# Performance Evaluation: Analysing parameter tuning for Halftone secure with Error Diffusion techniques for Visual Cryptography

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***Abstract*— A Security becomes a major concern for data transmission using image techniques and also used for the hiding of information in images. Visual Cryptography is a cryptography technique which allows to hide visual information (image, printed text etc.) within image. In Visual Cryptography the image is divided into two part called shares and then they are distributed to the participants. At Decryption side just stacking the share images and gets the original images. In this paper, we produce an enhanced form of the proposed method by modifying the encryption technique by halftone error diffusion scheme. When the share are generated, it is uses the halftone processing, which first the encryption images with high quality secret image and the decryption the secret images with same image quality by using error diffusion methodology with higher quality images. We studies various image quality measurement parameters based on different techniques and which contains fast execution ,accuracy and minimum error value and with a better value of PSNR, MSE, WSNR ,SNR and UQI.**

***Keywords*— Visual cryptography, halftone, Error Diffusion, Secret sharing scheme, PSNR, MSE, SNR, WSNR, UQI.**

## I. Introduction

The world today relies on the internet information storage, transmission and retrieval, hence a huge amount of multimedia information is transmitted over the internet. There are some applications where it is required to send various credential data such as military maps, signatures, thumb impressions, confidential model, and diagram of project over the internet. While sending these secret images over network security issues should be taken into consideration. Hackers may utilize weak link over communication network to steal information or masquerade it to get the information they want. To deal with security problems of secret images, various image secret sharing schemes have been developed. Visual Cryptograph is a unique technique where images are split into number of shares during encryption. These shares are overlapped over one another to get back the original image during decryption.

Visual Cryptography (VC), first proposed in 1994 by Naor and Shamir [1], is a secret sharing scheme, based on black and white or binary images. Secret images are divided into share images which, on their own, reveal no information of the original secret. Shares may be distributed to various parties so that only by collaborating with an appropriate number of other parties, can the resulting combined shares reveal the secret image. Recovery of the secret can be done by superimposing the share images and, hence, the decoding process requires no special hardware or software and can be simply done by the human eye.

Fig 1 shown a traditional cryptography scheme, VC uses human eyes to decrypt the secret without any complex decryption algorithm and the aid of computers.

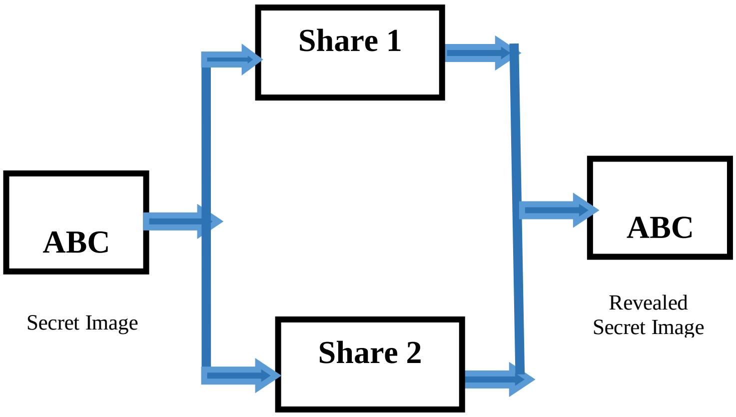


Fig.1 Traditional Way of Visual Cryptography

In figure 1 a secret image that has to be sent is divided into shares. When these two shares are stacked together and put into a Human Visual System the original image display. In the visual secret sharing representation, a secret picture must be shared among n applicants. The image is partitioned into n shares so that if m transparencies i.e. shares are placed together the photograph is able to be seen. This makes sure that the top secret image is viewed as a set of black and white pixels with each pixel being handled separately.

Image quality assessment points to measure image quality parameters such as PSNR, MSE, SNR, WSNR and UQI. In evaluating image quality there are two method followed, the subjective method and objective method. The subjective method evaluation is considered costly, expensive and time consuming. The objective method assess the quality of the image without any human interfere.

In our experiment we have both the original and the distorted images and focus on quality measures. Image quality measures could be classified into six classes of objective image assessment measures [2], that is:

 

a) Pixel difference-base measures: The mean square error (MSE), signal-to-noise ratio (SNR) and peak signal-to-noise ratio (PSNR) and weighted signal-to-noise (WSNR). These measures are easy to evaluate.

b) Correlation-based measures: Correlation is used to measure the difference between two digital images. In image quality assessment, correlation of pixels is used as a measure of the image quality.

c) Edge-based measure: In this class the edges in the original and distorted images are found, then a measure of displacement of edge positions or there consistency are used to find the image quality for the whole image.

d) Spectral distance-based measures: Discrete Fourier transform is applied on the original and the distorted images. The difference of the Fourier magnitude or phase spectral is used as a measure of image quality.

e) Context-based measures: Instead of comparing pixels in original and distorted images, pixel neighbourhoods are compared against each other by finding the multidimensional context probability to use it for measuring image quality.

f) Human Visual System-based measures (HVS): Here image quality is measured as the human eye. Humans usually use contrast color and frequency changes in their measures.

