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Yi Xie
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Introduction

International Conference on Digital Image Processing (ICDIP) 2010 is sponsored by International Association of Computer Science and Information Technology (IACSIT). If you have attended a conference sponsored by IACSIT before, you are aware that the conferences together report the results of research efforts in a broad range of computer science and Information technology. These conferences are aimed at discussing the wide range of problems encountered in present and future high technologies. ICDIP 2010 is organized to gather members of our international community of scientists so that researchers from around the world can present their leading-edge work, expanding our community's knowledge and insight into the significant challenges currently being addressed in that research. The conference Program Committee is itself quite diverse and truly international, with membership from the Americas, Europe, Asia, Africa and Oceania.

This proceedings volume contains the fully refereed papers presented at the conference. The main conference themes and tracks involve digital image processing. The main goal of these events is to provide an international scientific forum for the exchange of new ideas in a number of fields that interact in-depth through discussions with their peers from around the world. Both inward research (core areas of digital image processing) and outward research (multi-disciplinary, inter-disciplinary, and applications) will be covered during these events.

The conference has solicited and gathered technical research submissions related to all aspects of major conference themes and tracks. All the submitted papers in these proceedings have been peer reviewed by the reviewers drawn from the scientific committee, external reviewers and editorial board depending on the subject matter of the paper. Reviewing and initial selection were undertaken electronically. After the rigorous peer review process, the submitted papers were selected on the basis of originality, significance, and clarity for the purpose of the conference. The selected papers and additional late-breaking contributions to be presented as lectures will make an exciting technical program. The conference program is extremely rich, featuring high-impact presentations.

The high quality of the program, guaranteed by the presence of an unparalleled number of internationally recognized top experts, can be assessed when reading the contents of the program. The conference will therefore be a unique event, where attendees will be able to appreciate the latest results in their field of expertise, and to acquire additional knowledge in other fields. The program has been structured to favor interactions among attendees coming

from many diverse horizons, scientifically, geographically, from academia and from industry. These interaction will include social events at prestigious sites.

Yi Xie

Satellite Image Compression Using Wavelet

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ABSTRACT

Image data is a combination of information and redundancies, the information is part of the data be protected because it contains the meaning and designation data. Meanwhile, the redundancies are part of data that can be reduced, compressed, or eliminated. Problems that arise are related to the nature of image data that spends a lot of memory. In this paper will compare 31 wavelet function by looking at its impact on PSNR, compression ratio, and bits per pixel (bpp) and the influence of decomposition level of PSNR and compression ratio.

Based on testing performed, Haar wavelet has the advantage that is obtained PSNR is relatively higher compared with other wavelets. Compression ratio is relatively better than other types of wavelets. Bits per pixel is relatively better than other types of wavelet.

Keyword: Wavelet, Compression, Satellite Image

1. INTRODUCTION

Image is data in picture forming that can represent those data. Image data is combination with information and redundancy, a part of information is a part of data that is existence because having meaning and aiming data. Otherwise a part of redundant is a part of data than can be reduction, compressed, and turned away.

Problems can be happened with image data characters that spend too much memory. Memories that can be spent by those pictures reduce capability saving of data image. In telecommunication image data transmission need transmission channel that have big bandwidth. In Computer and Internet world, Compressing file is used in all necessity, if we want to make data refill, It is not necessary to copy all original file but wit compressing that file so saving capacity will be smaller. If anytime the data will be needed, we must return to original file.

Specific aim this research is getting a wavelet function that appropriate to compress satellite image so this advantage is to save saving space, saving time of central processing unit and if we use the computer, data that have been compressed is not need long time so it can save delivery time.

2. DEFINITION OF WAVELET

Wavelet is a mathematic function that divide data to be several component that have different frequency, It learn every component with appropriate resolution for every scale [1]. Wavelet is a wave forming that has limited duration with zero mean value. Successful application with wavelet is data image compressing, water making, edge detection, radar system, finger print code. There are 3 reasons for using wavelet transformation to refreshing image namely:

1. Wavelet transformations have unconditional basis character. It have meaning that coefficient transformation result will be reduced quickly from approach coefficient to detail coefficient or transformation result have small or zero value, So image character can be represented by a small part of coefficients transformation result or a sign can be represented effectively with using a small part of coefficients transformation result.
2. Wavelet transformation have sign location characteristic, so it can be separated irregulars sign component at specific space and frequency well
3. Wavelet transformations have quick transformation process, so it is caused computation time will be short and It is appropriate to apply in digital computer.

