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Compression of Astronomical Image Using Five Modulus Method

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Abstract:

The computer vision branch of the artificial intelligence field is concerned with developing algorithms for analyzing image content. Data may be compressed by reducing the redundancy in the original data, but this makes the data have more errors. In this paper image compression based on a new method that has been created for image compression which is called Five Modulus Method (FMM). The new method consists of converting each pixel value in an (4x4, 8×8,16x16) block into a multiple of 5 for each of the R, G and B arrays. After that, the new values could be divided by 5 to get new values which are 6-bit length for each pixel and it is less in storage space than the original value which is 8-bits.

Keywords: Compression, Astronomical image, FMM, block size.

ضغط الصورة الفلكية باستخدام طريقة خمسة معاملات

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الخلاصة:

في مجال الكمبيوتر والذكاء الصناعي تطور الاهتمام بخوارزميات تحليل محتوى الصور. ضغط البيانات يقلل من حجم هذة البيانات الاصلية ولكن يعمل بعض الاخطاء. في هذا البحث استخدمت طريقة جديدةلضغط الصور تسمى طريقة خمسة معامل. تتضمن هذة الطريقة تحويل قيمة كل بكسل في البلوك الى مضاعفات الخمسة لكل من مصفوفات الصور الملونة. بعد ذلك القيم الجديدة يمكن ان تقسم على خمسة لنحصل على قيم جديدة والتي طولها ستة بت لكل بكسل وبالتالي تكون بسعة خزن اقل من القيمة الاصلية والتي طولها ثمانية بت.

1-Introduction:

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it or to compression images which will deal with it in this paper. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing System includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too [1]. Digital image processing deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output. The most common example is

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Adobe Photoshop. It is one of the widely used application for processing digital images. Signal processing is a discipline in electrical engineering and in mathematics that deals with analysis and processing of analog and digital signals, and deals with storing, filtering, and other operations on signals.

These signals include transmission signals, sound or voice signals, image signals, and other signals e.t.c.Out of all these signals, the field that deals with the type of signals for which the input is an image and the output is also an image is done in image processing. As it name suggests, it deals with the processing on images.It can be further divided into analog image processing and digital image processing.Images are very important documents nowadays; to work with them in some applications they need to be compressed, more or less depending on the purpose of the application [2]. There are some algorithms that perform this compression in different ways; some are lossless and keep the same information as the original image, some others loss information when compressing the image. Some of these compression methods are designed for specific kinds of images, so they will not be so good for other kinds of images. Some algorithms even let you change parameters they use to adjust the compression better to the image. Image quality is measured using peaksignal-to-noise ratio (PSNR) as most common objective measure. Whenever the value of PSNR is high this implies good compression because it means high Signal to Noise. In other words, the signal represents the original image while the noise represents the error in reconstruction. So, a compression scheme having a high PSNR can be recognized as a better one. Compression Ratio (CR) is defined as the ratio of the number of bits required to represent the data before compression to the number of bits required after compression. CR is denoted by [3]:

$$compression \quad ratio = \frac{Uncompressed \quad File \quad Size}{Compressed \quad File \quad Size}$$

.

And PSNR can be computed by:-

$$\mathrm{PSNR} = \frac{[\text{Peak to Peak of } x_i]^2}{\mathrm{MSE}}$$

The PSNR can be represented in decidable (dB) unit as:

$$\mathrm{PSNR} = 10\log_{10}\left[\frac{gray \quad scale \quad of \quad image}{MSE}\right]^2$$

In this paper uses a technique which is called Five Modulus Method (FFM) to compression the Astronomical image is consists ofdividing the image into blocks of 4.4, 8.8 and 16.16 pixels each. Clearly, we know that each pixel is a number between (0 to 255)for each of the Red, Green, and Blue arrays. Therefore, if we can transform each number in that range into a number divisible by 5, then this will not affect the Human Visual System (HVS). Mathematically speaking, any number divided by 5 will give a remainder ranges from 0-4.

2- Astronomy image:

From year to year, the quantity of astronomical data increases at an ever growing rate. In part this is due to very large digitized sky surveys in the optical and near infrared, which in turn owes its origin to the development of digital imaging arrays such as CCDs. The size of digital arrays continually increases following the demands of astronomical research for obtaining larger quantities of data in shorter time periods [4] in this paper taken two astronomical images, the first is Jupiter and the second is NGC6946 galaxy.

i- Jupiter:

