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IMAGE COMPRESSION METHOD BASED ON WAVELET TRANSFORM

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Annotation. In many algorithms for image compression, the SPIHT and SPECK algorithms based on wavelet transform have good performance. This article introduces the basic principles of wavelet transform, and implements the SPHIT and SPECK image compression algorithms based on wavelet transform. Besides, the two algorithms are compared, and experimental results and experimental conclusions are given in conclusion.

Keywords: wavelet, image compression, SPECK, SPIHT

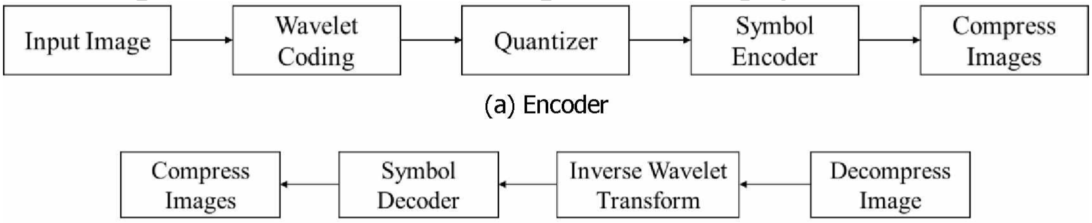
Introduction. The main problem solved by image compression is to minimize the amount of data used to represent image information. Some kind of transformation is usually used to remove redundant information in the image to achieve the purpose of compression. Image transformation for image compression concentrates the energy of the image in the transformation domain It means that a large amount of information is concentrated on a small number of coefficients, while other data is very small or almost zero. When the data is compressed and encoded, the data can be compressed more effectively, which is very important for the efficient storage and transmission of images significance. At present, the common transformations used for image compression mainly include K-L exchange, Fourier transform, discrete cosine transform (DCT), wavelet transform, and geometric multi-scale analysis that have appeared in recent years [1].

Wavelet transform is a signal processing technique that decomposes the original signal into multiple sub bands, each sub band containing information in a different frequency range. It has good scale invariance and local adaptability, can perform good sparse representation of irregular area images, and has a complete theoretical system to restore the original image from sparse coefficients, and has developed rapidly in the field of image processing.

To improve the shortcomings of poor reconstruction quality of wavelet compressed images, this paper uses spectrogram wavelet transform to decompose the Set Partitioning in Hierarchical Trees (SPIHT) and Set Partitioned Embedded Block (SPECK) algorithm. In the lab, the results shown that SPECK algorithm has higher encoding speed and it is one of the better-performing embedded image coding algorithms. This algorithm achieves good compression effects after compressing and encoding classic images, and has a high compression ratio and peak signal-to-noise ratio.

Classic Wavelet Transform. For a long time, image compression coding has used discrete cosine transform (DCT) as the main transformation technology, and has been successfully applied to various standards, such as JPEG, MPEG. However, in DCT-based image transformation coding, people divide the image into blocks of 88 pixels or 1616 pixels for processing, which is prone to block effects and mosquito noise.

Wavelet transform is a global transform with good local optimization performance in both time domain and frequency domain. Wavelet transform encodes the transform coefficients of image pixel decorrelation, which is more efficient than classical encoding and has almost no distortion. It is easy to consider human visual characteristics in applications, thus becoming one of the main technologies for image compression and coding. Wavelet transform can achieve better time resolution in the high-frequency part of the signal: better frequency resolution can be achieved in the low-frequency part of the signal, thereby effectively extracting information from signals (such as speech, images, etc.) to achieve Data compression purposes [2]. The figure below is a block diagram of the wavelet encoding and decoding system.



(b) Decoder

Figure 1 – Block diagram of the wavelet encoding and decoding system

The basic steps of image compression based on wavelet transform are as follows, and Figure 2 shows the wavelet transform decomposition steps taking the 'Lena' image as an example.

①Use wavelet to decompose the image layer and extract the low-frequency and high-frequency coefficients in the decomposition structure.

②Reconstruction of each frequency component.

③Compress the first layer of low-frequency information.

④ Compress the second layer of low-frequency information.

