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Review on Visual Cryptography for Color Images

Asmita Kapsepatil

#*Information Technology Department, Mumbai University*
Pillai's institute of Information Technology, New Panvel, India
asmitakapsepatil@gmail.com

Abstract **- this paper provides a review on the concept of visual cryptography with two fundamental principles as pixel synchronization and error diffusion which is applicable on color images. Error diffusion improves the visibility of shares.VIP synchronization helps to keep the same position of pixels throughout the color channels.**

Keywords— **cryptography, visual cryptography, visual information pixel synchronization, error diffusion**

I. INTRODUCTION

Cryptography is the desired technique which is used to provide security for the transmitted data. Cryptography involves two fundamental processes as encryption is the first process in which the plain text or readable text is converted into cipher text or unreadable text and second process is called decryption process in which cipher text is converted into plain text or readable text. These processes include encryption algorithm and decryption algorithm at sender and receiver end respectively. Naor and Shamir proposed a new cryptography area, as visual cryptography in which it eliminates the need of decryption algorithm. This approach can recover a secret image without any computation. In visual cryptography visual information is encrypted using encryption algorithm but here there is no need of decryption algorithm to reveal the visual information. Visual cryptography is a special encryption technique to hide information in images in such a way that it can be decrypted by human vision if correct key image is used. The technique was proposed by Naor and Shamir in 1994.

II. LITERATURE REVIEW

A number of researchers have explored different visual cryptography schemes for binary, grey scale and some for color images. There are some approaches to color VC which attempts to generate meaningful shares but it produces shares with low visibility due color inconsistency across color channels [1]. Several new methods for VC have been introduced recently in the literature. Blundo proposed an optimal contrast k-out-of-n scheme to alleviate the contrast loss problem in the reconstructed images [3]. The VC concept has been extended to grayscale share images rather than binary image shares. Hou transformed a gray-level image into halftone images and then applied binary VC schemes to generate grayscale shares. Although the secret image is grayscale, shares are still constructed by random binary patterns carrying visual information which may lead to suspicion of secret information [2]. Nakajima extended EVC to a scheme with natural grayscale images to improve image quality [4]. Zhou used half toning methods to produce good quality halftone shares in VC. Fu generated halftone shares that carry visual information by using VC and watermarking methods [5]. Wang produced halftone shares showing meaningful images by using error diffusion techniques [6]. This scheme generates more pleasing halftone shares owing to error diffused to neighbour pixels. In order to reduce the size of encrypted share and to improve shares quality, this paper provides an overview of visual cryptography scheme for colored images.

III. ANALYSIS ON VISUAL CRYPTOGRAPHY PRINCIPLES

This section provides an overview on a color VC encryption method with two fundamental principles used to generate shares namely, error diffusion and pixel synchronization.

A. Error diffusion

Error diffusion is simple in which quantization error at each pixel is filtered and fed back to future inputs. In this scheme each of the three color layers are fed into the input for the generation of i-th halftone share. From the Fig. 2, let $f_{ij(m,n)}$

be the $(m,n)-th$ pixel on the input channel $j(1 \le i \le n, 1 \le j \le 3)$ of i-Th share. The input to the threshold quantization is:

$$d_{ij}(m,n) = f_{ij}(m,n) - \sum_{k.l} h(k,l) e_{ij}(m-k, n-l) \quad (1)$$

Where $h(k,l) \in H$ and H is a two dimensional error filter. $e_{ij}(m,n)$ Is a difference between $d_{ij}(m,n)$ and $g_{ij}(m,n)$ is a quantized output pixel value given by:

$$g_{ij} = \{1, if d_{ij}(m,n) \ge t_{ij}(m,n), 0, \} \quad (2)$$

Quantization error $e_{ij}(m,n)$ depends on not only a current input and output but also the entire history as shown in Fig.2.The error filter minimizes low frequency differences between the input and output images [8].

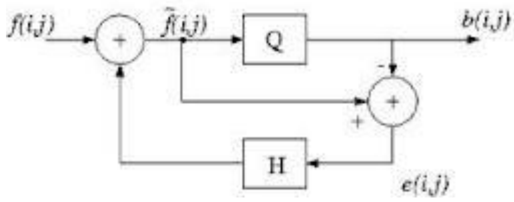

Fig. 1 Error diffusion system [8]

B. VIP Synchronization

VIPs are pixels on the encrypted shares that have color values of the original images, which make the encrypted share meaningful. In each of the m sub pixels of the encrypted share, there are λ number of VIPs, denoted as c_i and the remaining pixels deliver the message information of the secret message image. Thus in this method each sub pixel carries visual information as well as message information, while other method needs extra pixel in addition to the pixel expansion to produce meaningful shares. Since each VIP is placed at the same bit position in sub pixels across three color channels, VIP represents accurate colors of the original image [8].

