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Propose Computation Model for Calculating Efficient Result to Images Quality Measurements

A Project Submitted to the Department of Communications Engineering Diyala University

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بِسْمِ اللهِ الرَّحْمنِ الرَّحِيمِ

إِنَّ فِي خَلْقِ السَّمواتِ وَالْأَرْضِ وَاخْتِلافِ اللَّيلِ وَالنَّهارِ وَالْفُلْكِ الَّتِي تَجْرِي

فِي الْبَحْرِ بِمَا يَنْفَعُ النَّاسَ وَمَا أَنْزَلَ اللَّهُ مِنَ السماءِ مِنْ ماءٍ فَأَحيا بِهِ الأَرْضَ

بَعْدَ مَوْتِها وَبَثَّ فِيها مِنْ كُلِّ دَابَّةٍ وَتَصْرِيفِ الرِّياحِ وَالسَّحابِ الْمُسَخَّرِ

بَيْنَ السماءِ وَالأَرْضِ لَآياتٍ لِقَوْمٍ يَعْقِلُونَ (164)

صدق الله العلي العظيم

سورة البقرة

DEDICATION

This project is dedicated to my teacher , who has always given me spiritual and educational support.

Acknowledgement

We are greatly thankful to our project advisor, Ass. Lecture Hussein SH. , who has fully supported us, not only throughout our project. He suggested this topic to us, a challenging but interesting topic. He was always very flexible with our work schedule. we know this project would have never been written and finished without his encouragement, guidance, knowledge, and tolerance. Thank you both for taking your precious time to give us advices and comments. we would also like to thank Mr. Hussein for giving us some wonderful questions on our project.

Abstract

As the requirement for Image Quality Evaluation is needed in many application areas. Image quality analysis is one of the challenging fields of digital image processing system. Measurement of visual quality is of fundamental importance for fine image and video processing applications, where the goal of quality assessment (QA) algorithms is to automatically evaluate the quality of images or videos in agreement with human quality judgments. The evaluation of image quality based on single strategy Human Vision System (HVS) may not very sufficient. We need some more dimensions , so in this work will discuss with mathematics algorithms such as Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Average Difference (AD), Normalized Cross correlation (NK), Structural Content (SC) and Maximum Difference (MD) may contribute to calculate efficient result to image quality measurements.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATIONS

MSE	_	Mean Square Error
PSNR	–	Peak Signal to Noise Ratio
AD	–	Average Difference
NCC	–	Normalized Cross-Correlation
MD	–	Maximum Difference
FR	–	Full-reference
NR	–	No-reference
JPEG	–	Joint Photographic Expert Group
IQM	–	Image quality metric
SC	–	Structural Content

LIST OF SYMBOLS

M ,N	_	Is are the dimensions of the images
X(I,J)	_	Is the original image
Y(I,J)	_	Is the processed image
I , J	_	are the pixel position of the M×N image
X(i,j)	_	being the pixel density values of the perfect image.
Y(i,j)	_	being the pixel density values of the fused image

1.1Introduction:

Image Processing is a technique to enhance raw images received from sources placed on satellites and aircrafts or pictures taken in normal life for various applications [1].

Various techniques have been developed in Image Processing during the last years. Most of the techniques are developed for enhancing images obtained from unmanned spacecraft and military reconnaissance flights. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc. [1].
Image Processing is used in various applications such as:

- Remote Sensing
- Medical Imaging
- Non-destructive Evaluation
- Forensic Studies
- Material Science.
- Military
- Film industry
- Document processing
- Graphic arts

Image processing involves changing the nature of an image in order to improve its pictorial information for human interpretation ,We shall be concerned with digital image processing, which involves using a computer to change the nature of a digital image [2].

1.2 The various Image Processing techniques are:

- Image representation
- Image preprocessing
- Image enhancement
- Image restoration
- Image analysis
- Image reconstruction

• Image data compression

1.2.1Image Representation

An image defined in the "real world" is considered to be a function of two real variables, for example, *f*(*x*,*y*) with *f* as the amplitude (e.g. brightness) of the image at the *real* coordinate position (*x*,*y*). The effect of digitization is shown in Figure 1.1.

