THE EFFECT OF TRANSFORMATION PART IN IMAGE COMPRESSION

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ABSTRACT

Image compression is an important part in many signal processing applications to minimize data storage. In the last few years, many experiments of wavelet-based schemes for image compression have been developed and implemented. This paper presents comparison of DCT-based method with wavelet-based image compression.

Keywords: *Discrete Cosine Transform, Wavelet, Dual Tree Complex Wavelet Transform, Image Compression*

1. INTRODUCTION

Uncompressed multimedia data usually need considerable data storage capacity and data transmission bandwidth. It will also influence transmission time needed. In order to minimize data storage, transmission bandwidth and transmission time, many researchers have completed their experiments in image compression but it still continue to have better method.

Image codec consists of many parts. Each part of those can influence the quality of image compression and so also transformation as one part of those. Many methods in this part observed to find more optimal one. Experiments begun using DCT (Discrete Cosine Transform) schemes and it has been developed until wavelet schemes found.
In DCT, transformed signal is represented in frequency domain only. But in wavelet, not only frequency, time is represented also. So, if there is any usefully information in time domain, can still observed it by wavelet-based transform. Generally, DCT-based method is still the most widely used in many image compression algorithms because it is simple, efficient, and easy to be implemented.

There has been a rapid progress in wavelet-based methods, especially in application for image compression. In the last few years, many experiments of wavelet-based schemes for image compression have been developed and implemented. In this paper, some of those will be discussed. This paper is organized as follows. Section 2 outlines briefly about image compression. Section 3 details about DCT-based and wavelet-based image compression. Section 4 displays experiment result about wavelet-based image compression and last session will give conclusion and also future work of this study.

2. IMAGE COMPRESSION

Virtually, as shown in figure 1, image compression process flow has many tools. In transmission systems, compression means fewer data, reduction in bandwidth, reduction in cost which relating with hardware needed, less maintenances and faster transmitting time, but allows a better quality image after the process.

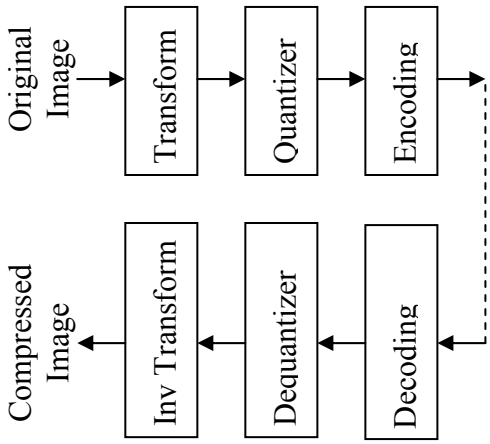

Figure 1 Image Compression Process Flow

Compression can be applied in any or all part of image compression process. Hopefully, by focus the compression on transformation method, fewer steps can be achieved to represent the same information.

Based on figure 1 image compression process flow above, a part of it is transformation. In this step, the principle is how to transform image without losing data. The decoder uses the inverse transform to drawback the image.

3. DCT-BASED AND WAVELET-BASED IMAGE COMPRESSION

Year by year many researchers try to find a way to reduce computational cost of image compression. A good compromise should be reached between computational complexity and image quality. The quality itself is not only based on some measurement such as Signal to Noise Ratio (SNR) or Peak Signal to Noise Ratio (PSNR) which is commonly used for comparison, but also its decoded image quality, it is significant to the eye or not.

Discrete Cosine Transform (DCT) is the former method that is still be used also in Joint

Pictures Experts Group (JPEG), standard for image compression and transmission. In this method for image compression, the image is segmented into 8x8 array or 64 pixels, but basically, it can be any rectangular array. The principle in this method is the DCT-based do compression by concentrating most of the signal in the lower spatial frequencies which have zero or near-zero amplitude and no need to be encoded. It means that the DCT shows no loss to the source image samples. The transformed signal can be more efficiently encoded.

Actually, DCT-based method is simple and easy to be implemented. But behind of those, improving quality of compressed image becomes need. Communication application, clinical environment and any other field want their images have high quality but not require a very large storage space. As one of the solution, Wavelet has been developing and implementing.

This method works by representing any function as a superposition of a set of wavelets or basis functions. These basis functions are obtained from scaling (s) and translation (τ) a single prototype wavelet which is called mother wavelet (ψ).

