daily work. Many cryptographic algorithms had been developed for such purpose but due to the overhead of key management and substantial computational cost such techniques are rarely used. This gave dimension to a new cryptographic technique known as visual cryptography. Visual cryptography was first time introduced in 1994 by Naor and Shamir [1]. Visual cryptography is simple and images encoded can be decoded using the normal human visual system by a layperson, without the aid of any shophisticated service. Visual cryptography scheme is not associated with any complex computation in decryption process, and simple overlapping of shares operation can regenerate the secret images. It does not require any particular cryptographic knowledge to implement and hence many researchers' had worked on it. Mostly visual cryptographic methods deal with binary images, but there is few that deal with color images[2]. However, most of the methods used for color images have a poor reconstruction of the original image-compromising image quality and information loss of the recovered image.

This paper describes a technique of visual cryptography using image RGB plane slicing. The shares are generated in this scheme from the original secret image by dividing the secret image into its constituent RGB planes and selecting a plane from its RGB component and adding random pixels to the remaining planes from a random image. The original image is obtained by copying the pixel value from required planes of the shared image and original image to a third image. This method is a keyless technique and implies no loss of pixel information from the original reconstructed image with less computational complexity.

II. LITERATURE REVIEW

A. RGB Color Model

RGB model is composed of three color component red, green, blue. It is an additive color model. The Primary red, green blue colors are added to the black color to have different color models. If the intensity is minmum i.e.zero intensity for each color gives a black color while maximum intensity for each component gives a white color.

Secondary colors are formed by the mixng of two primary colors from RGB model of equal intensity: e.g., cyan is formed by the addition of green and blue, magenta is formed by mixing red and blue, and yellow by adding red and green respectively.

B. Visual Cryptography

Visual cryptography deals with encoding a secret information such that it can be decoded visually by stacking of n shares which were formed by dividing an image into n parts such that no part reveals the secret information individually. Table I shows a comparison of six such techniques[3].

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Sr.	No.	Number of Secret Images	Pixel Expansion	Image Format	Type of Share generated
1.	Naor and Shamir [1]	1	4	Binary	Random
2.	Wu and Chen [4]	2	4	Binary	Random
3.	Chin-Chen Chang et al [5]	1	4	Binary	Meaningful
4.	Liguo Fang et al [6]	1	2	Binary	Random
5.	S. J. Shyu et al [7]	n(n>=2)	2n	Binary	Random
6.	W. P. Fang [8]	2	9	Binary	Random

III. PROPOSED METHOD

The proposed technique uses visual cryptography with image RGB plane slicing property to provide accuracy, secrecy, andconfidentiality of the secret image. An RGB image is made up of the red, green and blue pixel plane. In the encryption phase the scheme separates all the three planes and selects any one plane to encrypt, and for other planes, it uses random pixels from the random image share. The encrypted image share carries no data of the original image. In the process of decrypting it, the original image planes are reconstructed by copying the share image pixel and original image pixel of required planes. The reconstructed image has no information loss and identically recover the original image with minimal computational cost without any key management

A. The Algorithm

1) Step 1: A random share is generated by taking any random value for R, G, and B for each pixel. Every time a random share is created, it gives a different value for each pixel. So each iteration has a different random share.

2) Step 2: A key share is generated by taking the red plane of the original image and green, blue plane of the random image.

3) Step 3: Overlapping of the shares is done by copying the key share red plane value and original image green and blue plane value. This results in the generation of the original image.We can use any RGB plane. Here we used the red plane as key share.

Algorithm RGB ( )

{

For every pixel i=0 to n

{

Rsi = R(0-255) + G(0-255) + B(0-255)

KSI = $OI(R_{0\text{-}255})+Rsi(G_{0\text{-}255})+Rsi(B_{0\text{-}255})$

}

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$OI = KSI(R_{0\text{-}255})+OI(G_{0\text{-}255})+OI(B_{0\text{-}255})$
} /* OI = Original Image */

B. Implementation Details

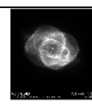
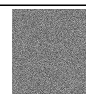
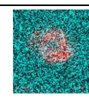
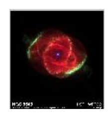
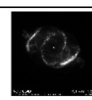
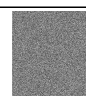
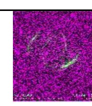
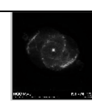
The implementation was on Matlab in windows XP. The image was decrypted by overlapping of the secret shares by simple logical OR operation. The computation cost for the method is minimal and fast as not heavy computation is performed. In the proposed scheme there are no keys involved, and hence there is no key management. The secret image could be transmitted by any unsecured medium with this method without revealing any information.

