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Digital Image Enhancement Gray Scale Images In Frequency Domain

Israa M. Hayder[1,*] , Hussain A. Younis[2] and Hameed Abdul-Kareem Younis[3]

[1]Department of Computer Systems Techniques, Qurna Technique institute, Southern Technical University, Basrah, Iraq.

[2]Basra of University, College of Education for Women, Iraq.

[3]Basra of University, College of computer science and Information Technology, Dept. of computer science, Iraq.

* E-mail: Israa.mh@stu.edu.iq

Abstract: The aim of the research is to improve the distorted digital images using one of the methods of frequency domain. Where The Transform Cosine Discrete (DCT) function was used as one methods of frequency domain. Good results have been obtained using this method**.** standard gray scale images, which have distortions, have been improved and get improved image results.

1 Introduction

An image is an artifact that depicts visual perception, such as a photograph or other two-dimensional picture, that resembles a subject—usually a physical object—and thus provides a depiction of it. In the context of signal processing, an image is a distributed amplitude of color(s)[1].

The image is a visual representation of something. In information technology, Images play an important role today in computer applications, where it is known that the picture may be better than thousands of words, and this is a fact in presenting and displaying data on the computer, and sometimes it is urgent to use images. Today, images are the first pillar in the multimedia programming world, which uses a wide range of images in animation programming and video games that are widespread and high-speed [2].

Imaging is the capture, storage, manipulation, and display of images. In document imaging, the emphasis is on capturing, storing, and retrieving information from the images (which are often mainly images of text). In graphical imaging, the emphasis is on the manipulation of created images in order to achieve special effects through rotating, stretching, blurring, resizing, twirling, and other changes to the original image [3][4].

Hence the importance of knowing how to program the image. The processes that can be used in the images are the image processing. Here, the image processing is the result of some calculations resulting in a new form of image such as rotation, zoom in and out, lighting adjustment, contrast, coloring, image enhancement, noise deletion and many other operations. Most websites need images to disseminate information, as well as most shops and markets need ads that feed images that are clear to people passing by. In this research, a method was proposed to improve the image and remove the distortion using Transform Cosine Discrete DCT..

2 Image Enhancement Methods
Image enhancement is to make the image clearer for easy further operations. Since the fingerprint images acquired from sensors or other medias are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and furrows and for connecting the false broken points of ridges due to insufficient amount of ink, are very useful for keep a higher accuracy to fingerprint recognition [5] .
Image enhancement is mostly refining the sensitivvity of information in improved input for automated image processing methods [6][7]. The enhancement approaches arg generally divided into types: spatial domain methods and frequency domain methods. In spatial domain methods, image pixels are enhanced diectly .the pixel values are attered to obtain the desired enhancements.
Taguchi revewed color systems and image enhancement methods and inteoduced an improved color spacce [8][9].

2.1 Spatial Domain Methods:-
  The spatial domain image enhancement operations is expressed by using Equ(1)
$g(x,y)=T[f(x,y)]$ ...(1)
Where $I(x,y)$ is the input image, $S(x,y)$ is the processed image , and T is an operator on I. Defined over some neighborhood of (x,y) some spatial domain image enhancement includes point processing ,mask processing, and soon. In point processing a neighborhood of lXl pixel is processing. As shown in fig(1).
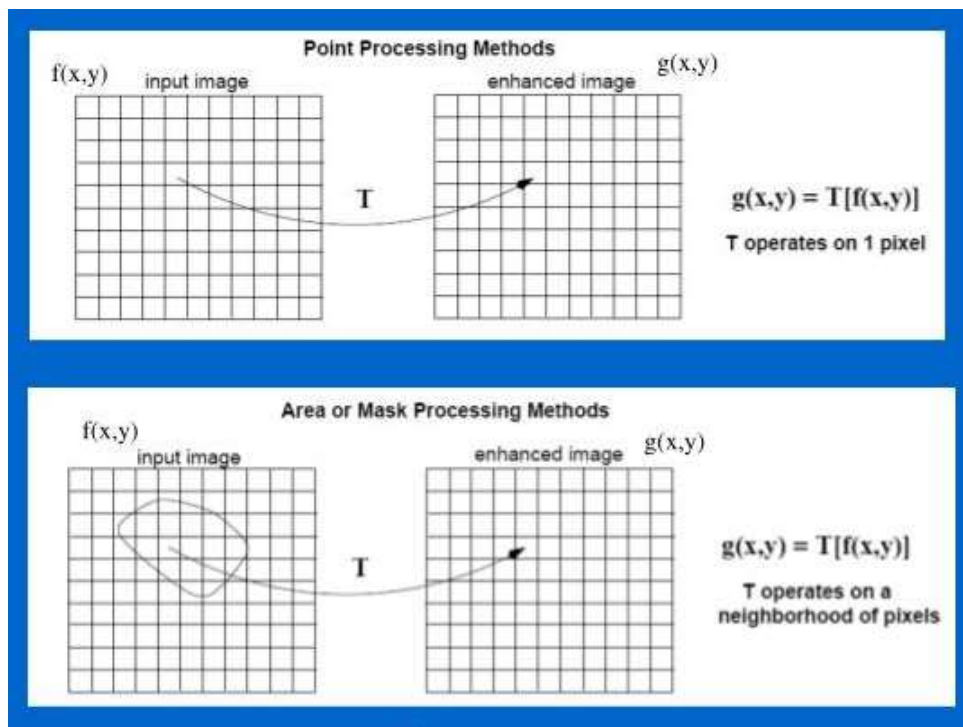