Jupiter is the largest of the nine planets, more than 10 times the diameter of Earth and more than 300 times its mass. In fact, the mass of Jupiter is almost 2.5 times that of all the other planets combined. Being composed largely of the light elements hydrogen and helium, its mean density is only 1.314 times that of water. The mean density of Earth is 5.245 times that of water. The pull of gravity on Jupiter at the top of the clouds at the equator is 2.4 times as great as gravity's pull at the surface of Earth at the equator. The bulk of Jupiter rotates once in 9 hours, 55.5 minutes, although the period determined by watching cloud features differs by up to five minutes due to intrinsic cloud motion [5].

ii- (NGC6946) galaxy:

NGC 6946 is a Spiral galaxy with 8.9 mag, was discovered by William Herschel [1] on September 9, 1798. NGC 6946 is a rather nearby spiral galaxy, which at one time was suspected to be an outlying member of the Local Group (see Hubble 1936) [2]. It is highly obscured by interstellar matter of the Milky Way galaxy, as it is quite close to the galactic plane. Located at a distance of 5.9 Mpc, NGC 6946 is a large spiral galaxy seen almost face-on [3], shows a bright central nucleus, the central regions are affected by dust extinction (Elmegreen et al. 1998)[6].

3- Five Modulus Method

In most of images, there is a common feature which is the neighboring pixels are correlated. Therefore, finding a less correlated representation of image is one of the most important tasks. One of the basic concepts in compression is the reduction of redundancy and Irrelevancy. This can be done by removing duplication from the image. Sometime, Human Visual System (HVS) can not notice some parts of the signal, i.e. omitting these parts will not be noticed by the receiver.

This is called asIrrelevancy Also, for bi-level images, the principle of image compression tells us that the neighbors of a pixel tend to be similar to the pixel. According to [7], this principle can be extended as that if the current pixel has any color (black or white), then pixels seen in the past or future of the same color tend to have the same neighbors [8].

The basic idea in FMM is to check the whole pixels in the 4x4, 8x8 and 16x16 and transform each pixel into anumber divisible by 5 according to the following conditions [9].

if A(i,j) Mod 5 = 4
A(i,j)=A(i,j)+1
Else if A(i,j) Mod 5 = 3
A(i,j)=A(i,j)+2
Else if A(i,j) Mod 5 = 2
A(i,j)=A(i,j)-2
Else if A(i,j) Mod 5 = 1
A(i,j)=A(i,j)-1

Where A(i,j) is the digital image representation of the 4x4, 8x8 and 16x16 block for any of the R,G, or B arrays consisting the digital image.

In addition, we can see that the new pixels are always having zero remainder when divided by 5. Consequently, the resulting numbers are multiples of 5 between 0-255, which are 52 numbers (0,5,10,15,20,…,255). Hence, if we divide these numbers by 5 again we will get remainder range from 0-51.

4- Experimental Result:-

In this paper we implemented the technique of Five Modulus Method (FFM) to compression the Astronomical image as follow:

Firstly, for each 4.4, 8.8 and 16.16 block, the new stream starts with 6 bits in the beginning that is reserved for the value of the minimum for the block after transformation.

Secondly, a bit for repetition, i.e. if the whole block consists of the same value, this value will be 1 otherwise its 0. This bit is used to decrease storage for each block when there is no need to repeat values if the entire block consisting of the same value.

