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Research on the Approximation Characteristics of Bandelet Transform

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Abstract. In this paper, from the geometric flow and the horizon model, the flow integral and the edge expression in the scanning band are analyzed. Secondly, the deficiency of the discrete binary wavelet basis function is constructed, and the standard orthogonal basis of the Bandelet transform is constructed. Finally, And the approximation error formula of the estimated edge and the real edge is constructed. The results show that the optimal frame can be obtained on the edge of image.

Introduction

Bandelet transform has undergone two generations of transform theory, and its main application fields are image sparse expression and image compression. Among them, Pennec for the first generation of Bandelet transform made an important contribution, he not only involved in the proposed first generation Bandelet transform theory, but also further on the Bandelet transform to improve and develop, greatly enhance its practical application. The biggest advantage of Bandelet transform is that it makes up the defects of wavelet transform anisotropic feature, which is more favorable for sparse expression and sparse coding of image. The first generation Bande-let transform technique is based on the theory of wavelet transform, from reasoning to evolution and evolution of continuous, and then relying on the concept of geometric flow to construct Bandelet transform basis function, so as to promote discrete Bandelet transform algorithm, continuous bandlet transform algorithm, The Development of Fast Bandelet Transform Algorithm. Based on the principle of Bandelet transform, this paper analyzes the in - band approximation and global approximation of Bandelet transform.

The Development of Bandelet Transform and Its Principle

First, the Bandelet transform defines a geometric vector line to characterize the local regular direction of the image. The binary section method is used to subdivide the support interval S of the image.

$$S = \cup \ \Omega i.$$

Time, each of the small split interval Q contains only a certain contour in the image. However, the gray scale variation in the region Q that does not contain any contour lines is uniform and does not need to define any geometric vector lines in these local regions. The geometric regular direction in the local region Q containing a contour is The tangent direction of the contour line, which contains the sub-region of the contour line, is marked as horizontal and vertical. Under the global optimal constraint, the local vector flow on the vector field τ (x1, x2) on the local region Ωi can be calculated according to the obtained local geometric regular direction. Then, Bandlet can be processed by the interval wavelet with the Ban-delet blocks along the vector flow to generate the required Bandelet base. Through this process, we can make full use of the local geometric regularity

of the image itself, and the set of Bandelet bases on all the subdivided regions constitute a set of standard orthogonal bases on L2 (S).

In the geometric direction, assuming that the image equation is regular, for this geometric regular image, the image changes in the direction parallel to the edge line, and changes in the direction perpendicular to the edge line. The geometric flow in the image generally refers to the vector field τ (x1, x2) defined on the support area of the image, which is used to describe the direction of the regular change of each point. For parallel to the edge of the line direction, you can use geometric flow to describe. The primary purpose of the Bandelet transform is to make full use of the regularity of the image along the geometric flow. Near the edge line, the geometric flow is generally parallel to the tangent direction of the edge line, and for geometric regular images, the geometric flow in the local range is generally parallel.

In order to reduce the data overhead and simplify the algorithm, the bandlet transform algorithm is used to merge the adjacent subbands with similar geometric flow characteristics in the pre-segmentation. After the optimization of the quadtree, the basic Represents the result of image processing. Let the bottom of the small box width of 4 pixels, that is, the size of 4 * 4.

Bandelet process is the two-dimensional wavelet coefficients stored in the Bandelet block, resampling along the best geometric flow direction θ, generating one-dimensional data, and transforming the one-dimensional data using one-dimensional Wavelet transform. The one-dimensional wavelet transform is carried out in the direction of the optimal geometric flow to find the discontinuous direction, and then the wavelet transform is carried out along these directions. In addition, a method of projecting two-dimensional information into one-dimensional information along the optimal geometric direction can be used to convert the two-dimensional singularity into point singularity.

The basic flow of the algorithm is: 1) input the image that needs to be processed; 2) set the quantization threshold T according to the experience; 3) make the wavelet transform of the input image by biorthogonal wavelet transform; 4) And then calculating the optimal geometric flow direction in each segmented region. 5) For each bandletlet block, that is, the Bandelet subband, the Bandelet processing is performed separately, and the corresponding sub-band is divided into two sub- 6) the resulting Bandelet coefficients are arranged in the form of the corresponding matrix according to the basic principles and methods of the Bandelet transform; 7) the resulting quadtree structure, the best geometric flow direction and the Ban-delet directions The coefficient is the final result of the process.