Figure 1: Image Enhancement in Spatial Domain

2.2 Frequency Domain Methods
In this type the pixel composing of image details are considered and the various procedures and directiy applied on these pixels .The image processing functions in the spatial domain may be expressed as
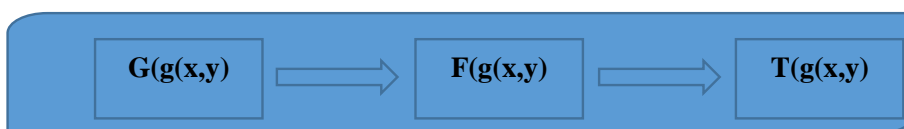$g(x,y)=T[f(x,y)]$ ...(2)
as showon in fig (2).

Figure 2: Frequency Domain

The difference between spatial domain and frequency domain.

No	Describe	Spang domain	frequency domain
1	defination	Chang pixel position changes in the scene. Distance is real.	Change in image pisition changes in spatial frequency. Which image intensity values are changing in the spatial domain image.
2	Processing	Directly process the input image pixel array	Transform the image to frequency representation. Perform image processing .Compute.

3 The Proposed Image Enhancement Scheme

The method proposed in this research is the algorithm image using DCT and its steps as follows:
1.   Split the entered image into 8 * 8 blocks.

2.   Calculate the sinusoidal DCT conversion for each block and according to the following equations [3]

$$B_{pq} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_{mn} \cos \frac{\pi(2m+1)p}{2M} \cos \frac{\pi(2n+1)q}{2N}, \quad \begin{array}{l} 0 \le p \le M-1 \\ 0 \le q \le N-1 \end{array}$$

$$\alpha_p = \begin{cases} 1/\sqrt{M}, & p=0 \\ \sqrt{2/M}, & 1 \le p \le M-1 \end{cases} \qquad \alpha_q = \begin{cases} 1/\sqrt{N}, & q=0 \\ \sqrt{2/N}, & 1 \le q \le N-1 \end{cases}$$

(3)

3.   The lining of the elements located under the main diameter (diagonal).
4.   Find the inverted integer conversion IDCT for each mass of blocks as follows:

$$A_{mn} = \sum_{p=0}^{M-1} \sum_{q=0}^{N-1} \alpha_p \alpha_q B_{pq} \cos \frac{\pi(2m+1)p}{2M} \cos \frac{\pi(2n+1)q}{2N}, \quad \begin{array}{l} 0 \le m \le M-1 \\ 0 \le n \le N-1 \end{array}$$

$$\alpha_p = \begin{cases} 1/\sqrt{M}, & p=0 \\ \sqrt{2/M}, & 1 \le p \le M-1 \end{cases} \qquad \alpha_q = \begin{cases} 1/\sqrt{N}, & q=0 \\ \sqrt{2/N}, & 1 \le q \le N-1 \end{cases}$$

(4)

5.   Re-assemble the image.

4 The Quality Criteria
There are many quality standards applied to images from them :

4.1 entropy
Entropy is the measure of randomness or variance in an image. When the maximum of this variance is measured, it becomes Maximum Entropy. There are various theories regarding calculation of entropy which are Shannon, Tsallis, and Renyi etc. Multilevel threshold is a method that segments a gray level image into a number of dissimilar portions. It establishes more than one threshold for the given image, which correspond to background and foreground. It works well for complex data because simple thre sholding methods do not give satisfactory results on such data [11][12.]