IV. EXPERIMENTAL RESULTS

A. Color Image

The method was implemented on an RGB color image which is shown in Table 2. The two shares of the image formed are share1 and share2 shown in column 3 and column 4 respectively. The original image and resultant image which is reconstructed after overlapping the three planes are shown in column 1 and column 6 respectively. Column 5 represents the reconstructed planes after overlapping both share1 and share2

TABLE 2 ALGORITHM IMPLEMENTATION FOR COLORED IMAGE

Original image	plane	Share 1	Share 2	overlapped Plane	Recovered Image
	Red				
	Green				
	Blue				

V. RESULTS AND DISCUSSIONS

We used Normalized Correlation (NC)[3] measure to validate our result. NC is used to measure the correlation between the encoded and decoded image

$$NC=\sum^{w}_{i=1} \sum^{h}_{j=1}(S_{ij} \oplus R_{ij})/w \times h$$

S represents the secret image and R the recovered image. W, h represents the width/height of the image and $\oplus$ represents the exclusive OR operator. The features of our scheme is listed in Table 3

TABLE 3: FEATURES OF SCHEMES

Features	RGB slicing
Noise Correlation	Always 1.00
Image transparency Delivery	Mild
Additional Data Structure	No
Key Management	No
Pixel expansion	No

VI. CONCLUSIONS

The paper describes a novel hybrid Visual Cryptography technique with image RGB plane slicing is presented. It provides both visual cryptographies with image encryption together with image RGB plane slicing technique. A secret colored image is split into its constituent RGB planes, and two shares from each plane are generated, and with minimum calculation, the original secret image can be retrieved back. The proposed algorithm has the following advantages. (a) There is no information loss of transmitted image since the decrypted image is identical to the original image.(b) There is no pixel expansion. (c) It is a keyless encryption method as computation is on pixel values of the secret image.(d) It can counter attacks such as guessing, shouldering, dictionary, password stealing, replay and brute force attacks. The proposed scheme is suited for entity authentication based application where authentication can be done by overlapping the shares over one another to reveal the secret information. If the secret image matches the original image, then access is granted else denied.

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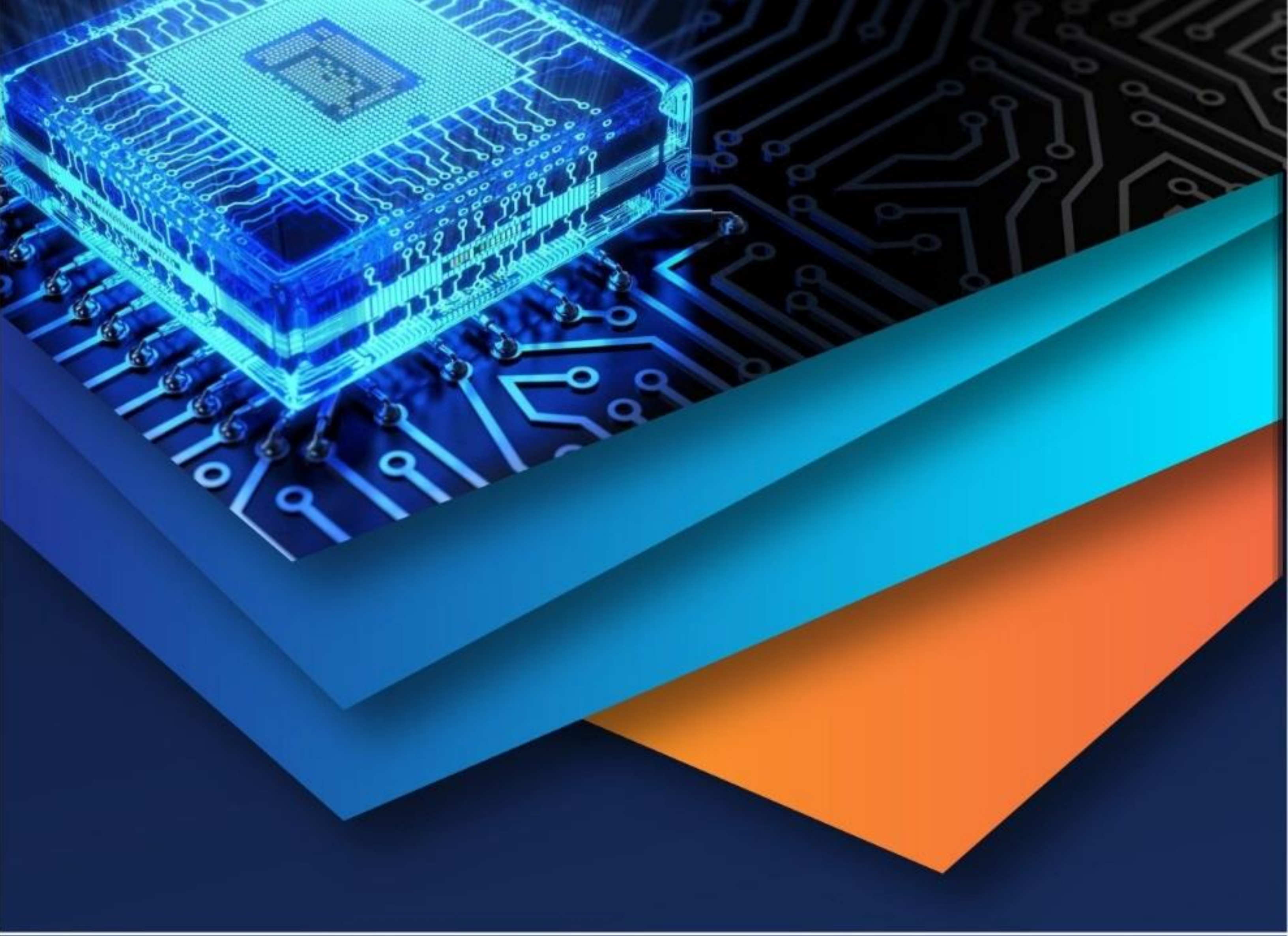

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