The Continuous Wavelet Transform is defined as follows.

$$CWT_x^{\psi}(\tau,s) = \frac{1}{\sqrt{|s|}} \int x(t)\psi^* \left(\frac{t-\tau}{s} \right) dt \quad (1)$$

Wavelet is capable of revealing aspects of data that other signal analysis techniques missed aspects like trends, breakdown points, discontinuities in higher derivatives, and self-similarity. Furthermore, because it affords a different view of data than those presented by traditional techniques, wavelet analysis can often compress or de-noise a signal without appreciable degradation.

Although research has shown that Wavelet Transform outperform JPEG in Image Compression [1], Kondo and Kou have tried to combine those two methods, wavelet using sub block DCT in [2]. Another developed method is shown where Wavelet-based image codec mixed with Sub-pixel Motion Vectors and R-D Optimization [5].

Another version of developed wavelet is Dual Tree Complex Wavelet Transform. In [6], Miller et all has introduced this method well in application for seismic data. Fernandes et all also presents A New Framework for Complex Wavelet Transforms in [3]. This new form of wavelet has shift invariance [4], directional selectivity and phase information.

4. EXPERIMENTAL RESULT

DCT, DWT and DTCWT algorithm has been occupied to compress Missa. Following in Figure 2, compressed image is displayed.

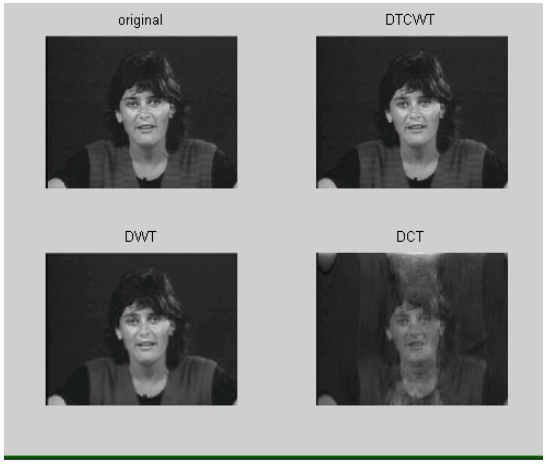

Figure 2. Compression ratio 30:1

Based on those result, it can be seen that DTCWT can give better visual quality than DWT and DCT.

As the measured parameter for image quality, PSNR is also calculated for that image. The result is presented in Table 1 below.

Table 1. PSNR value

Method	Missa
DCT	21,31
DTCWT	39,096
DWT	34,169

As shown above, with DTCWT method in transformation, better result is given in visual and also in PSNR value.

5. CONCLUSION AND FUTURE WORK

In this paper, some researches have been presented about wavelet-based image compression compared with DCT-based. Based on those experimental results, Wavelet-based method yields DCT-based method in PSNR and also visual quality.

For a future work, it is better to use DTCWT-based combined with others part. With the fast development of computer hardware devices, more wavelet method but promising better accuracy may be more and more preferable due to the higher image quality can give.

REFERENCES

[1] A Saffor, A R Ramli, and Kwan-Hoong Ng. "A Comparative Study of Image Compression between JPEG and Wavelet". Malaysian Journal of Computer Science, Vol. 14 No.1, pp.39-45. June 2001.

[2] H Kondo and H Kou. "Wavelet Image Compression using Sub-block DCT". Proceedings Ninth IEEE International Conference on Networks, 10-12 Oct. 2001.

[3] Fernandes, Spaendock and Burrus. "A New Framework for Complex Wavelet Transforms". IEEE Transaction on Signal Processing, Vol. XX, No. Y, 2002.

[4] Andrew P Bradley. "Shift-invariance in the Discrete Wavelet Transform". Proc. VIIth Digital Image Computing : Technique and Applications, Sun C, Talbot H, Ourselin S, and Adriansen T (Eds.), . Sydney .10-12 Feb 2003.

[5] Cho-Chun Cheng and Wen-Liang Hwang. "A Block-Based SNR Scalable Wavelet Image Codec with Sub-pixel Motion Vectors and R-D Optimization". Technical Report No. TR-IIS-05-001 / Institute of Information Science, Academia Sinica. January, 2005.

[6] M A Miller, N G Kingsbury and R W Hobbs: "Seismic imaging using complex wavelets", Proc. ICASSP Conference, Philadelphia, , p II-557. March 18-23, 2005.

[7] W Yan and Y Chen. "DCT-based Image Compression using Wavelet-based Algorithm with Efficient Deblocking Filter". EUSIPCO 2006.