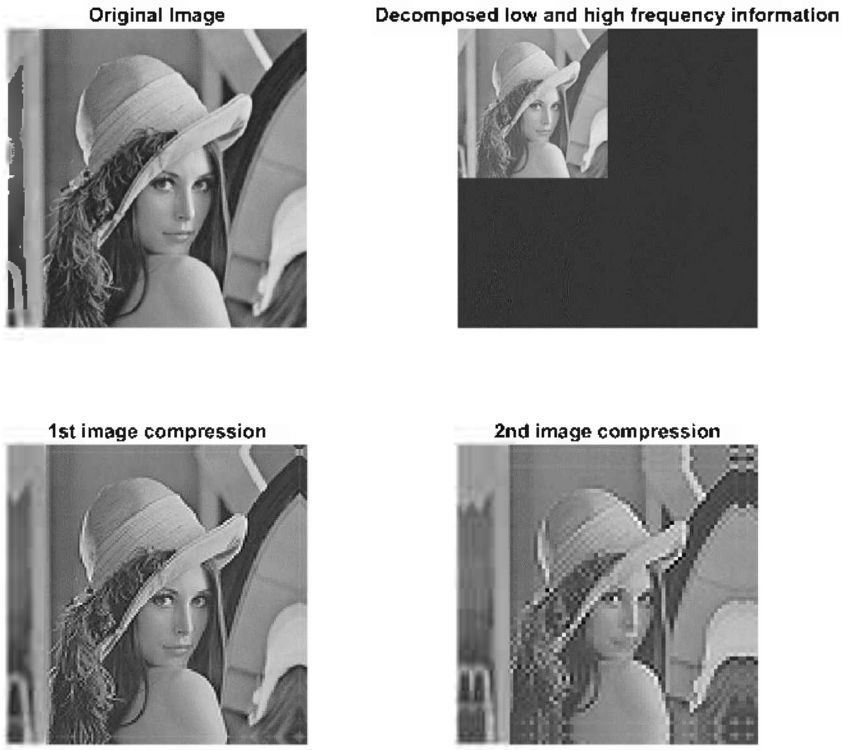


Figure 2 – An example process of Wavelet compression

SPIHT Algorithm. After completing the spectral wavelet transform of the image, multiple one-dimensional wavelet coefficient vectors are obtained.

The main idea of the SPIHT algorithm is to use a given threshold to compare each coefficient in the wavelet coefficient set. If the value is greater than the threshold, a binary number is output as a sign of the importance of the coefficient; this binary flag is the key to the image [3]. The code stream generated after encoding the coefficients. After all the wavelet transform coefficient values have been traversed, the threshold value is halved, and then the wavelet coefficient set is scanned, compared with the updated threshold value, and then the corresponding image compression code stream is output until the threshold value becomes 1. Figure 3 and Figure 4 illustrate the wavelet principle of SPIHT transform, which is an image compression process based on wavelet blocks.

