

# Analysis on the Compression Technique of Adaptive Lifting Wavelet Transform Image

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**Abstract.** An adaptive lifting wavelet transform algorithm is proposed. The algorithm is based on the local characteristics of the signal to be analyzed, the adaptive selection updater, and the selection of an adaptive updater. The main purpose is to keep the edges of the image from being smoothed and to prevent the appearance of large wavelets. coefficient. In order to ensure the stability of the system, it also proposes a lifting structure that is updated after the prediction. In this structure, the prediction process does not affect the update process, which also provides favorable conditions for the reconstruction of the adaptive algorithm. Due to high stability, high frequency coefficients and complete reconstruction, this method is conducive to the improvement of compression performance. .

## Introduction

Wavelet analysis [1] is a milestone in the history of Fourier analysis and harmonic analysis and is known as the "Mathematical Microscope." As a multi-resolution analysis method, wavelet analysis has good time-frequency localization characteristics, and is particularly suitable for designing image coding methods according to human visual characteristics, and is also very favorable for progressive transmission of image signals. The lifting wavelet transform proposes a new vitality for the wavelet image coding [2]. Compared with the traditional wavelet transform, it does not depend on the Fourier transform. The calculation is simple, the time and space complexity is low, and it is easy to implement. For the second generation wavelet transform. Moreover, with the development of various efficient wavelet coefficient quantification methods, the development of wavelet-based image coding methods has become more rapid and has achieved very good results. Therefore, the image coding method based on wavelet transform is adopted in the new international coding standards JPEG2000 [3] and MPEG-4. However, since the second-generation wavelet transform [4] uses a fixed filter structure, it may affect the transformed results, especially for the mutation signal transformation, the effect is not very good. Therefore, this paper presents an adaptive wavelet transform based on the lifting scheme, mainly based on the updater's self-adaptation, which can well solve the mutation point transformation in the signal. At the same time, the key to adaptive transformation is for data compression. In the reconstruction of the signal, this paper solves the problem of adaptive reconstruction.

## The basic principle of lifting wavelet transforms

The first generation of wavelet research tools is mainly Fourier analysis, which analyzes problems from the frequency domain. In practical applications, the implementation of the traditional wavelet transform is accomplished through convolution. It has complex calculation, slow operation speed and large memory requirements, and is not suitable for real-time implementation. After the signal passes the traditional wavelet transform, it is a floating-point number. Due to the limited word length of the computer, the original signal cannot be accurately reconstructed. Moreover, the traditional wavelet has strict requirements on the size of the original image. Generally, the length and width of the image must be a multiple of the power of two. The lifting wavelet analyzes the problem directly in the time (empty) domain, making the problem simpler, and it is possible to construct all the conventional wavelets through the lifting method. The wavelet transform based on lifting method not only maintains the characteristics of time-frequency localization of traditional

wavelets, but also overcomes its limitations. The lifting algorithm gives a simple and effective construction method of biorthogonal wavelet. It uses basic polynomial interpolation to obtain high frequency components (coefficients) of the signal, and then builds a scaling function to obtain low frequency components (coefficients) of the signal. The basic idea of the lifting algorithm is to gradually construct a new wavelet with better properties through a basic wavelet. This is the basic meaning of promotion. A standard lifting algorithm consists of 3 steps: splitting; predicting; correcting.

In practical projects, lifting formats are often used to implement wavelet transforms. Since the introduction of prediction and update brought floating-point operations, in order to reduce the error in the reversible reconstruction of the image, the integer wavelet transform was used to eliminate the conversion error from floating-point to integer in the transform, but the filter was repeatedly raised. The error still affects the compression performance of the image; in addition, the image energy after the format conversion is improved is relatively poor in the concentration of the low-frequency sub-band, which also has an adverse effect on the encoding and compression of the image. These problems have caused great concern to front-line field technicians and researchers. Adaptive wavelets have brought new ideas to the wavelet transform of the lifting scheme [5].

In order to improve the image reconstruction effect and reduce the distortion caused by image compression, on the one hand, the lifting format is used to construct the optimal wavelet function, and on the other hand, the lifting format is used to implement the wavelet filter. The CDF9/7 filter adopted by JPEG2000 has been proved to have good compression performance, and Daubichies et al. decomposed the CDF9/7 wavelet filter bank into several lifting steps to achieve a wide range of applications.

In the actual implementation of the lifting format of the CDF9/7 wavelet, the prediction operator and the update operator become the key factors affecting the performance of the CDF9/7. In the lifting wavelet, the prediction operator  $P$  and the update operator  $U$  are fixed and invariant, and have limitations in applying compression filters to images of different features. In addition, the prediction and update operators constructed in the lifting method also introduce some errors, which makes it important to increase the format to reduce these errors. Many scholars proposed to use polynomial fitting prediction instead of interpolation prediction in the lifting scheme, or to make the wavelet filter adaptively adjust the prediction operator and the update operator to correct the deviation.