In 1948, the entropy of Boltzmann/Gibbs has been redefined by Shannon [13][14] as a measure of uncertainty regarding the information content of a system. Therefore,An expression could be defined for measuring the amountof information produced by a process entropy(H) is defined as the following:

$$H(s_m) = -\sum_{n=1}^{256} p_n(s_m) \cdot log_2(p_n(s_m)), m = 1, ..., M \tag{5}$$

and they say that " are probabilities associated with the bins of the histogram of "

4.2 UACR and NPCR

The NPCR and UACI are first shown in 2004 [17, 16] both of which point to Yaobin Mao and Guanrong Chen. Since then NPCR and UACI become two widely used security analyses in the image encryption community for differential attacks.

Suppose ciphertext images before and after one pixel change in a plaintext image areC1 and ,C2 respectively; the pixel value at grid (i,j) in C1and C2 are denoted asC1 (i,j) and C2 (i,j) ; and a bipolar array D is defined in Eqn. (6). Then the NPCR and UACI can be mathematically defined by Eqns. (6) and(7), respectively, where symbol F denotes the total number pixels in the cipher text, symbol denotes the largest supported pixelvalue compatible with the cipher text image format, and |. |denotes the absolute value function.

$$D(i,j) = \begin{cases} 0, if C^1(i,j) = C^2(i,j) \\ 1, if C^1(i,j) \neq C^2(i,j) \end{cases}$$

$$\text{NPCR: } \mathcal{N}(C^1, C^2) = \sum_{i,j} \frac{D(i,j)}{T} \times 100\% \tag{6}$$

$$\text{UACI: } \mathcal{U}(C^1, C^2) = \sum_{i,j} \frac{|C^1(i,j) - C^2(i,j)|}{F \cdot T} \times 100\% \tag{7}$$

It is clear that NPCR concentrates on the absolute number of pixels which changes value in differential attacks, while the UACI focuses on the averaged difference between two paired ciphertext images.

The range of NPCR is [0,1]. When N(C1,C2)=0 , it implies that all pixels in C2

remain the same values as in C1. When N(C1,C2)=1, it implies that all pixel values in C2 are changed compared to those in C1.In other words, it is very difficult to establish relationships between this pair of ciphertext image C1and C2 However, N(C1,C2)=1

rarely happens, because even two independently generated true random images fail to achieve this NPCR maximum with a high.

possibility, especially when the image size is fairly large compared to F . The range of UACI is [0,1] clearly as well, but it is not obvious that what a desired UACI for two ideally encrypted images is. Fortunately, these results will be given in next sections with the form of expectations and variances[18][20].

4.3 Correlation

correlation is compute the two-dimensional correlation coefficient between two matrices.

Description: r = corr2(A,B) computes the correlation coefficient between A and B, where A and B are matrices or vectors of the same size. Class Support is A and B can be numeric or logical. The return value, r, is a scalar double. Algorithm is correlation computes the correlation coefficient using

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right)\left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \tag{8}$$

Where $\bar{A}$ = mean (A), and $\bar{B}$ = mean (B).

4.4 Pink Signal to Noise Ratio (PSNR)

In this measure, which is based on the peak-to-noise ratio, it is good for image processing and noise reduction of images, and is good at maintaining the edges and angles based on the following equation:

$$PSNR = 10 \log_{10} \left[\frac{255^2}{\frac{1}{MN} \sum_i \sum_j (r_{ij} - x_{ij})^2} \right] \qquad (9)$$

Where ri, j, and xi, j represent the values of the elements for both the original images and the processing, and (MN) represents the size of the image [10].

4.5 Universal Quality Index (UQI)

It consists of three components: the first is the correlation coefficient between the original and the decay in the distorted picture, and the image of the linear correlation between them is restored. Their dynamic range is (-1 and 1). The second element with a set of zero -1 measures the convergence between the average illumination from the

first. The third element is the measure of the similarity between the levels of contrast in images ranging from 0 to 1. The optimal value of one is achieved only, and the combination of the three coefficients : Correlation and similarity now average and the similarity at the level of variance given by equation:

$$UQI = \frac{4 \bar{I} \bar{I}_n \sigma_{IIn}}{(\bar{I}^2 + \bar{I}_n^2)(\sigma_I^2 + \sigma_{In}^2)} \qquad (10)$$

In: heterogeneity

: σI Standard deviation of the original image.