Wavelet transformation is explanation of a sign or image that use wavelet function with different location and size also it is counted with pyramid algorithm. In Image processing, digital Image are formed Discrete Wavelet Transform. Wavelet is a base, wavelet base is come from a scaling function. Scaling function has character namely it can be arranged from several copying than have been dilation, translated, scaled. This function is reduced from

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dilatation equation, as basic from wavelet theory. From scaling function can be formed first wavelet equation (mother wavelet) namely:

$$\psi_{ab}(x) = \frac{1}{\sqrt{a}}\psi\left(\frac{x-b}{a}\right)$$

From this mother wavelet can be formed the next wavelet (ψ^1, ψ^2, etc) with dilating, moving mother wavelet. Based on scaling function, mother wavelet, has different name examples:

- Wavelet Haar has scaling function with coefficient $c_0 = c_1 = 1$.
- Wavelet daubechies with 4 coefficients (Db4) have scaling function with coefficient $c_0 = (1+\sqrt{3})/4$, $c_1=(3+\sqrt{3})/4$, $c_2= (3-\sqrt{3})/4$, $c_3 = (1-\sqrt{3})/4$
- Wavelet B–Spline cubic has scaling function with coefficient $c_0 = 1/8$, $c_1 = 4/8$, $c_2 = 6/8$, $c_3 = 4/8$, $c_4 = 1/8$.

3 . DEFINITION OF COMPRESSION

The development of information technology that allows large amounts of data accumulated. For example, nationwide department store sales save each using a POS (Point of Sales). Database sales data can reach several GB per day for a supermarket network is. Therefore there is need for compression, which can reduce the storage space limitations can be speed up access times. The nature of the data compression there are two, that is, without a lossless, and lossy. Data compression without loss is used to reduce the size of the data by providing the exact appearance of the original. For compression without losing accuracy of the results of compression rate is 100% of the original data. Data compression is lost, there is a difference compression results with the original data but still within the specified tolerances. In this study, the nature of the data compression is used without a loss, because the compressed image database to produce 100% accuracy level.

4. IMAGE COMPRESSION USING WAVELET

Destination image compression is to reduce the storage capacity without losing image quality significantly. A characteristic of an image is a close correlation between a pixel with other pixels. Image data compression can be done with wavelets transform. Stollnitz [2] says that one of the characteristics of wavelet is the infrequency. In fact, many coefficients in the representation of wavelet whose value is zero or very small. This nature provides an opportunity to perform image data compression. The main properties of wavelet brief silence in image compression is the minimum distortion in the image of disappearances carried out reconstructs although the coefficients are near zero transform. Whereas wavelet transform the image will result in many subfields images that have very small magnitudes. Threshold determination of non-negative, subfields elements of the image is very small value can be zero which can lead to very rare matrix. The existence of the matrix is very rarely make it easier to be transmitted and stored, even a reconstructed image with threshold (quantization) can provide acceptable results in a visual eye. Currently wavelet applications are received much attention in the world of research, one of which is to analyze the image. Signal analysis techniques as discrete 2-dimensional, such as images, wavelet signals into signals decomposes average, details of vertical, horizontal and diagonal at some desired level. Or, the original signal wavelet becomes decomposes signals in some frequency bands (called multi-resolution analysis). Analysis can be done with the Discrete Wavelet Transform [3] or the standard decomposition techniques and non-standard with the Haar wavelet ([4], and [5]. Signature image generated by wavelet derived from the wavelet coefficients at a certain level (eg 3, 4 or 5) and can be sized much smaller than the original image.

5. SATELLITE IMAGE

Satellite imagery is the data that uses satellite imagery as property. The satellite uses sensors to record the condition or description of the earth's surface. Generally applied in activities related to monitoring of natural resources in the earth's surface (there are even a few satellites that can record up to below the earth's surface), the study of land and environmental changes, and other applications that involve human activities on the earth's surface. The advantages of the technology, especially in this decade are the ability to record a wide range of areas and levels of resolution in the recording a very high objects. The data generated from satellite imagery and then lowered to the thematic data and stored in a database for use in various applications.

