

A Comprehensive View on Encryption Techniques of Visual Cryptography

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Abstract — Visual Cryptography plays an important role in area of information security. It is a technique of cryptography to secure the visual information by encrypting them into cipher text. At user's end human visual system is used for decryption. For this there is no need of any computer aid. Performance of Visual Cryptography scheme depends on the several measures these are generated share is meaningful or meaningless, computational complexity, accuracy, security pixel expansion, number of secret images. This paper explores a study and performance analysis of the various schemes of visual cryptography on the basis of number of secret images, image format, type of shares generated and pixel expansion.

Keywords- Security, Computational complexity, Pixel Expansion, Contrast, Accuracy, Visual Cryptography Scheme (VCS)

I. INTRODUCTION

In 1994, Naor & Shamir introduced Visual Cryptography [1]. Visual Cryptography is an encryption technique to encrypt the information (e.g. printed text, hand written text, images) in a manner that at the user's end decryption can be done by human visual system. There is no need of any computer aid. Visual Cryptography scheme remove the complexity of computation in the process of decryption and secret image can be recover by stacking the shares. Visual cryptography mainly helpful for it's less complexity of computation.

In this paper, we have expressed the view of different Visual Cryptography schemes. In the consideration of limited bandwidth & storage there are

two major points (i) pixel expansion (ii) no of shares generation. Pixel expansion of smaller results in share with smaller size. Multiple secret image encoding in to same share image take 's' less overhead while sharing multiple secrete.

This paper includes four sections; first section gives the comprehensive view of black & white Visual Cryptography schemes, second section includes color Visual Cryptography scheme, section third includes performance of Visual Cryptography, last section includes Conclusion.

II. BLACK & WHITE VISUAL CRYPTOGRAPHY SCHEME

Sharing Single Secret: This encoding scheme was proposed by Naor and Shamir's [1] to generate the share from a binary image in to two shares Share1 and Share2. The above two rows of Table 1 is chosen to generate Share1 and Share2 If pixel is white one. For black pixel below two rows of Table I is chosen to generate Share1 and Share2. Every pixel p of share encoded in to two black and two white pixels each of share alone gives noise clear out the pixel p whether it is white or black. Secret image is shown only when both of the images became shares are superimposed.

Table I

Pixel	Probability	Share ₁	Share ₂	Share ₁ ⊕ Share ₂
□	50%	■ □	■ □	■ □
	50%	□ ■	□ ■	□ ■
■	50%	■ □	□ ■	■ ■
	50%	■ □	■ □	■ ■

Hidden a binary image in to two meaning full shares Chin-Chen Chang et al [5] proposed spatial-domain image hiding schemes. Embedded these two secret shares in to two gray level cover images. Embedding images can be superimposed to decrypt the hidden information. Performance balancing between contrast and pixel expansion Liguo Fang [6] proposed a (2, n) scheme. Threshold visual secret sharing schemes mixed XOR and OR operation with reversing and based on binary linear error correcting code was suggested by Xiao-Qing and Tan [16].

The disadvantage is only that one set of confidential messages can be embedded, so several shares have to be generated to share large amounts of confidential messages.

Sharing Multiple Secrets: The visual cryptography schemes to share two secret images in two shares presented by Wu and Chen [2] were first researchers. According to them two binary secret images hidden into two random Shares, namely s_1 and s_2 , such that by stacking the two shares the first secret can be visible, denoted by $s_1 \otimes s_2$ and by first rotating s_1 Θ anti-clockwise the second secret can be obtained. They designed the rotation angle Θ to be 90° . However, it is easy to obtain that Θ can be 180° or 270° . Hsuetal [3] Proposed a scheme to overcome the angle restriction of Wuand Chen's scheme [2], in this scheme two secret images hidden in two rectangular share images with arbitrary rotating angles. The idea of Wuand Chen [2] also refined by Wuand Chang [4] encoding shares to be circles so that there striations to the rotating angles ($\Theta=90^\circ, 180^\circ$ or 270°) can be removed.