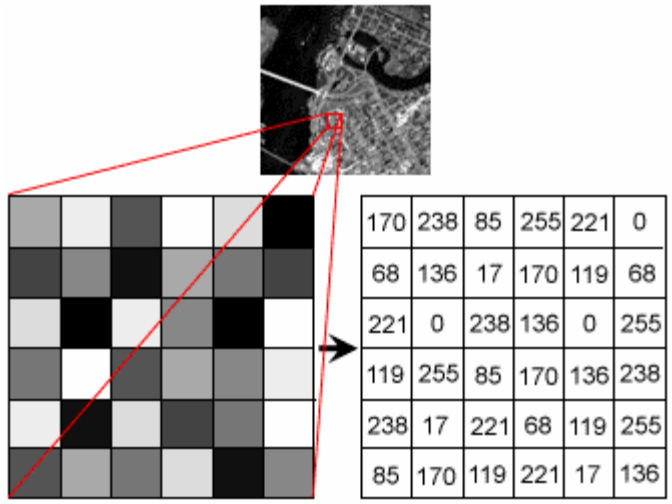

Fig. (1.1) The effect of digitization

The 2D continuous image f(x , y) is divided into N rows and M columns. The intersection of a row and a column is called as pixel. The value assigned to the integer coordinates [m , n] with {m=0,1, 2,...,M-1} and {n=0,1,2,...,N-1} is f[m,n]. In fact, in most cases f(x , y)--which we might consider to be the physical signal that impinges on the face of a sensor [1].

1.2.2 Image Restoration

Image restoration refers to removal or minimization of degradations in an image. This includes de-blurring of images degraded by the limitations of a sensor or its environment, noise filtering, and correction of geometric distortion or non-linearity due to sensors [1].

1.2.3 Image Compression

Compression is a very essential tool for archiving image data, image data transfer on the network etc. They are various techniques available for loss and lossless compressions. One of most popular compression techniques, JPEG (Joint Photographic Experts Group) based compression technique. Currently wavelet based compression techniques are used for higher compression ratios with minimal loss of data [1].

1.3 Type of image

1.3.1 Binary images Each pixel is just black or white. Since there are only two possible values for each pixel, we only need one bit per pixel. Such images can therefore be very efficient in terms of storage. Images for which a binary representation may be suitable include text (printed or handwriting), fingerprints, or architectural plans [2]. such as in figure 1.2

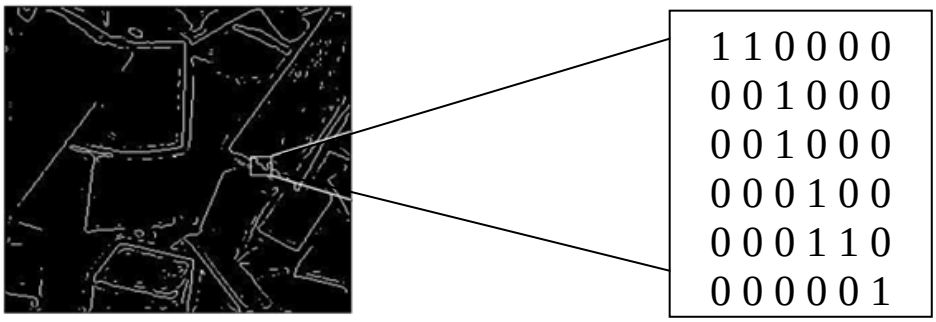

Fig.(1.2) Architectural plans of image

1.3.2 A gray scale Each pixel is a shade of grey, normally from 0 (black) to 255 (white). This range means that each pixel can be represented by eight bits, or exactly one byte.[2], such as in figure 1.3