6. RESEARCH METHODOLOGY

Proposed research is designed as a review of research literature and experiments. Literature research looking for some wavelet functions wavelets which already exist and image processing theory, and writing source code. While study conducted experiments to test the wavelet function is suitable or appropriate for the compression of satellite images and tests multiple satellite images.

The processes of research are:

1. Literature research with wavelet, image database, image processing, compressing techniques.
2. Experiment of several wavelet function. It will be used in process of image satellite compressing. Function wavelet will be used to experiment are:
    a. Haar
    b. Daubechies (db2, db3, db4, db5)
    c. Coiflets (coif1, coif2, coif3, coif4, coif5)
    d. Symlets (sym2, sym3, sym4, sym5, sym6, sym7, sym8)
    e. Biorthogonal (bior1.3, bior 1.5, bior2.2, bior2.4, bior2.6, bior2.8, bior3.1, bior3.3, bior3.5, bior3.7, bior3.9, bior4.4, bior5.5, bior6.8)

   The result data are:
    a. Ratio compression
    b. MSE
    c. PNSR
    d. Bit per pixel (Bpp)
3. Analyzing
    a. wavelet type vs compression ratio
    b. wavelet type vs PNSR
    c. wavelet type vs bit per pixel (bpp)
4. Conclusion of advantage and disadvantaged every wavelet function.

7. RESULT AND DISCUSSION

This study using satellite images of 24-bit color with 512x512 size obtained from satellite data. The image is tested in this study can be seen in Figure 2.

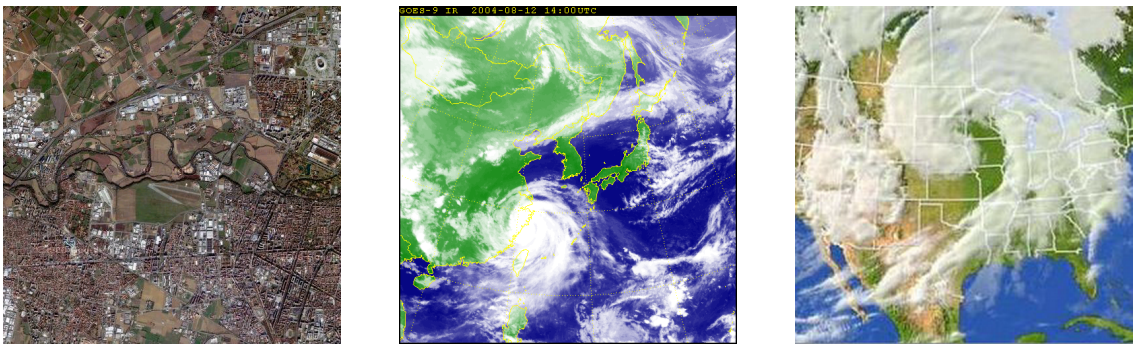

Figure 2. Satellite imagery is used for testing (a) bigmap.bmp, (b) 22.bmp, (c) awan1.bmp

It is used several wavelet function In this research namely wavelet Haar, db2, db3, db4, db5, coif1, coif2, coif3, coif4, coif5, sym2, sym3, sym4, sym5, sym6, sym7, sym8, bior1.3, bior1.5, bior2.2, bior2.4, bior2.6, bior2.8, bior3.1, bior3.3, bior3.5, bior3.7, bior3.9, bior4.4, bior5.5, bior6.8. This wavelet then tried to use to compress the test image. The results of compression of each wavelet are then compared by using several parameters, ie PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), bpp (bits per pixel), and the compression ratio. In this paper will be presented some results of the prototype program developed using Matlab program assistance, including the following:

1. Compression and decompression functions
2. Function calculation PSNR, MSE, bpp, and the compression ratio

Also to be presented also the compression test results using several types of wavelets and its impact on parameter values PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), bpp (bits per pixel), and compression ratio. Here is the output of the program.