Multiple secrets sharing in visual cryptography is advised by S J Shyu *et.al* [7] he was the first researchers in this field. According to this scheme it encodes secrets of a set of $n \geq 2$ in to two circle shares. By stacking the first share and the rotated second shares with n different rotation angles n secrets can be obtained one by one. Fang [8] proposed reversible visual cryptography scheme to encrypt unlimited shapes of image and to discard the limitation of transparencies to be circular. According to this scheme two secret images

which are encrypted into two shares; by just stacking two shares one secret image can appears and with stack two shares after reversing one of them the other secret image can appears. A visual secret sharing scheme was developed by Jen-Bang Feng *et. al* [9] for hiding multiple secret images into two shares. This scheme analyzes the secret pixels and the corresponding share blocks to construct a stacking relationship graph, in which the vertices denote the share blocks and the edges denote two blocks stacked together at the desired decryption angle. According to this graph and the pre-defined visual pattern set, two shares are generated.

To provide additional randomness for generating the shares Mustafa Ulutas *et.al* [10] advised secret sharing theme supported the rotation of shares. During this theme shares square measure rectangular in form and square measure created in an exceedingly totally random manner. Stacking the 2 shares reconstructs the primary secret. Rotating the primary share by 90° counterclockwise and stacking it with the second share reconstructs the second secret. Tzung-Her bird genus et al [11] offered the multiple image encoding schemes by rotating random grids, with none picture element enlargement and codebook plan. A non-expansion reversible visual secret sharing technique that doesn't ought to outline the operation table offered by Fang [13]. To cipher four secrets into 2 shares and convalescent the reconstructed pictures while not distortions Zhengxin Fu *et. al* [14] supposed a rotation visual cryptography theme. Rotation visual cryptography theme construction was supported correlative matrices set and random permutation, which may be accustomed cipher four secret pictures into 2 shares. Eating apple Weir *et.al* [15] prompt sharing multiple secrets mistreatment visual cryptography. A key is generated for all the secrets; correspondingly, secrets square measure shared mistreatment the key and multiple shares square measure obtained.

Above schemes are only applicable for black and white image, but visual cryptography schemes should also support color secrete images. For this

demand researches have been made to share the color images.

III. COLOR VISUAL CRYPTOGRAPHY SCHEMES

Sharing Single Secret: Verheul and Van Tilborg developed the first color visual cryptography [17]. The concept of arcs can be shared with Colored secret images to construct a colored visual cryptography scheme. According to *c*-colorful scheme, one pixel is converted into *m* sub pixels, and each sub pixel is divided into *c* color regions. In each sub pixel contains exactly one color region colored, and all remaining color regions are black. The pixel's color depends on the interrelations between the stacked sub pixels. The pixel expansion *m* is $c \times 3$ for a colored visual cryptography scheme with *c* colors. Yang and Lai [18] revised the pixel expansion to $c \times 2$. But both schemes produce the meaningless shares.

For generating a meaningful secret of color image and sharing a secret color image a scheme "anticipated color visual cryptography" was developed by Chang and Tsai [19]. Two significant color images are selected as cover images for a secret color image, size are the same as the secret color image. On the basis of predefined Color Index Table, the secret color image will be hidden into two camouflage images. This scheme has one disadvantage that is for accumulate the Color Index Table it required extra space. In this scheme also number of sub pixels is in proportional to the number of colors in the secret image as in Verheul and Van Tilborg [17] Yang and Lai [18] schemes. More colors in the secret image produce the larger size of shares. To reduce this limitation a scheme of a secret color image sharing based on modified visual cryptography was proposed by Chin- Chen Chang *et. al* [20]. According to this scheme to hide a gray image in different shares it contains a more efficient way. This scheme contains shares of the fixed size; it does not vary when the number of colors appearing in the secret image differs. Any predefined Color Index Table does not require in this Scheme. It is not suitable for true-color secret image due to the pixel expansion is fixed in