I: The rate of the original image and image processed.

4.6 Structural Similarity Image Quality Measure(SSIM)

The measurement is based on the evaluation of three different subjects: lighting, contrast and comparison of the general structure.

contrast and comparison of the general structure.

$$l(x, y) = \frac{2\mu_X(x, y)\mu_Y(x, y) + C_1}{\mu_X^2(x, y) + \mu_Y^2(x, y) + C_1} \qquad \ldots (11)$$

$$c(x, y) = \frac{2\sigma_X(x, y)\sigma_Y(x, y) + C_2}{\sigma_X^2(x, y) + \sigma_Y^2(x, y) + C_2} \qquad \ldots (12)$$

$$s(x, y) = \frac{\sigma_{XY}(x, y) + C_3}{\sigma_X(x, y)\sigma_Y(x, y) + C_3} \qquad \ldots (13)$$

$$SSIM(x, y) = [l(x, y)] \cdot [c(x, y)] \cdot [s(x, y)] \qquad \ldots (14)$$

Where as:-

L (x ,y) is the variance, and S (x, y) is the structural similarity [15].

4.7 Histogram

A histogram is a plot that lets you discover, and show, the underlying frequency distribution (shape) of a set of continuous data. This allows the inspection of the data for its underlying distribution (e.g., normal distribution), outliers, skewness,.. etc. An example of a histogram, and the raw data it was constructed from. H(k) specifies the # of pixels with gray-value k

Let N be the number of pixels: $N = \sum_k H(k)$

P(k) = H(k)/N defines the normalized histogram

defines the accumulated histogram $C(k) = \sum_{i=1}^{k} H(i)$

5 Experimental Result

In order to study the process of improving the digital image, the kausa noise is added at different rates (10%) and zero to the original image to produce a distorted image and apply our method of using the sinusoidal transference. (ERMS, NPCR, UACR, UIQ, CORR, SSIM, PSNR values and ENTROEPY) was used to measure the efficiency of the image enhancement and performance comparison of these parameters. Standard gray digital images (256 x 256 pixels), In images (a, b ,c, d, e, f,   g ,h , and j) As shown in Figures (4) and (5).

Figure 3: Sample Images.

Table 1: between Original image and Noise image

No	ERMS	NPCR(%)	UACR(%)	UQI	CORR	SSIM	PSNR(db)	ENTROPY
Image a	2.864	1.626	6.033	0.384	0.882	0.440	20.060	7.009
Image b	2.822	1.827	6.233	0.3127	0.810	0.427	20.341	7.217
Image c	2.713	2.027	6.434	0.3187	0.838	0.411	20.612	7.4434
Image d	2.640	2.227	6.634	0.230	0.841	0.475	20.644	4.116
Image e	2.994	2.428	6.835	0.381	0.886	0.460	20.690	7.304
Image f	2.784	2.628	6.035	0.362	0.867	0.431	20.671	7.190
Image g	2.822	2.829	6.235	0.371	0.817	0.401	20.334	7.483
Image h	2.891	3.029	6.436	0.377	0.825	0.437	20.415	7.202
Image j	3.156	3.229	6.636	0.379	0.845	0.461	20.701	6.491