This paper is as follows: Section II gives the discusses of visual secret sharing, halftone visual cryptography and error diffusion technique, Section III discuss the different image quality metrics and , Section IV shows simulation results and analysis , finally section V discusses overall conclusion.

## II.RELATED WORK

Visual cryptography may be a cryptanalytic technique that permits visual data (pictures, text, etc.) to be encrypted in such the way that the cryptography are often performed by humans while not the help computers. The subsequent section give introduction to visual secret sharing scheme, halftone visual cryptography and error diffusion.

### A. Visual Secret Sharing Scheme

Visual secret sharing is predicated on the access structure scheme such that as follow.

- 2 out of 2 Visual Cryptography scheme: During this scheme, each pixel ‘p of sub pixels in each of the two share. If ‘p’ is white, one of the two columns under the white pixels is selected. If ‘p’ is black, one of the two columns under the black pixels are selected. The first two pairs of sub pixels in the selected columns are assigned to share 1 and share 2 respectively [5]. Since each shares, p is encrypted into black and white or white and black pair of sub pixels, an individual share gives no clue about the secret image. If ‘p’ is white it always output one black and one white sub pixel during encryption. If ‘p’ is black, it outputs two black sub pixels in encryption process.
- (n,n) Visual Cryptography Scheme: In this technique, which separates the secret images into n shares, and complete share are required to detect the secret image. Therefore, n>=2 where ‘n’ is defined as an integer. A (2, 2) visual cryptography scheme is schemes is regarded as specific condition of (n, n) visual cryptography scheme.
- (k,n) Visual Cryptography Scheme: This technique classifies the secret image shares into n shares, and k-out-of-n shares are required to detect the secret image, where $2 \leqslant k \leqslant n$, and k and n both are represented as an integer. However, there is specific condition for this technique such as (2, 3) visual cryptography schemes and etc. [6].

### B. Halftone Visual Cryptography

Halftone Visual Cryptography was introduced in [7][8] and is constructed upon the idea matrices collections out there in typical visual cryptography. A secret binary element p in halftone visual cryptography is encoded into associate degree array of q=v1*v2 known as a halftone cell, in every of the n shares. Halftoning technique used in visual cryptography. Halftoning play a key role in almost every discipline that involves printing and displaying. All Newspapers, magazines, and books are printed with digital halftoning. It is used in image display devices capable of reproducing two-level outputs such as scientific workstations, laser printers, and digital typesetters. The grayscale digital image consists of 256 gray levels, while the black and white printers only have one colored ink. So, there is a need to replace wide range of grayscale pixels for printers. These 256 levels of gray should somehow be represented by placing black marks on white paper. Halftoning is a representation technique to transform the original continuous tone digital image into a binary image only of 1's and 0's consisting. The value 1 means to fire a dot in the current position and 0 means to keep the corresponding position empty since the human eyes have the low pass spatial frequency prosperity.

The objective of image halftoning is the process of generating a pattern of binary pixels that create the illusion of a continuous-tone image. Halftoning algorithms can produce results of very different qualities and characteristics. The performance from different halftoning algorithms must therefore be quantified to allow comparison. Conducting visual tests under controlled conditions is very time-consuming. There is therefore a strong incentive to develop quality measures that numerically expresses the perceived visual difference between the continuous-tone original image and the binary halftone.

Finding an objective measure of image quality that can cover several aspects is the optimal goal. In order to evaluate and improve the algorithms, it is important to have robust and reliable quality measures. A problem to find and develop such measures is that some halftoning methods works fine for certain kinds of images but produce results of low quality for other images. There are several of other factors, such as the paper quality, the type of ink or dye used, the printing technology, which also will affect the quality of the printed image. In this work we will mainly focus on the halftone's influence on the image quality.

In such case halftoning algorithms, we need to select one from multiple halftoning algorithms for a specific task, then a quality measure can help us evaluate which of them provides the best quality. It is not always easy to provide a quantitative definition of what constitutes the visual quality of a halftone image.

There are basically two different classes of objective quality measures. The first are mathematically/statistical defined measures, which could be used to study binary halftone patterns of constant gray-level. These metrics offer a fundamental understanding of the relationships that may exist for a given point distribution. These kinds of measures are usually easy to calculate and in general have low computational complexity.

The second class of measurement methods considers human visual system (HVS) characteristics, which attempts to predict perceptual visual quality. Halftoning relies on the fact that the human eye acts as a low-pass filter. By taking into account properties and limitations of the human vision system HVS, images can be more efficiently reproduced. To achieve these goals it is necessary to build a computational model of the HVS.