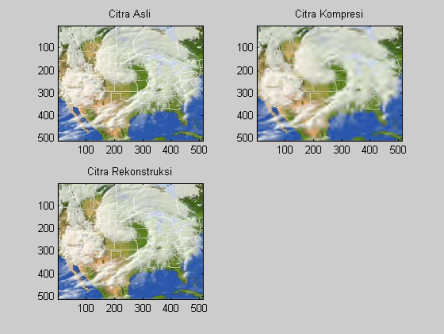

Figure 3. Image compression and Decompressing Awan 1

Figure 3 is an example of image compression and decompression tests. The image displayed on the image is compressed using wavelet biorthogonal 6.8, with the number of decomposition level 4. Based on statistical calculations, obtained MSE values are small enough to show that the image reconstruction results similar to the image that will be compressed

7.1. The Influence of Wavelet Type of PSNR

PNSR is one of parameter that can be used to make quantification image qualities. Parameter of PNSR is always used as resembling level between reconstruction image and original image. The Bigger PNSR will make better qualities image.

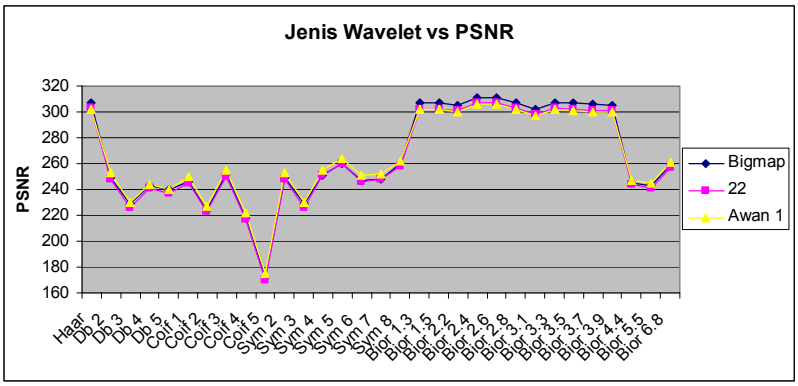

Figure 4. Graphic Relationship Between Wavelet type of PSNR

From the graphs can be seen that the sequence of the 3 types of wavelets have the highest PSNR is
a. For bigmap.bmp satellite imagery are Bior 2.4, Bior 2.6, and Haar.
b. For 22.bmp and awan1.bmp satellite images are Bior 2.6, Bior 2.4, and Haar.
Wavelet Biorthogonal 2.4 more suitable for color image which is almost similar, whereas bior 2.6 is more suitable for color image is more varied. While Haar wavelet is more adaptable to several types of test images.

7.2. The Influence of Wavelet Type of Compression Ratio

Compression ratio is used to measure the ability of data compression, namely by comparing the size of the original image with the size of the compressed image. The greater the compression ratio means the better the wavelet function.

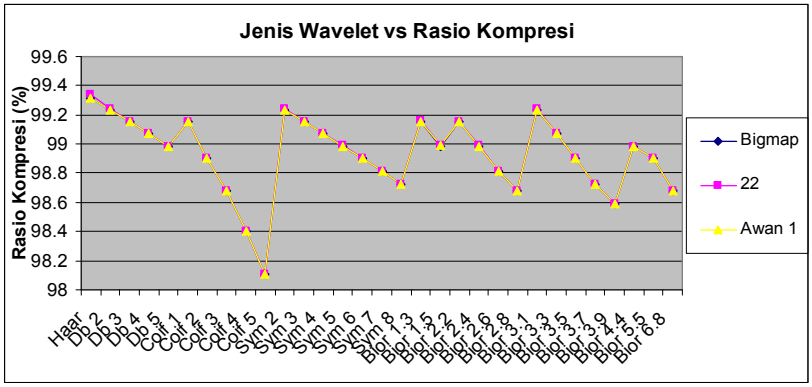

Figure 5. Relationship Between Graph Types of Wavelet Compression Ratio

From the graph can be seen that the sequence of 3 types of wavelet have the highest compression ratio are Haar, Bior 3.1, then Symlet 2 or Db 2.

7.3. The Influence of Wavelet Type of The Bit Rate or Bit per Pixel (bpp)

Parameter bit rate is a mathematical parameter which can quantify the performance of compression. More specifically the bit rate is a parameter used to compare elements of nonzero quantized image with elements not zero in the original image. The lower the bit rate the better is the ability of wavelet as image compressor. Parameters so that the bit rate can be used to test the performance of wavelet compression.