IV. EXAMPLE FOR THE PROPOSED METHOD

Example 1 of VC for color image with OR and XOR

Fig. 2 Secret Image [7]

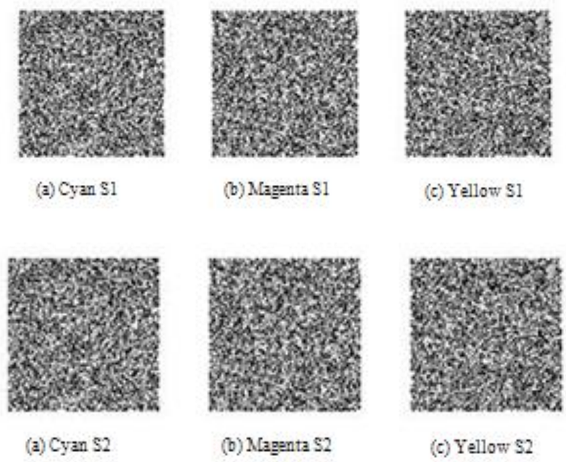

Fig. 3 Encrypting (a) and (b) two shares of cyan channel [7]
Encrypting (c) and (d) two shares of magenta channel
Encrypting (e) and (f) two shares of yellow channel

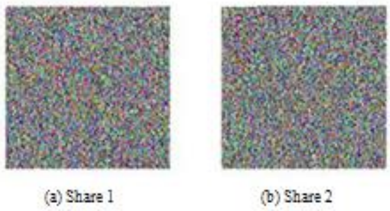

Fig.4 Combination of all shares [7]

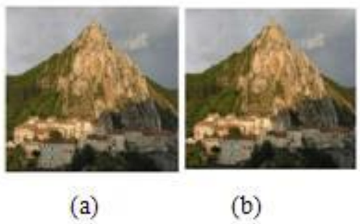

Fig. 5 Reconstruction (a) result of OR operation of shares (b) Result of XOR operation of shares [7]

Example 2 of VC for color image with OR and XOR

Fig. 6 Secret Image [7]

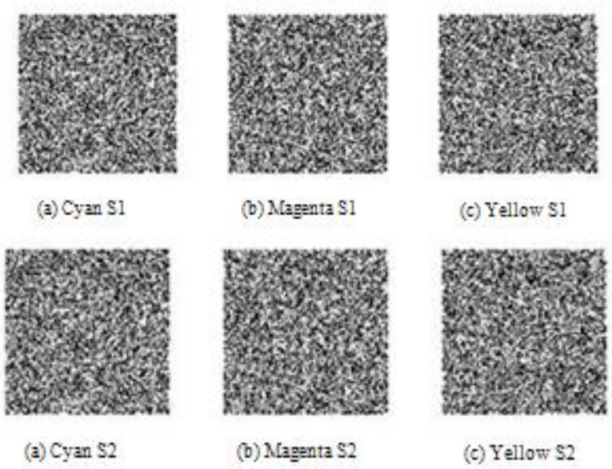

Fig. 7 Encrypting (a) and (b) two shares of cyan channel [7]
Encrypting (c) and (d) two shares of magenta channel
Encrypting (e) and (f) two shares of yellow channel

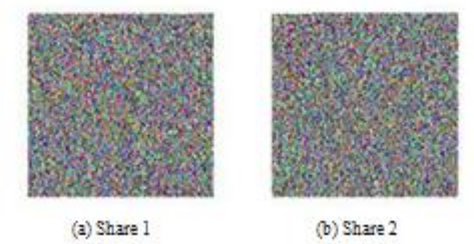

Fig. 8 Combination of all shares [7]

Fig. 9 Reconstruction (a) result of OR operation of shares
(b) Result of XOR operation of shares [7]

V. CONCLUSION

This paper provides a brief review of color visual cryptography which is simple and efficient. The overview of methods used for color visual cryptography as error diffusion and pixel synchronization shows an improvement with quality of reconstructed images.

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