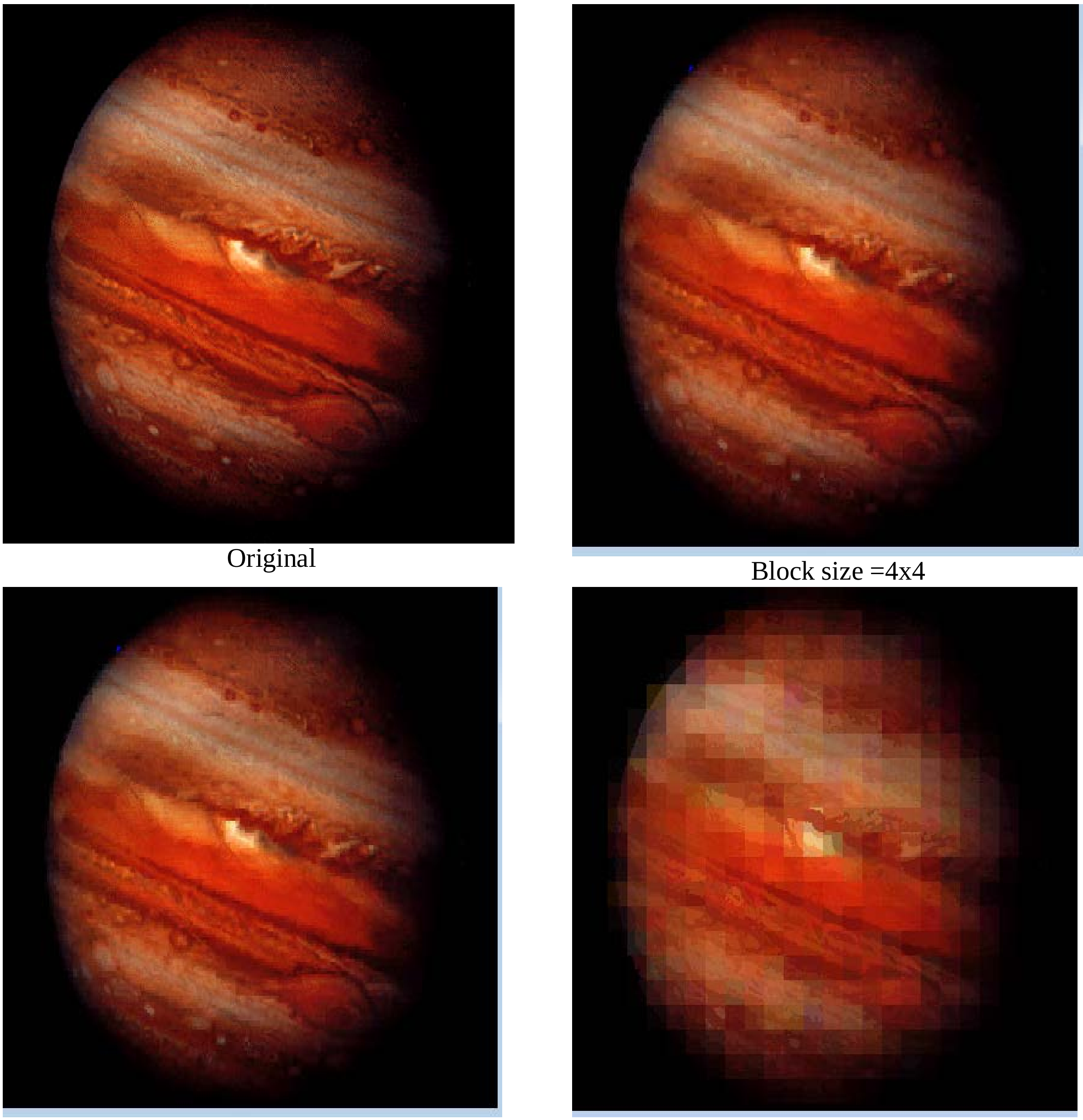
Next, the value of the maximum for the current block can be added to determine the width of the current stream values.

Finally, a stream of {max length}-bits, i.e. the length of the maximum will be the standard length for all other values in that stream, for each new pixel coordinate will follow.

The result of this technique is illustrated in Table-1, which contain values of C.R, MSE, PSNR for different size block of two images, in Figure-1, and Figure-2 show the original images and reconstructed image.

Table 1- values of C.R, MSE, PSNR for different block size of image

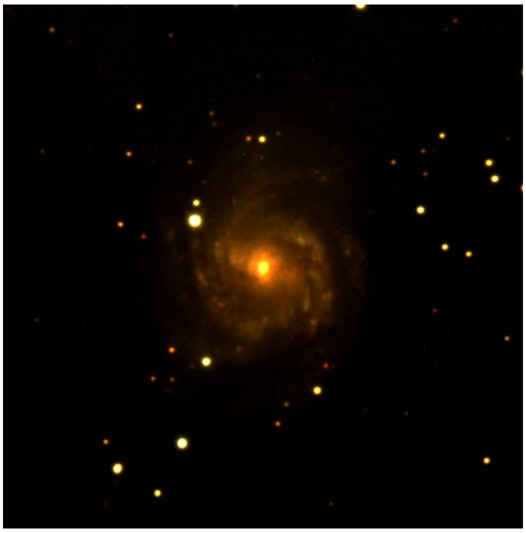
Images	Size block	C.R	MSE	PSNR
Jupiter	4x4	5.8	123	27.6
	8x8	7.5	167	24.8
	16x16	9.6	187	21.4
(NGC6946) galaxy	4x4	6	122	27
	8x8	7.9	160	25.4
	16x16	8.9	190	20.5