### C. Error Diffusion

The more popular technology of halftoning algorithms is error diffusion. This technology propagates quantization errors to unprocessed neighbouring pixels according to some fixed ratios. The error diffusion preserves the average intensity level between the original input images and the binary output image.

Further, the error diffusion produces good halftone image despite relatively low cost. Error diffusion was introduced by Floyd and Steinberg. It was a completely new method of image halftoning that produced much higher quality images. The algorithm relies on distributing the quantization error from thresholding to neighbors of current pixel. As the image is scanned (from left to right and top to bottom), the quantization error “diffuses” across and down the image, giving the algorithm its name. Error diffusion accurately reproduces the gray level in a local region by driving the average error to zero through the use of feedback.

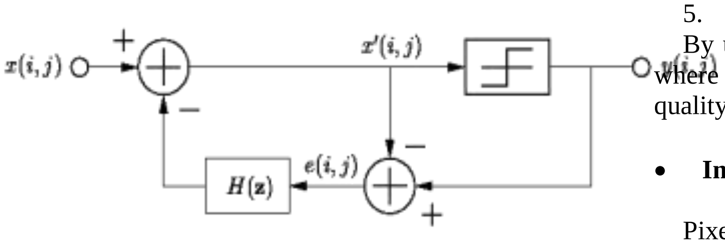


Fig. 2. Error Diffusion Algorithm.

Error diffusion algorithm is graphically illustrated in Fig.2. The process is described mathematically as follows. Assume an input image x (i, j) of size M × N pixels, with pixel values ranging from 0 to 1. As the algorithm proceeds, each input pixel is effectively modified by the weighted errors diffused from previous pixels; this modified input is denoted x′ (i, j). For the first pixel in the image, x′ (i, j) = x (i, j). The modified input x′ (i, j) is threshold to produce an output pixel y (i, j):

$$y(i,j) = \begin{cases} 0, & x'(i,j) < 0.5 \\ 1, & x'(i,j) \geq 0.5 \end{cases} .$$

The quantization error is given by

$$e(i,j) = y(i,j) - x'(i,j) ,$$

And is subtracted from neighboring pixels according to

$$x'(k,l) = x(k,l) - h(k-i, l-j)e(i,j) \begin{cases} 0 < k < M \\ 0 < l < N-1 \end{cases}$$

Where h (i, j) is known as the error filter.

## II. PROPOSED METHOD

In this paper, we propose the secure visual quality of secret images by halftone scheme with diffusion techniques. At first, the visible images is translated into binary image. Next, the binary image is converted into halftone shares containing efficient visual information. Thus the shared images are disseminated to particular participants and then they are extremely enforced to reveal the secret images. When the shares are generated, it is uses the halftone processing, which first the encryption the images with high quality secret images and then decryption the secret images with same image quality by using diffusion methodology.

The proposed methodology is consists of following process:

1. Input Gray scale image.
2. Convert gray scale image into Binary image
3. Calculate error by subtracting from binary pixel into original pixel.
4. Apply halftone scheme with error diffusion technique.
5. Retrieving high quality image.

By using proposed algorithm we get higher quality image, where the quality is computed by comparing different image quality metrics.

- **Image Quality Metrics**

Pixel Difference Measurement are like PSNR, MSE, WSNR, SNR and UQI:

a) The Mean Square Error (MSE): The MSE represents the cumulative squared error between the compressed and the original image, whereas value of MSE is lower, and then we get the lower the error. The MSE use the following equation:

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where, M and N are the number of rows and columns in the input images, respectively.

b) Peak signal-to-noise ratio (PSNR): PSNR is a mathematical measure of image quality based on pixel difference between two images [9]. The PSNR is define as

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

Where, R is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then R is 1. If it has an 8-bit unsigned integer data type, R is 255, etc.

c) Weighted Signal-to-Noise Ratio (WSNR): WSNR is calculated in the spatial frequency domain. Human Visual System is a nonlinear, spatially varying system. Weight Signal-to-Noise-Ratio (WSNR) is computed.

$$\text{wsnr} = \log_{10} \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} |X(i,j)\ CSF(i,j)|^2}{\sum_{i=1}^{m}\sum_{j=1}^{n} |(X(i,j) - X'(i,j))\ CSF(i,j)|^2}$$

Where $X_{i,j}$ , $X'_{i,j}$ and $CSF_{i,j}$ represent the discrete Fourier transform (DFT) of the input image, reconstructed image and frequency response termed as Contrast Sensitivity Function CSF, respectively [10]. WSNR is defined as the ratio of average weighted signal power to average weighted noise power, where the weighting is derived from the CSF.

d) Signal-to-Noise Ratio (SNR) :SNR is the ratio of signal power to the noise power. In terms of images, how the original image is affected by the added noise. The SNR are used to measure the quality of an image after the reconstruction. The higher SNR value, the reconstruction is good. SNR is calculate as