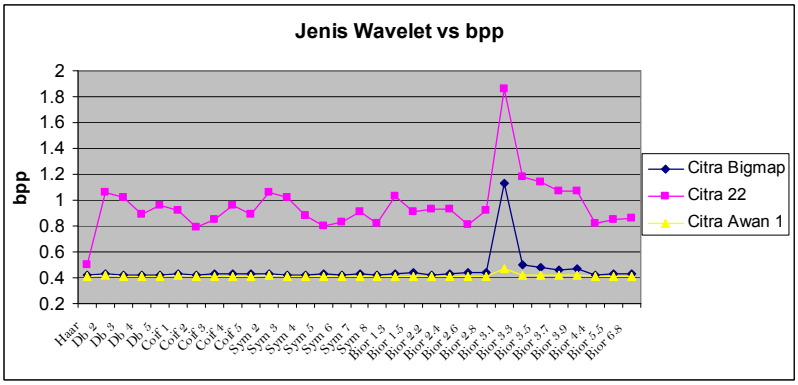

Figure 6. Graphic Relationship Between Wavelet type of bits per pixel

From the graphs can be seen that the type of wavelet which has the lowest bpp is Haar. To image Bigmap.bmp and awan1.bmp bit per pixel (bpp) images tended to same except for the type of wavelet Bior 3.1 there is a significant difference. As for his image 22.bmp tends bit per pixel (bpp) fickle, and significant changes occurred in the types of wavelet Bior 3.1.

7.4. Influence Decomposition Level

Affect the decomposition level PSNR and compression ratio, taking into account both aspects can be determined at what level is chosen as the test image. Determining the level of decomposition is very important because it will affect the computing process, the greater the level the greater the computing process. But keep in mind these two parameters are PSNR and compression ratio can be determined so that the optimal level of decomposition. In this paper the decomposition level is used 4 the optimal for color satellite image measuring 512 x 512.

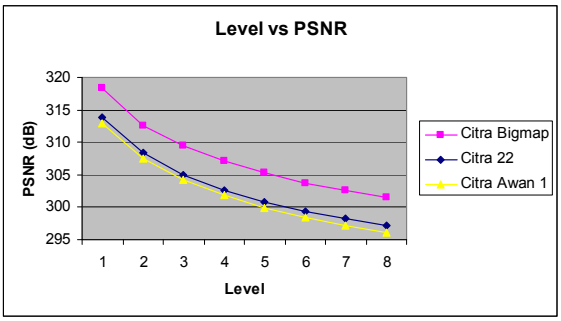

Figure 7. Graphic Relationship Between Decomposition Level of PSNR

From the graphs can be seen that the greater the level of decomposition the smaller PSNR value, this means that the value of error between the original image and the image reconstruction greater.

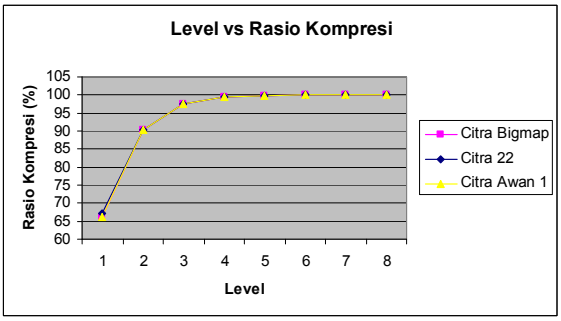

Figure 8. Graphic Relationship Between Decomposition Level of Compression Ratio

From the graphs can be seen that the greater the level of decomposition, the greater the value of the compression ratio.

8. CONCLUSION

Based on testing performed, Haar wavelet has the advantages in terms of:
a. PSNR obtained relatively higher compared with other wavelet
b. Compression ratio is relatively better compared with other types of wavelet
c. Bits per pixel (bpp) is relatively better compared with other types of wavelet
Based on the testing also found that biorthogonal wavelets have similar characteristics with the Haar wavelet, which has a better PSNR, bpp is good, and the compression ratio is better.

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