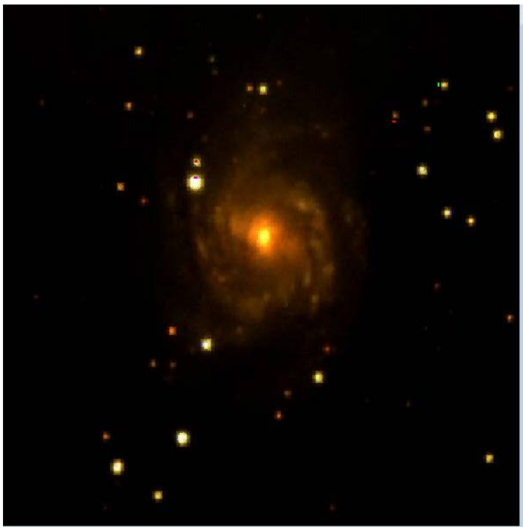
Original | Block size =4x4

Block size =8x8 | Block size =16x16

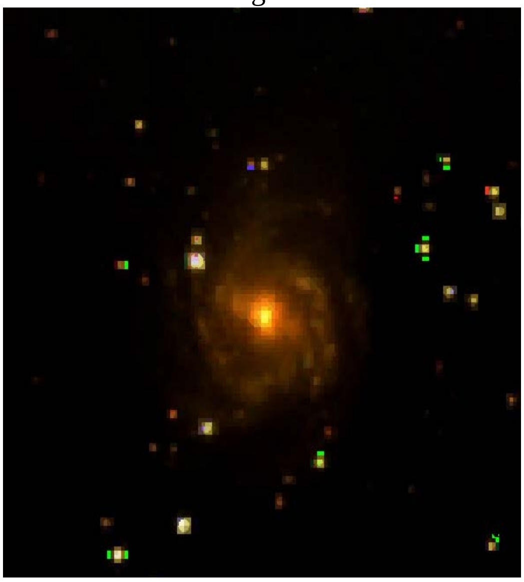
Figure 1- Original and reconstructed images of Jupiter by Using FMM Technique



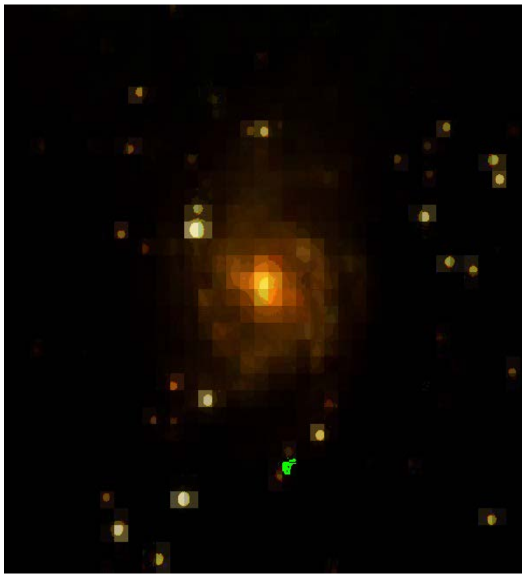
Original



Block size= 4x4



Block size= 8x8



Block size 16x16

Figure 2- Original and reconstructed images of (NGC6946) galaxy by Using FMM Technique

5.Conclusion:

In this work we applied one of the Lossy compression methods which is called Five Modulus Method (FFM) to cmpress the tow different Astronomy images (Jopetor , and glaxy .NGC6946) . From the results that clears can be seen, the values of compression rates C.R, the value of PSNR, and MSE that the large block (16x16) size may lead to higher compression rates but smaller value of PSNR i.e bad reconcetracted image which that mean deterioration in image quality, So when PSNR is low that's mean the noise signal is greater than orignal signal, at other hand when the t small block size (4x4) may give low compression rates withso high quality of reconcetcted image is better, High value of PSNR.

Refrences:

1. Campbell, G. B.**2002**. *Introduction to Remote Sensing,Corine Land Cover Technical Guide, European Commission,Luxemburg.*
2. Chintan, A. S.Arora, M.K. and Pramod, K. V. **2004**. *International Journal of Remote Sensing*, 25, pp:481-487.
3. Conzales, R.C. and Woods, R.E. **2002.** *Digital image processing,* Second Edition, Addison Wesley.
4. Bagetakos, I., Brinks, E., Walter, F., de Blok, W. J. G., Usero, A., Leroy, A. K., Rich, J. W. and Kennicutt, R. C., Jr. **2011**. *The Astronomical Journal*, 141(1), article id. 23, p:35.

5. Lira, P., Johnson, R. A., Lawrence A. and Cid Fernandes, R. **2007**. Monthly Notices of the Royal Astronomical Society, 382(4), pp:1552-1590.

6. Marcelo D. Cicco. **2015**. *Compression and Dnoising of Aseronomical Images*, Fifth Edition, pp.435-440.

7. Salomon, D**. 2007.***Data Compression: The Complete Reference*, Fourth Edition, Springer.

8. Firas A. Jassim and Hind E. Qassim. **2012**. Five Modulus Method for image compression, *An International Journal (SIPIJ)*, 3(5).

9. Motta, G. Rizzo, F. and Storer, J. A. **2003**. Digital Image Compression, in Encyclopedia of Computer Science, John Wiley & Sons, Fourth Edition, pp:836-840.