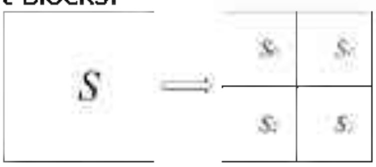


Figure 3 - Wavelet block of partitioning

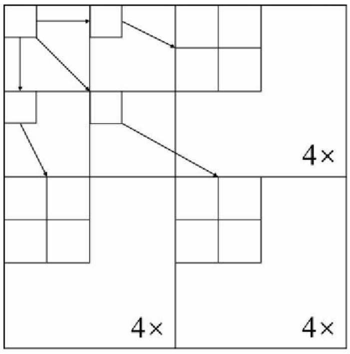
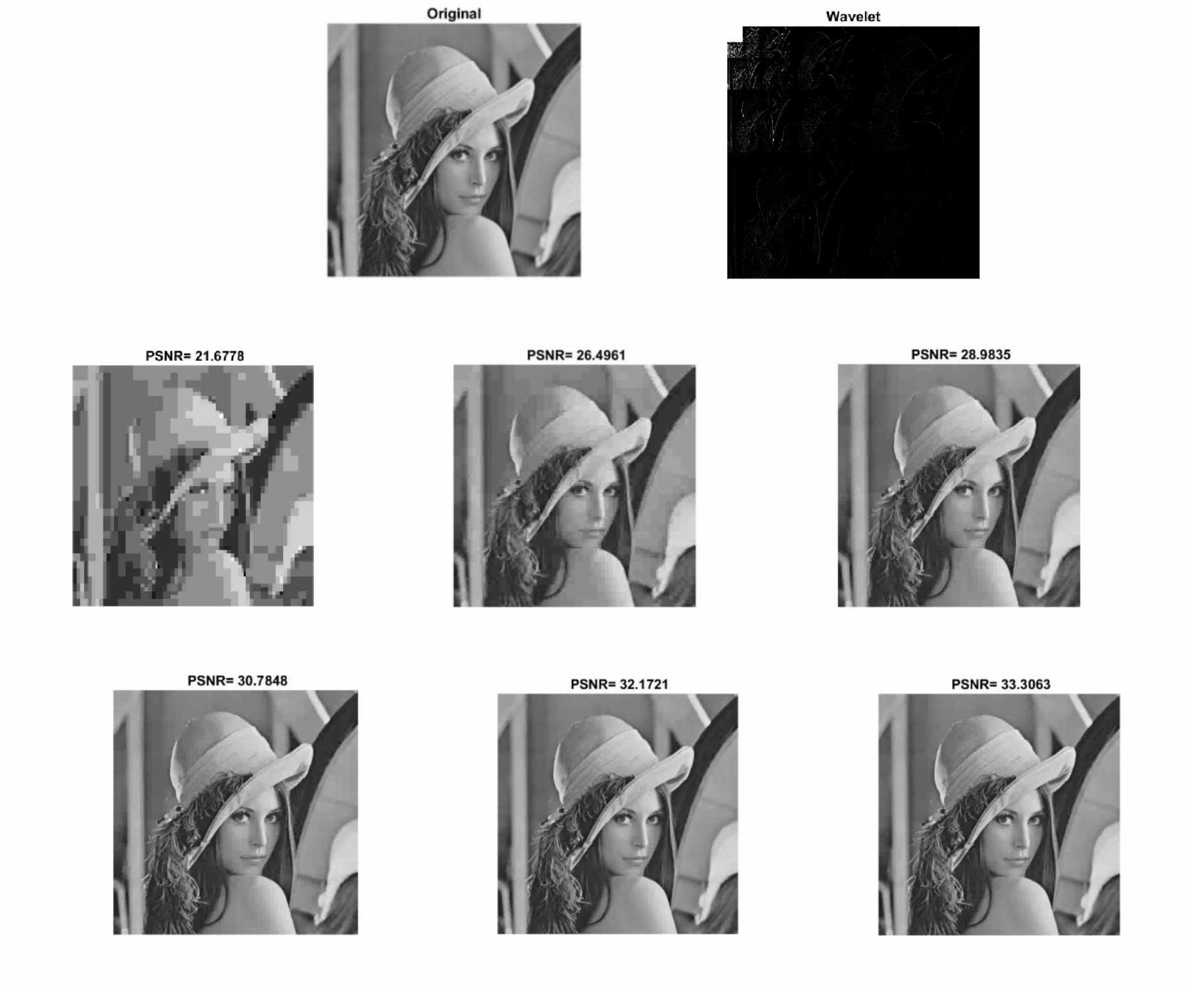


Figure 4 - Tree-based organization in wavelet transform

Here is an example of SPIHT algorithm based on wavelet. In Figure 5, wavelet 'haar' is used and the transform level is 4. PSNR stands for Peak Signal-to-Noise Ratio. In the process of using speck to process images, 9 iterations were carried out, the PSNR continued to increase, and the compression quality became better and better.



(a) Interaction times 1-6

(a) Interaction times 7-9

Figure 5 – An example of SPIHT algorithm, level = 4, wavelet 'haar', 9 interaction times

To the set classification strategy of the SPIHT algorithm is relatively complex, three lists are needed to store the wavelet coefficients to be encoded and quantized, and the calculation amount is relatively complex, so the encoding speed will be reduced accordingly.

SPECK Algorithm. When the SPIHT algorithm performs image compression, it needs to be iterated many times, so there is an improved algorithm. Since there are many unimportant coefficients in the wavelet coefficients, which have the characteristics of energy aggregation and energy attenuation as the scale increases, based on block set division the ideological SPECK (Set Partition Embedded Block Code) algorithm is a coding algorithm for wavelet coefficients. This algorithm is one of the better performing embedded hierarchical image coding algorithms in recent times. In SPECK, the blocks are recursively and adaptively partitioned such that high energy areas are grouped together into small sets whereas low energy areas are grouped together in large sets.

Here is an example of SPECK algorithm based on wavelet. In Figure 6, wavelet 'haar' is used and the transform level is 4. PSNR stands for Peak Signal-to-Noise Ratio. In the process of using speck to process images, 4 iterations were carried out, the PSNR continued to increase, and the compression quality became better and better.