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SNR=10*log10 ((ima)^2/MSE);
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Where ima=max(img(:));

e) Universal Image Quality Index (UQI): Objective of image quality measures play important roles in various image processing applications. There are basically two classes of objective quality or distortion assessment approaches. UQI is designed by modeling any image distortion as a combination of three factors: loss of correlation, luminance distortion, and contrast distortion.
Let x={xi | i= 1,2,…,N} and y={ yi | i = 1,2,…,N} and be the original and the test image signals, respectively. The quality index is defined as

$$\text{UQI} = \frac{4\sigma_{xy}\,\bar{x}\bar{y}}{(\sigma_x^2+\sigma_y^2)*(\bar{x}^2+\bar{y}}$$

where

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i, \quad \bar{y} = \frac{1}{N}\sum_{i=1}^{N} y_i$$

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2, \quad \sigma_y^2 = \frac{1}{N-1}\sum_{i=1}^{N}(y_i - \bar{y})^2$$

$$\sigma_{xy} = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})(y_i - \bar{y}).$$

The range of values for the index UQI is [-1, 1]. The best value 1 is achieved if and only if the images are identical. The first component is the correlation coefficient between x and y, which measures the degree of linear correlation between x and y, and its dynamic range is [-1, 1]. The best value 1 is obtained when yi= a xi +b for all i=1, 2,…,N , where a and b are constants and a > 0 . Even if x and y are linearly related, there still might be relative distortions between them.

## IV. Simulation Results and Analysis

The Proposed method is executed in MATLAB R2012 and implementation results obtained are described in this section. This experiments made on various images (Lena, peppers, Barbara and tree).

All used image quality metrics are objective measurements that are automatics and mathematical defined algorithms. After applying some distortion to the original images, see Fig.3. We got the distorted images included here, see Fig.4, and the image quality is applied to theses distorted images and the result are compared. Measuring image quality for these images gave the experiment results shown in TABLE 1.

TABLE I
COMPARISON OF MSE, PSNR, WSNR, SNR AND UQI IMAGE QUALITY MEASUREMENTS APPLIED ON IMAGES INCLUDED IN THE EXPERIMENT

| Types of Quality measurement (db.) / Images | MSE | PSNR | WSNR | SNR | UQI |
|---|---|---|---|---|---|
| Lena | 1.3904e+04 | 6.8125 | 26.8425 | 6.3520 | 0.0826 |
| Peppers | 1.3208e+04 | 7.0866 | 27.3095 | 5.9994 | 0.1984 |
| Barbara | 1.2543e+04 | 7.3095 | 27.0866 | 6.9620 | 0.1837 |
| Tree | 1.1619e+04 | 7.7664 | 27.7664 | 7.1306 | 0.1333 |


(a) Lena

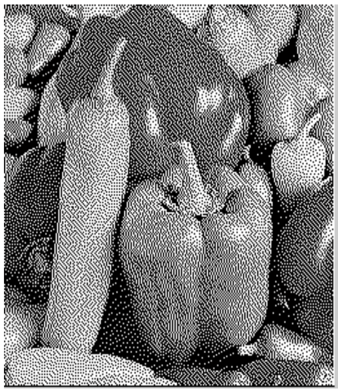

(b) Peppers

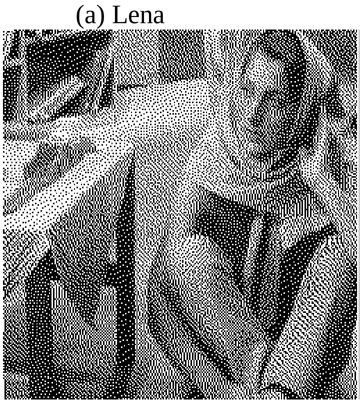

(c)Barbara


(d) Tree

Fig.3 a) b) c) and d) Original image (Input image) use for experiment.


(a) Lena


(b) Peppers


(c)Barbara

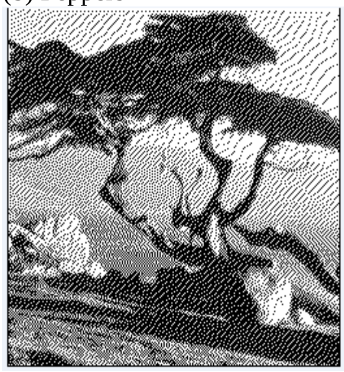

(d) Tree

Fig.4 a), b), c) and d) Distorted images get after experiment

## V. CONCLUSIONS

In this paper, we proposed advanced halftone scheme with error diffusion technique and there are many different types of image quality metrics implemented for getting the quality of an image.
So, in future as the further work, we will apply proposed algorithm on color images.

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