[20] this scheme. Lukac and Plataniotis [21] introduced bit-level based scheme to share true-color image by operating directly on *S*-bit planes of a secret image. For hiding secret color image in to multiple color image, for this it is expected that the created camouflage images is filled with less noise. To overcome this problem and get a desirable output R.Youmaran *et. al* [22] proposed an advanced visual cryptography scheme for hiding a secret image in to multiple colored cover image. This gives improved signal to noise ratio of camouflage images by producing similar quality to the originals. S.J.Shyu [23] advised a more efficient colored Visual secret sharing scheme with pixel expansion of $\lceil \log_2 c \cdot m \rceil$ for reducing pixel expansion in color visual cryptography scheme where *m* is the pixel expansion of the exploited binary scheme. By considering color image transmission over information measure constraint channels a price effective visual cryptography theme was fictitious by Mohsen Heidarinejad *et.al* [24]. the answer offers excellent reconstruction whereas manufacturing shares with size smaller than that of the input image exploitation most distance severable. This theme provides picture element growth but one. to boost the speed of secret writing Haibo Zhang *et. al* [25] bestowed a multi-pixel secret writing which may write variable variety of pixels for every run. F. Liu *et. al* [26] developed a color visual cryptography theme below the visual cryptography model of Naor and Shamir with no picture element growth. During this theme the rise within the variety of colors of recovered secret image doesn't increase picture element growth. Wei dynasty Qiao *et. al* [27] advised visual cryptography theme for color pictures supported halftone technique. A secret image sharing theme for true-color secret pictures was devised by Du-Shiau Tsai *et. al* [28]. Within the projected theme through combination of neural networks and variant visual secret sharing, the standard of the reconstructed secret image and camouflage pictures are visually identical because the corresponding original pictures. For secret writing multiple color pictures exploitation visual cryptography very little

researches have been carried out that are mentioned here.

Sharing Multiple Secrets: A multi-secrets Visual Cryptography which is extended from traditional visual secret sharing produced by Tzung-Her Chen *et. al* [12]. To generate share images macro block by macro block, the codebook of traditional visual secret sharing implemented in such a way that multiple secret images are merged into only two share images and decrypt all the secrets images one by one by superimposing two of share images in a way of shifting. This scheme helps for multiple gray, color, and binary secret images with pixel expansion of 4.

A simple construction for extended visual cryptography schemes using matrix extension algorithm produced by Daoshun Wang *et. al* [29]. It is simple construction method for single or multiple and grayscale, color, binary secret images using matrix extension utilizing meaningful shares. With the help of extension matrix algorithm, Modification can easily implemented any existing visual cryptography scheme with random-looking shares

IV. PERFORMANCE ANALYSIS OF VISUAL CRYPTOGRAPHY SCHEMES

Various parameters area unit suggested by researchers to gauge the performance of Visual Cryptography theme. Naor and Shamir [1] instructed 2 main parameters: constituent enlargement m and distinction. Constituent enlargement m refers to the amount of sub constituents within the generated shares that represents a pixel of the initial input image. It represents the loss in resolution from the initial image to the shared one. Distinction is that the relative distinction in weight between combined shares that return from a white constituent and a black constituent within the original image.

Jung-San Lee *et.al* [30] suggested security, element enlargement, accuracy and procedure quality as a performance measures. Security is glad if every share reveals no info of the initial image and also the original image can't be reconstructed if there square measure

fewer than k shares collected. Accuracy is taken into account to be the standard of the reconstructed secret image and evaluated by peak signal-to-noise (PSNR) live. Procedure quality considerations the full variety of operators needed each to get the set of n shares and to reconstitute the initial secret image C . Chang *et. al* [19] prompt that visual cryptography theme ought to support wide image format like color and grey scale. Author additionally argued that random trying shares seem to be suspicious and so area unit at risk of attacks by attackers within the middle, to fill during this security gap, meaning shares ought to be made. Jen-Bang Feng *et. al* [9] prompt that VCS ought to support multiple secret to figure with efficiency. If theme support only 1 secret to share at a time to share multiple secret pictures varied shares has got to be generated, transmitted and maintained.