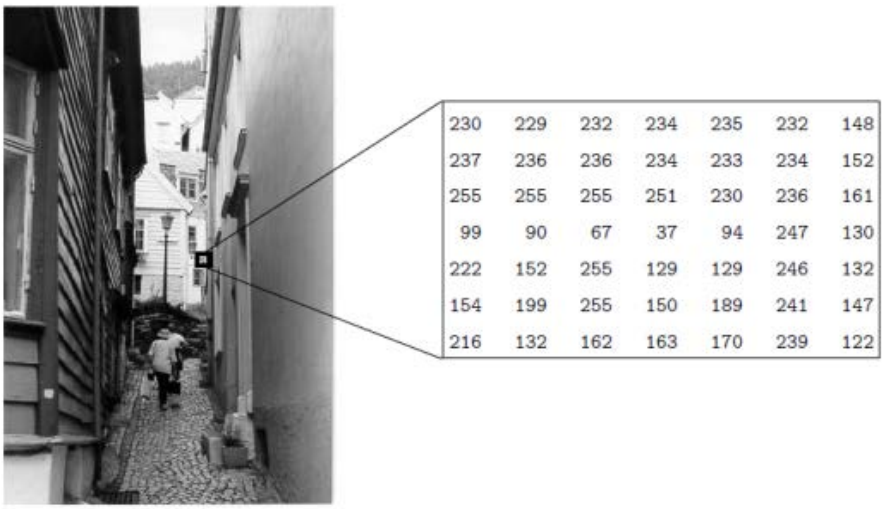

Fig. (1.3) Each pixel can be represented by eight bits

1.3.3 RGB image(Color image) Here each pixel has a particular color ; that color being described by the amount of red, green and blue in it. If each of these components has a range 0_ 255 , this gives a total of 255^3 =16,777,216 different possible colors in the image. This is enough colors for any image. Since the total number of bits required for each pixel is 24 such images are also called 24 -bit color images.

Such an image may be considered as consisting of a "stack" of three matrices; representing the red, green and blue values for each pixel. This means that for every pixel there correspond three values.[2] .We show an example in figure 1.4.