Table 2: between Original image and enhanced image

No	ERMS	NPCR(%)	UACR(%)	UQI	CORR	SSIM	PSNR(db)	ENTROPY

|							
Image a	1.999	0.019	3.831	0.438	9840.	0.540	22.774	6.109
Image b	1.028	0.219	4.031	0.341	0.992	0.524	22.433	6.222
Image c	1.057	0.420	4.231	0.412	0.985	0.526	22.195	6.720
Image d	1.086	0.620	4.432	0.433	0.999	0.539	22.608	6.608
Image e	1.115	0.821	4.632	0.320	0.984	0.570	22.1108	6.144
Image f	1.143	0.021	4.833	0.459	0.962	0.544	22.608	6.601
Image g	1.172	0.221	5.033	0.494	0.950	0.598	22.608	6.899
Image h	1.201	0.422	5.233	0.424	0.967	0.582	22.608	6.625
Image J	1.230	0.622	5.434	0.488	0.994	0.533	22.608	6.454
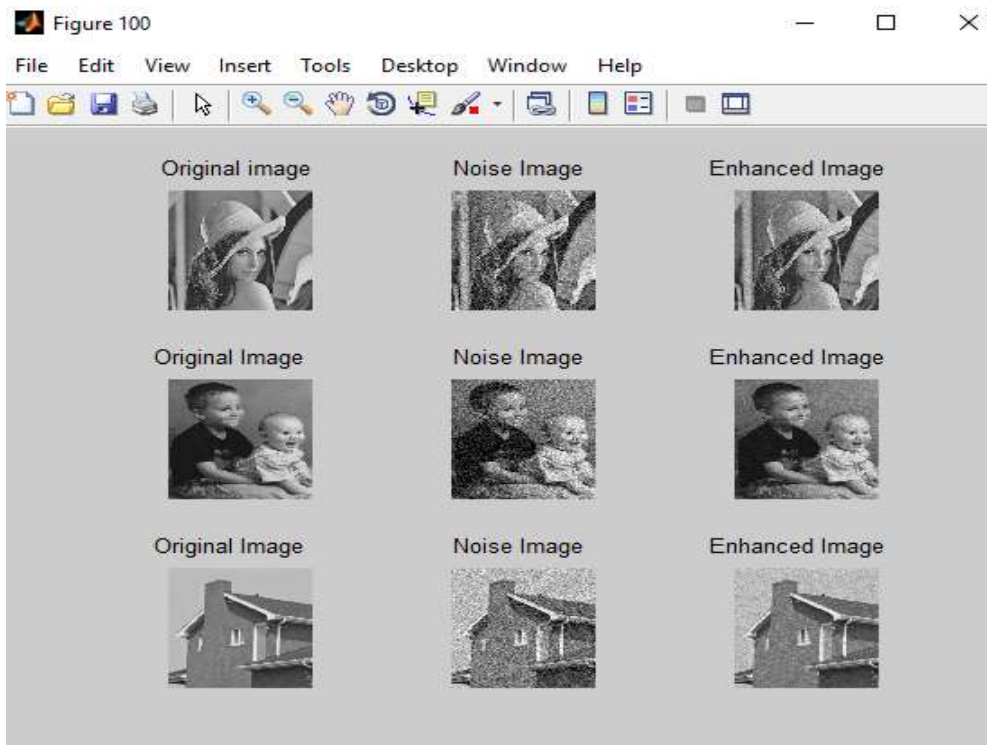
Figure 4:Experiments.
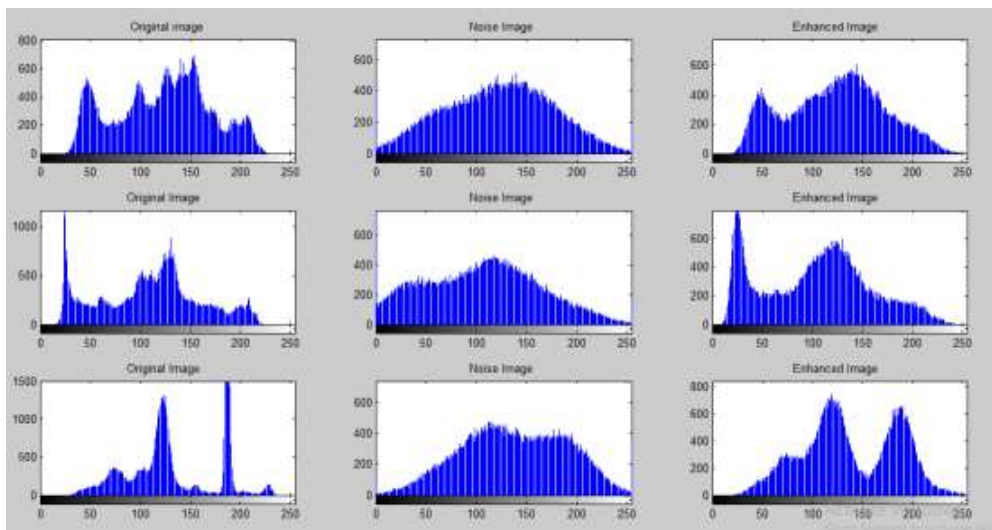
Figure 5: Histogram for image Experiments.

6 Conclusion

The proposed image enhancement method in the field of bandwidth is a good way to improve the image, since the high frequencies below the main diameter of the image, which are small values (not visible to the human eye), can be reset and used (noise is often found in the high frequency region). The larger PSNR value for the enhanced image was an indication of an improvement in the resulting image and the removal of some distortions in the picture. ERMS, NPCR, UACR, UIQ, CORR, SSIM, PSNR values and ENTROEPY values were greater for the improved image, indicating that the resulting image was closer to the original image and less distortion.

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