The operation of the image to achieve wavelet transform by lifting the format is a floating-point number operation, which will increase the amount of calculation, increase the complexity of the system, and also bring errors to the image reconstruction. Therefore, when the lifting wavelet transform is performed, most of them are based on integers. The wavelet transform to achieve integer to integer data operations. The lifting format wavelet transform has nothing to do with what kind of continuation method to use when transforming the boundary of the image. In order to achieve distortion-free image reconstruction, boundary error and precision must be estimated; on the other hand, statistical characteristics of subband quantization The scheme, based on the probability distribution of each subband coefficient, uses different quantization schemes and threshold strategies to reduce this error.

The wavelet basis used for image compression is generally a smooth scaling function and a wavelet function. In order to solve the problem of image discontinuity region processing, the self-adaption is introduced, ie, the prediction operator  $P$  is selected based on the local characteristics of the image, so that the prediction operator is Image data related. Adaptive filtering is to use the data already obtained in the filtering of the previous moment to automatically adjust the filter parameters at the current moment so that the transformed wavelet coefficients can approach the original image very well. The adaptive lifting scheme is to apply the minimum mean square error (LMS) criterion in wavelet lifting, adjust the prediction operator and the update operator according to the local characteristics of the image, and adaptively construct a group of wavelets, thereby improving the detail coefficients of the image in the transformation and Approximate coefficient, finally get the ideal compression effect.

## New image compression algorithm

Based on the above analysis and research, this paper chooses CDF9/7 wavelet as filter in image compression and adopts lifting wavelet transform to realize image coefficient conversion. In order to make the filter have symmetry performance, the length of decomposition and reconstruction filter is 9 and 7. The positive and negative vanishing distance is 4, and the adaptive lifting format is used to implement the CDF 9/7 wavelet transform. Some improvement methods are proposed in the implementation.

In order to achieve image reconstruction without distortion, an integer-based lifting scheme wavelet transform is implemented. At the same time, in the adaptive promotion of the CDF9/7 wavelet, a strategy of updating after prediction is adopted. First, update the even-numbered sampling points according to the odd sampling points to obtain the low-pass coefficient  $c(n)$ , and then use  $c(n)$  to predict the odd-numbered sampling points so as to obtain the high-pass coefficient  $d(n)$ .

In the implementation of the scheme, in order to implement adaptive filtering adjustment, the update operator and the prediction operator at the next upgrade are adaptively adjusted according to the local deviation of the detail of each point of the image after each transformation. In the lifting wavelet transform, according to the minimum mean square error criterion, the error of the output signal of the filter should be small. This is a problem to find the optimal solution. When adjusting the update operator and the predictor operator, use the gradient method to implement, that is, use the gradient vector information of this point to construct the decision function to adjust the CDF9/7, that is, according to the local image. Characteristics to achieve adaptive adjustment of the various operator coefficients of the CDF9/7 filter. The key is to establish a decision map  $D$  based on the local gradient size of the wavelet coefficients, and then control the change of  $U$  through the decision result  $d$  so that the approximate signal  $y'$  obtained after the adaptive  $U$  transform can better represent the characteristics of the original signal. .

Noise reduction is an important issue in the field of signal processing. Image denoising is an important part of image processing. The traditional linear filtering method has the contradiction between the local characteristics of the protection signal and the suppression of noise. It passes the noise interference signal through a filter and filters out the noise frequency components. However, for the pulse signal, white noise, and non-stationary process signals, the traditional method has certain limitations. For such signals, the signal-to-noise ratio of the signal cannot be greatly improved at low signal-to-noise ratios. The wavelet domain denoising method proposed by Donoho et al. based on threshold decision has been proved to be a very effective signal denoising method. Here we start from the structure of the lifting scheme and combine it with the soft threshold denoising by introducing constraints to obtain a completely adaptive denoising method. Through this method, the PSNR (power signal-to-noise ratio) is significantly improved. . In general, the image itself is very smooth or highly correlated, so the wavelet decomposition format will make the image processing very effective. However, it is often extremely discontinuous and not smooth in most images. This discontinuity region of the image cannot be well expressed with a smooth basis function. One of the ways to solve this problem is to introduce adaptation. The following uses an adaptive algorithm based on lifting format. This method is to modify the update operator and introduce self-adaption during the correction process, that is, to select the update operator according to the local information of the signal.

In recent years, the application of wavelet transform in image compression has also gradually increased. However, due to the large amount of computation based on the convolutional discrete wavelet transform and the large amount of memory, even if an integer type filter bank is used, the number of decomposition layers increases. It also cannot provide the required accuracy of the filter coefficients. Therefore, based on the characteristics of lifting wavelet just to make up for this deficiency, this method follows the JPEG2000 standard, not only reduces the system memory requirements, but also reduces the amount of wavelet transform operations, thereby improving the efficiency of image compression. The simple structure of the lifting wavelet facilitates effective control using parameters, making it a good application value in adaptive image compression. Here

we take the LeGall5/3 wavelet as an example to construct its lifting wavelet algorithm, which is to derive its prediction and update operator.

## **Conclusion**

Lifting algorithm is a flexible wavelet construction method. It can use linear, non-linear or spatially varying predictor and update operators, and it can ensure the reversibility of the transform. The lifting wavelet transform is faster than the traditional wavelet transform, and the calculation method is simpler and saves memory. Based on these characteristics and experimental results of the lifting method, it can be seen that it has a high value in image processing.

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