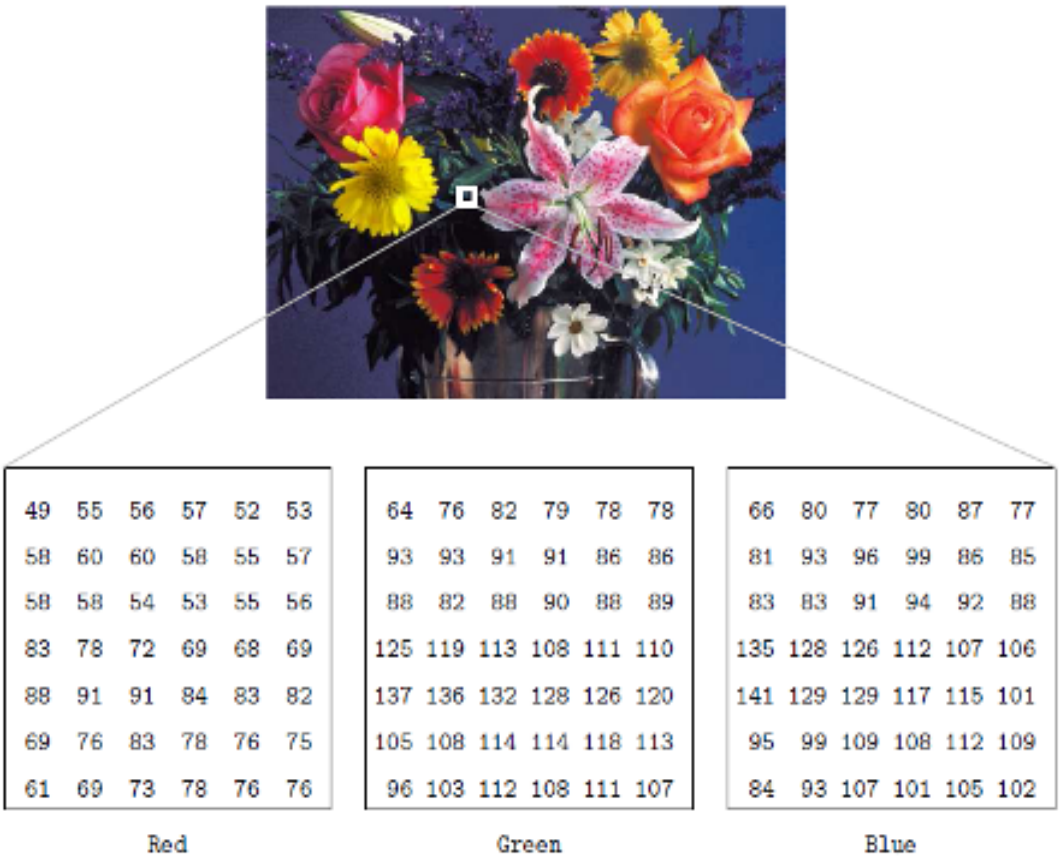

Fig. (1.4) Every pixel there correspond three values(RGB)

1.4 Problem Background

As the requirement for Image Quality Evaluation is needed in many application areas. Image quality review is one of the challenging fields of digital image processing system. Measurement of visual quality is of fundamental importance for plentiful image and video processing applications, where the evaluation of image quality based on single strategy Human Vision System (HVS) may not very sufficient.

1.5 Objectives

1. Assess the quality of images or videos in agreement with human quality judgments.

2. Calculate efficient result to image quality measurements with discuss the mathematics algorithms such as Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Average Difference (AD), Normalized Cross correlation (NK), Structural Content (SC) and Maximum Difference (MD).

2.1 Image quality

Measurement of image quality is important for many image processing applications. Image quality assessment is closely related to image similarity assessment in which quality is based on the differences (or similarity) between a degraded image and the original, unmodified image. There are two ways to measure image quality by subjective or objective assessment. Subjective evaluations are expensive and time-consuming. Objective evaluations are automatic and mathematical defined algorithms.[3]

Subjective measurements can be used to validate the usefulness of objective measurements. Therefore objective methods have attracted more attentions in recent years. Well-known objective evaluation algorithms for measuring image quality include mean squared error (MSE), peak signal-to-noise ratio (PSNR) [3].

Image quality is a characteristic of an image that measures the perceived image degradation (typically, compared to an ideal or perfect image). Imaging systems may introduce some amounts of distortion or artifacts in the signal, so the quality assessment is an important problem[4].

2.2 Types of Quality Measure

There are basically two approaches for image Quality measurement [3]:-

1. Subjective measurement.
2. Objective measurement.

2.2.1 Subjective measurement

A number of observers are selected, tested for their visual capabilities, shown a series of test scenes and asked to score the quality of the scenes. It is the only “correct” method of quantifying visual image quality. However, subjective evaluation is usually too inconvenient, time-consuming and expensive .[3]

2.2.2 Objective measurement

These are automatic algorithms for quality assessment that could analyses images and report their quality without human involvement. Such methods could eliminate the need for expensive subjective studies. Objective image quality metrics can be classified according to the availability of an original (distortion-free) image, with which the distorted image is to be compared [3].
So in chapter three will discuss some of this objective quality metrics such as PSNR,MSE,AD,NK,SC,MD.

2.3 Image quality assessment categories

There are several techniques and metrics that can be measured objectively and automatically evaluated by a computer program. Therefore, they can be classified as full-reference (FR) methods and no-reference (NR) methods. In FR image quality assessment methods, the quality of a test image is evaluated by comparing it with a reference image that is assumed to have perfect quality. NR metrics try to assess the quality of an image without any reference to the original one .

For example, comparing an original image to the output of JPEG compression of that image is full-reference – it uses the original as reference[4].