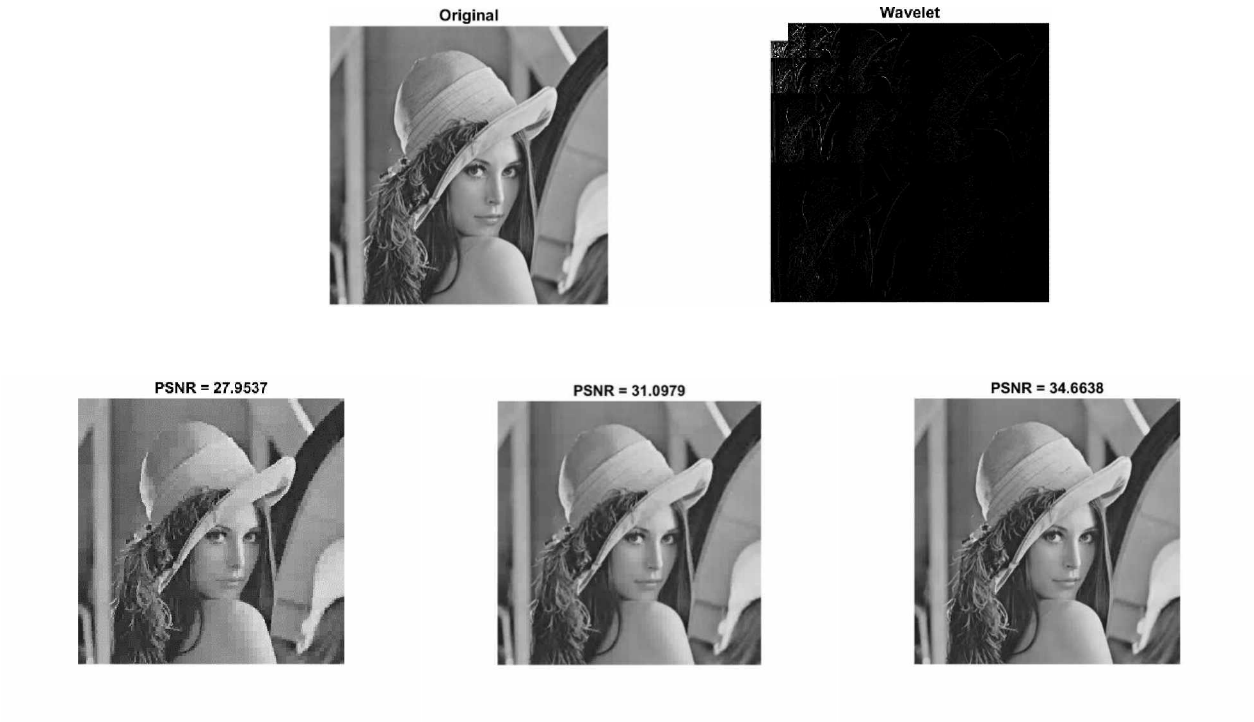


Figure 6 – An example of SPECK algorithm, level = 4, wavelet 'haar', 3 interaction times

Compared with the SPIHT algorithm, this algorithm reduces the number of recursive calls of the function, which improves memory space utilization, so the complexity of the algorithm is reduced, and the operation rate increases accordingly.

Conclusion. This article introduces the basic principles of wavelet transform, and takes the 512pixel×512pixel×8bit standard image 'Lena' as an example to conduct a 4-level wavelet decomposition and reconstruction experiment, and conducts a 4-level wavelet decomposition and reconstruction experiment on the SPIHT algorithm, and in the same situation compare with the SPECK algorithm. Combining the above results, the following conclusions can be drawn:

(1) Compared with the SPIHT algorithm, due to the reduced memory space of the SPECK encoding algorithm, the bit allocation is more reasonable and the classification strategy is more complete. Under the same compression ratio, the image restoration quality of this algorithm is better than that of the original SPIHT algorithm.

(2) The SPECK algorithm is more efficient than SPIHT algorithm. It mainly reduces the complexity of the algorithm and allocates bits reasonably, so that under the same compression ratio, not only the reconstruction quality of the algorithm is better than that of the SPIHT algorithm, but also the operation rate is also higher than the before one.

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МЕТОД СЖАТИЯ ИЗОБРАЖЕНИЙ НА ОСНОВЕ ВЕЙВЛЕТ-ПРЕОБРАЗОВАНИЯ

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Аннотация. Во многих алгоритмах сжатия изображений хорошую производительность демонстрируют алгоритмы SPIHT и SPECK, основанные на вейвлет-преобразовании. В этой статье представлены основные принципы вейвлет-преобразования и реализованы алгоритмы сжатия изображений SPHIT и SPECK, основанные на вейвлет-преобразовании. Кроме того, проводится сравнение двух алгоритмов, а в заключение приводятся экспериментальные результаты и экспериментальные выводы.

Ключевые слова: вейвлет, сжатие изображения, SPECK, SPIHT