Comparison of Several Short Waves in the MODIS Image Compression

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Abstract. In remote sensing field, satellite imagery has a very important role. Satellite imagery has a very large data size that have to compressed before transmission or storage. In the other hand it’s difficult to compress the data due to the limited bandwidth and storage capacity, satellite images need to be compressed before transmitted or stored. The purpose of this research is to find a best short wave to compress data (image) in the compression. In this research using short wave Haar, Symlet2, Symlet5, Coiflet1, Coiflet2 with input in the form of a color image with a size of 512 x 512, and image files used extension * jpg. The result of this research are one of four kind of short wave that is used in the compression of the image to the compression ratio that has the highest value is the Haar and the lowest value is the Coiflet2. PSNR value of all testing images from Haar has the highest value and from Coiflet2 has the lowest value.

Keywords: modis image, satellite, short wave

1. Introduction
Remote sensing has been used as a tool that can recognize objects on the surface of the earth. Remote sensing used to obtain information about the object or area, and also analyze the data without having to deal directly with the object. In the world of remote sensing, satellite imagery has a very important role. It has a very large data size, which is difficult to compress the data, while the satellite image data need the data that already compressed before it is sent to a ground station to maintain the visual quality of the image of a high depressive image (Samra, 2012). In addition, satellite imagery involving the storage and transmission of it. Due to the limited bandwidth and storage capacity, satellite images need to be compressed before transmission/storage. (Santoso, Nugroho, Suparta, Hidayat, 2011) Compression can be classified into lossless and lossy, depending on all the information stored or some of the information will be removed during the compression process. Short-wave-based technique is the latest development in the field of image compression. It offers multi-resolution capability and provide substantial improvement in image quality at higher compression ratios [3].

The purpose of this research is to find a best short wave in the compression process the image by doing a comparison of several short wave (Haar, Symlet2, Symlet5, Coiflet1, Coiflet2) the terms of PSNR (peak signal to noise ratio) and the ratio compression.
2. Theory and Hypotheses

A short-wave is the name of functions that have non-zero values only within a certain time (for the rest of the time, its value is zero). As ethimology short wave is translation of wavelet (which is also identical with the small wave [4], [5].

Image compression is the compression of data associated with a digital image. It is needed for saving image data in the file becomes more efficient which aims to reduce the size of image files. It is also needed in the image stream thus the data transmission becomes faster and does not take up too much bandwidth [6], [7]. Furthermore, it is the application of data compression performed on the digital image to reduce the redundancy of data contained in the image so that it can be stored or transmitted efficiently. In general, digital image representation requires a large memory. The larger the size of a particular image, the more memory it needs.

The purpose image compression is to reduce redundancy of image data in order to store or transmit data with minimal space or bandwidth as much as possible, while maintaining resolution and visual quality of the reconstructed image as close as possible to the original image [1]. MODIS sensor is one of the main sensor which brought Earth Observing System (EOS) Terra satellite, which is part of the US space program, the National Aeronautics and Space Administration (NASA). The satellite, which was launched in 1999, and then refined by the Aqua satellite, which was launched in 2002.

MODIS orbits the Earth in a polar sun-synchronous (Terra satellite passed from north to south of the equator and Aqua crossed from south to north of the equator) with an altitude of 705 km, and passing the equator at 10:30 and at 22:30 hours local time [8]. In conducting the testing process of the system are made will do the testing criteria of the original image with the test image. To compare the original image and the image that has been processed can use the MSE (Mean Square Error), but because the MSE depends on the number of pixels used PSNR (Peak Signal to Noise Ratio).

\[
MSE = \frac{1}{MN} \sum_{y=1}^{M} \sum_{x=1}^{N} [I(x, y) - I'(x, y)]^2
\]

\[
PSNR = 20 \cdot \log_{10} \left( \frac{255}{\sqrt{MSE}} \right)
\]

\[
Ratio = 100\% - \left( \frac{\text{Size of Image Compression Result}}{\text{Size of Original Image}} \right) \times 100\%
\]

Where:
- \(I(x, y)\) is the pixel value in the original image
- \(I'(x, y)\) is the pixel value in the image compression results
- \(M, N\) is the dimension of the image

3. Research Methods

Data input in this study is color image each size is 512 x 512, and image files used *.jpg extension and using MATLAB. This study will signify the comparison results of compressing image that compressed by multiple short wave and also look at PSNR score (peak signal to noise ratio) and the compression ratio. The satellite images were used in this study can be seen in Table 1.
Table 1. MODIS Satellite Imagery Data

| No. | Stairs       | Imagery | File Name |
|-----|--------------|---------|-----------|
| 1   | May 3, 2018  | ![Image](image1.png) | M001      |
| 2   | April 9, 2018| ![Image](image2.png) | M002      |
| 3   | 24 April 2018| ![Image](image3.png) | M003      |

4. Result and discussion

4.1. Comparison of short-wave Against Compression Ratio

The compression ratio is used to measure the success of data compression by comparing the number of entries of the original matrix with many zero entries of matrix decomposition. The greater the percentage of the compression ratio the better the compression method. Results of testing can be seen in table 2.
Table 2. Comparison based Compression Ratio

| NO | Short wave | PSNR   |
|----|------------|--------|
|    |            | M001   | M002   | M003   |
| 1  | Haar       | 153 462| 152 267| 159 891|
| 2  | Symlet5    | 129 381| 129 604| 129 782|
| 3  | Symlet2    | 123 732| 123 890| 124 130|
| 4  | Coiflet1   | 122 048| 122 265| 122 471|
| 5  | Coiflet 2  | 110 922| 111 012| 111 316|

Based on the image file size compression results in Table 2, it indicates that the short wave Haar provides a percentage value of the highest compression ratio and short wave Coiflet 2 gives the percentage of the lowest compression ratio.

4.2. Effect of PSNR short wave

One of the parameters used for quantifying image quality is PSNR. This parameter is used to see the degree of similarity between the original image with the reconstructed image. PSNR with larger values will produce better image quality.

Table 3. Results Comparison Based on PSNR

| NO | Short wave | Compression ratio |
|----|------------|-------------------|
|    |            | M001   | M002   | M003   |
| 1  | Haar       | 99 827 | 99 833 | 99 835 |
| 2  | Symlet5    | 99 729 | 99 732 | 99 729 |
| 3  | Symlet2    | 99 801 | 99 806 | 99 803 |
| 4  | Coiflet1   | 99 778 | 99 781 | 99 778 |
| 5  | Coiflet 2  | 99 704 | 99 706 | 99 705 |

Table 3 shows that the highest PSNR value generated by the short wave Haar to the image of M003 with a value of 159 891, while the value of the lowest PSNR is a short wave Coiflet2 and for the M002 test images with the value 111 012

5. Conclusion

The conclusions of the research that has been done on the performance of some short wave (Haar, Symlet2, Symlet5, Coiflet1, Coiflet2) are:

a. Haar short wave has highest compression ratio for image compression and short wave Coiflet2 has lowest compression ratio from comparison result of four short wave (Haar,Symlet2,Symlet5,Coiflet1,Coiflet2) for image compression.

b. Haar short wave has highest PSNR value and short wave Coiflet2 has lowest PSNR value.
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