3.1 Introduction

One common approach to image quality and performance evaluation is to evaluate if the reference image and the processed image still remain a high level of similarity However, existing image quality metrics regarded one of the reference and processed image or both as perfect. Image quality metric (IQM) is essential for most image processing applications. Any image and video acquisition system can use the quality metric to adjust itself automatically for obtainingimproved quality images. It can be used to compare and evaluate image processing systems and algorithms [5].

As we see in chapter two image quality divided into two type Objective measurement and Subjective measurement, so in this chapter will deal with objective measurement. Below flowchart explain use of measures of quality for two images:

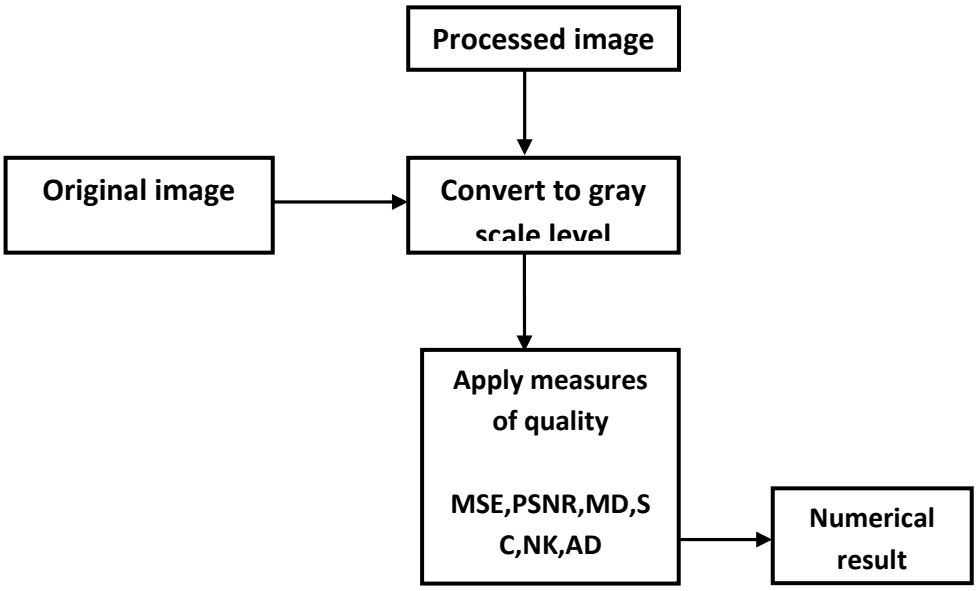

Fig.(3.1) flowchart explain use of measures of quality for two images

3.2 Image quality metrics (IQM)

3.2.1 Mean Squared Error (MSE)

$$MSE = \frac{1}{\mathrm{M} * \mathrm{N}} \sum_{J=1}^{M} \sum_{I=1}^{N} \left[X_{(I,J)} - Y_{(I,J)} \right]^2 \qquad (3.1)$$

Where :

M,NIs are the dimensions of the images

X(i,j)Is the original image

Y(i,j)Is the processed image

MSE zero when X(i,j)=Y(i,j).

i andj are the pixel position of the **M×N** image.

Mean square error is one of the most commonly used error projection method where, the error value is the value difference between the actual data and the resultant data. The mean of the square of this error provides the error or the actual difference between the expected/ideal result to the obtained or calculated result [6].

Here, the calculation is performed at pixel level. X total of M*N pixels are to be considered. *X(i,j)* will be the pixel density value of the perfect image and *Y(i,j)* being that of the processed image. Thedifference between the pixel density of the perfect image and the processed image is squared and themean of the same is the considered error. MSE value will be 0 if both the images are identical. The larger value of MSE, represents the poorer quality of the image.[6]

3.2.2 Peak Signal to Noise Ratio

$$PSNR = 10\log_{10}\frac{255^2}{MSE}$$

The PSNR is evaluated in decibels and is inversely proportional the Mean Squared Error. It is given by the equation above .[7]

at pixel level, the highest possible value is 255. i.e. in a 8 bit grayscale image, the maximum possible value is having every bit as 1 –> 11111111; which is equal to 255. The error between the processed image and the perfect image is calculated as the Mean Square Error and the ratio value if obtained. If both the processed and the perfect images are identical, then the MSE value would be 0. In that case, the PSNR value will remain undefined [6].