Abbreviations in Visual Cryptography Schemes:

m shows pixel extension of corresponding Visual Cryptography plans, c number of colors in visual cryptography schemes, n is the amount of shares. As demonstrated in the Table 2 just few visual are cryptography plans attain least pixel expansion. Assuming that $m > 1$ huge storage room needed to store and transmit the stakes. Plans with $m=1$ [11, 13, 16, 25] are great hopeful for secure transmission over constrained band width communication systems. Genuine allotments [5, 19, 20, 28] might be useful to avoid attacks by programmer. Plan supporting color pictures [5, 19, 20, 22, 28] are advantageous in the earth. Less overhead for capacity and transmission is obliged to share multiple insider facts while utilizing the plan [7, 9, 12].

V. CONCLUSION

This Paper includes considerations of different Visual Cryptography Scheme. Overall Performance assessed on four areas: type of share generated, image format, pixel expansion, and number of secret images while opting visual cryptography for a specific application Table II is useful. Assuming that if less bandwidth is available for base data transmission to share the secrets

plans then [24, 11, 13, 16, 25] is better decision. For sharing various color images schemes [12, 27] might be utilized. For evading consideration of programmer's (hackers) while transmitting the secret information [5, 19, 20, 22, 28] are suitable determinations.

VI. REFERENCES

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Table II

Comparison of Visual Cryptography schemes on the basis of number of secret images, pixel expansion, image format, type of share generated

Sr. No	Authors	Year	Secret Image	Expansion of Pixel	Format	Type Of Share
1	Naor & Shamir	1995	1	4	binary	random
2	Wu and Chen	1998	2	4	binary	random
3	Hsu <i>et. al</i>	2004	2	4	binary	random
4	Wu and Chang	2005	2	4	binary	random
5	Chin-Chen Chang <i>et. al</i>	2005	1	4	binary	meaningful
6	Ligou Fang	2006	1	2	binary	random
7	S.J. Shyu	2007	$n(n \geq 2)$	$2n$	binary	Random
8	W.P.Fang	2007	2	9	binary	random
9	Jen-Bang Feng <i>et. Al</i>	2008	$n(n \geq 2)$	$3n$	binary	random
10	Mustafa Ulutas	2008	2	4	binary	random
11	Tzung-Her Chen <i>et. Al</i>	2008	2	1	binary	random
12	Tzung-Her Chen <i>et. Al</i>	2008	$n(n \geq 2)$	4	Binary, gray, color	random
13	Wen-Pinn Fang	2009	2	1	binary	meaningful
14	Zhengxin Fu	2009	4	9	binary	random
15	Jonathan Weir	2009	n	4	binary	random
16	Xiao-qing tan	2009	1	1	binary	random
17	Verheul Tilborg	1997	1	$C*3$	color	random
18	Yang & liah	2000	1	$C*2$	color	random
19	Chang and Tsai	2000	1	529	color	random
20	Chin chen chang et al	2002	1	9	gray	meaningful

21	Lukac and Plataniotis	2005	1	2	color	random
22	R.Youmaran	2006	1	9	Color	meaningful
23	S.J.Shyu	2006	1	[log c*m]	Color	Random
24	Mohsen Heidarinejad	2008	1	9/16	Color	Random
25	Haibo Zang	2008	1	1	Gray	random
26	F.liu <i>et. Al</i>	2008	1	1	color	random
27	Wei Qiao	2009	1	M	color	random
28	Du-Shiau Tsai	2009	1	9	color	meaningful