A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction.[7]

3.2.3 Average Difference (AD)

$$AD = \frac{1}{\mathrm{M} * \mathrm{N}} \sum_{j=1}^{M} \sum_{i=1}^{N} \left[\mathrm{X}_{(i,j)} - \mathrm{Y}_{(i,j)} \right] \quad \textbf{(3.2)}$$

Where

M,N is are the dimensions of the images

X(i,j) being the pixel density values of the perfect image.

Y(i,j) being the pixel density values of the fused image.

Average Difference, as explained by the term itself, is the average value of the difference between the actual/ideal data and the obtained/resultant data. In our case, the corresponding pixel values of the perfect Image X and the processed image Y is considered. The difference of the Corresponding pixel density values is averaged to obtain the metric. This metric helps in providing the overall average difference between the corresponding pixels of the two images proving us a value that specifies, how much different is the processed image from the perfect image.Ideally it should be zero [6].

3.2.4 Structural content (SC)

$$SC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[X_{(i,j)}\right]^{2}}{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[Y_{(i,j)}\right]^{2}} \qquad (3.3)$$

Here the ratio between the content of the both the expected and the obtained data. Practically, it is the ratio between the net sum of the square of the expected data and the net sum of square of the obtained data.[6]

Structural content establishes the degree to which an image in the collection matches. It's the measure of image similarity based on small regions of the images containing significant low level structural

information. The more the number of such regions common to both images, the more similar they are considered. it is spread at 1, then the given image is of better quality and large value of SC means that the image is of poor quality [8].

3.2.5 Normalized Cross-Correlation (NCC)

$$NK = \frac{\sum_{i=0}^{M}\sum_{j=0}^{N} X_{(i,j)}.\, Y_{(i,j)}}{\sum_{i=0}^{M}\sum_{j=0}^{N} X_{(i,j)}^{2}} \qquad (3.4)$$

Normalized Cross-Correlation is one of the methods used for template matching , a process used for finding incidences of a pattern or object within an image. this method must be applied on the images that have the same scene (human eyes cannot distinguish one from the other),but they are different in the content.

Normalized Correlation Function Metric is one of the best known methods that evaluate the degree of closeness between two functions[8]. This measure measures the similarity between two images, hence in this sense it's complementary to the difference-based measures**[3].**The Normalized Cross Correlation value would ideally be 1 if the processed and the perfect images are identical.[6]

3.2.6 Maximum Difference (MD)

$$MD = MAX\left(\left|X_{(i,j)} - Y_{(i,j)}\right|\right) \qquad (3.5)$$

Maximum Difference is a very simple metric that gives us the information of the largest of the corresponding pixel error. The difference between each of the corresponding pixel densities is calculated. The biggest difference value of these is considered as the metric here. This metric reflects a high value when in any part of the two images, a significant difference exists. The large value of Maximum Difference (MD) means that image is poor quality [6].

4.1 Introduction

In this chapter will present & compare for the results obtained from VB6 on different image (gray scale image and RGB image)

4.2 Results

Below table show the result according to using of Visual Basic version 6 and it applied to eight pictures that enter through different processes.

Table(4.1) for measures MSE,PSNR,AD,NK,SC,MD FOR difference image:

Image name	***Image size***	***MSE***	***PSNR***	***AD***	***SC***	***NK***	***MD***
Lena1 ***Lena2***	(256X256) (256X256)	97.006	28.262	0.912	1.033	0.979	95
Cat1 ***Cat2***	(170X184) (170X184)	19.063	35.328	0.181	1.001	0.998	28
Lena1 ***Lena3***	(256X256) (256X256)	614.98	20.242	-0.81	0.945	1.003	103
Image1 ***Image2***	(384X256) (384X256)	1.410	46.636	-0.01	0.999	0.999	43

Original image

Lena1

Image with Gaussian blur3

Lena2

Fig.(4.1) Show effect of Gaussian blur 3

Original image

Lena1

Image with Gaussian blur10

Lena3

Fig.(4.2) Show effect of Gaussian blur 10

Original image

Cat1

Compression image

Cat2

*Fig.(4.3)*Show effect of Compression image

Original image

Image 1

Image contain hidden data

Image2

*Fig.(4.4)*Image contain hidden data

4.3 Conclusion

We use in our work four pairs of images we use technique of full reference, As we see from table(4.1), image Lena1(reference) and Lena2(noised image) has MSE=97.006 that mean the ratio of error is high between two image, and PSNR for two images (Lena1&Lena2) is 28.262 that mean low quality of this image and we can reduce about the inverse relationship between two metrics from result that appear in table(4.1), AD for this two image is 0.912 that mean less different between pixels.

Normalized correlation gives closeness between the original and test image and is obtained as 0.979 for images(Lena1 & Lena2), this value tends to 1 if the difference between the images is zero and from the computed values, it is observed that for the Lena2 images obtained highly correlated to the original images. MD is use to find maximum difference between image is given 95 for two picture and SC for this two image is 1.033 this measure equal to 1, if the different between two image is zero large value of it mean image is poor quality we can educe. from this result that image (Lena2) is poor quality, compare with reference image (Lena1).

In image Lena3, we notice the increase of Gaussian noise is increased the value of MSE and decrease the value of PSNR, AD has value negative and indicates difference between two images, SC is 0.945 images have less correlation between their original and noised images ,NK is equal to 1.003 that mean high correlation between two image, MD is equal to 103 this value is high that mean this image is poor quality. As we see and notice from figure (4), while image1 and image 2 look identical in the shape (scene) in fact they are not, they are different in the content. we can estimate and conclude the following result: NK is equal to 1 that mean there is no hidden data otherwise there is found hidden data in our example it equal to 0.999 that mean there is found hidden data , SC is equal to 0.999 that mean less correlation MSE is equal to1.410 it is low value ,PSNR is 47.636 this high value compare to MSE measure andAD is -0.1 low also and MD is 43 that mean this image is high quality. Of all the objective quality measures, PSNR which is the most commonly used quality measure which reflects the quality of processed images approximately. And MSE which give errorof two image.

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الخلاصه :

كما هو مطلوب شرط ل تقييم جودة الصورة في العديد من مجالات التطبيق . تحليل جودة الصورة هي واحدة من المجالات الصعبة المتمثلة في نظام معالجة الصور الرقمية . قياس جودة بصرية أهمية أساسية ل تطبيقات الصور و الفيديو وتجهيز الجميلة ، حيث كان الهدف من تقييم الجودة (QA) خوارزميات هو تقييم تلقائيا نوعية الصور أو أشرطة الفيديو في اتفاق مع الأحكام نوعية الإنسان . تقييم جودة الصورة تقوم على استراتيجية واحدة نظام الرؤية الإنسان (HVS) قد لا يكفي جدا . نحن بحاجة للمزيد من الأبعاد ، لذلك في هذا العمل سيبحث مع خوارزميات الرياضيات مثل ساحة متوسط خطأ (MSE) ، الذروة نسبة الإشارة إلى الضوضاء (PSNR) ، متوسط الفرق (AD) ، تمت تسويته الصليب الارتباط (NK) ، والمحتوى الهيكلي (SC) و الحد الأقصى الفرق (MD) يمكن أن تسهم في حساب نتيجة فعالة ل قياس جودة الصورة .

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قسم هندسة الاتصالات

اقتراح نموذج لحساب النتيجة فعالة لقياسات جودة الصورة

مشروع مقدمإلىقسمهندسة الاتصالات

في جامعة ديالى – كلية الهندسةكجزء منمتطلبات نيلدرجةالبكالوريوس في هندسة الاتصالات

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