Research on Bandelet Transform

Although the proposed time is not long, since the Bandelet transform can provide the most sparse representation of the image, the same approximation can be achieved with less non-zero coefficients than other basis functions, especially for geometric features Advantages, which led to a wide range of domestic and foreign scholars interest. At present, some scholars at home and abroad have studied the application of Bandelet, which shows that Bandelet transform has wide applicability.

The threshold de-noising method based on the first generation Bandelet was proposed by Pennec in 2000, and in 2005 they published papers on SIAM, proposed the use of Bandelet transform to adaptively find the optimal approximation of the image, and combined with image denoising and compression The experimental results are given fast discrete algorithm. 2008, G Peyré and S. Mallat proposed geometric image approximation of the orthogonal bandelets [3], until now abroad for Ban-delet transformations among researchers, E. Le Pennec, S. Mallat, G Peyré, and Ch. Dossal is the pioneer of Bandelet application promotion, most of their literature on the principle of Bandelet transformation to do a detailed introduction, but only threshold denoising and simple compression to the experiment, and compared with the wavelet transform.

The second generation of Bandelet transforms is gradually evolving from finding better ways to image compression. In 2005, Mallat and Peyre gave the image compression coding algorithm based on the second generation Bandelet transform. The method of effectively representing the geometrical direction of the image is given, and it is applied to image compression and denoising. A

fast discrete algorithm for Bandelet transforms. In this algorithm, the output result of the Bandelet transform is set up, and there are three aspects: the constructed quadtree structure, the optimal geometric flow direction and the Bandelet coefficient of each Bandelet block. The number of bits required for the final code R can be expressed as:

$$R = Ri + Rg + Rb$$

where Ri is used to encode the quadtree: the breadth of the obtained quadtree is searched for breadth, and the area represented by the quadratic root node will be Are divided into four blocks, encoded with binary symbol 1; each Bandelet block is represented by a leaf node in a quadtree, encoded with symbol 0, Ri is the number of all leaf nodes; Rg is used to encode the best geometric flow: 3), the coding length of the geometric flow of small squares of size L is about 2 log2 (L) bits. The algorithm uses geometric flow coding for different sizes of Bandelet blocks with different code lengths. The coding efficiency Rb is used to encode the quantized Ban- coefficients, encode them using adaptive arithmetic coding, and isometric coding for geometric flows.

Over the past two years, China has also made some research on Bandelet transform in image compression, and has achieved some results. For example, Sun Wenfang et al. Proposed an image compression scheme based on Contourlet and Bandelet transform, which combines the two transformations to compress the image. Zhang et al. Proposed a method of combining Bandelets with Wavelet transform, combined with the image compression method of the region of interest, using Bandelet and wavelet complementary compression method to better preserve the edge information and texture details of the image in the low bit , So that the overall visual quality of the image is improved. And also proposed a joint second-generation Bandelet and Wavelet on the image of the method of hierarchical compression. The wavelet transform and Bandelet transform of the structure and texture components of the image are respectively performed to optimize the compression result.

Bandelet transform is an adaptive MGA method, which, like other adaptive MGA representations, is essentially a combination of representation of an image and a combination of edge detection methods. In fact, the use of natural images, there are some gray-scale mutation, does not always represent the image of the target edge information. For example, the diffraction effect makes the true edge of the object may not really appear as a gray-scale mutation, which may not be seen at all; in some cases, the gray scale of the image changes greatly, possibly due to image texture information Not by the edge of the object information. Thus, a common problem that all edge-based adaptive methods need to solve is how to adaptively determine whether the region of gravity in the natural image should be the texture information of the image or the edge information of the object, which is a more difficult.

Although the second generation Bandelet transform is much more complex than the computational complexity of the generation, the computational complexity is still much higher than that of the wavelet transform. Bandelet transform is to increase the computational complexity of the cost in exchange for the image compression quality improvement, and thus can not be comparable with the JPEG-2000.

For the work already done at this stage, the work that can be further studied and the future direction of development are: (1) Bandelet is not the best for all images. According to the Bandelet theory and algorithm, it is best suited for dealing with slices of smooth and geometric features. For the texture information is too complex image, the effect and wavelet transform comparison is not much improvement, which is the future need to further study the problem. (2) Bandelet transform is a new MGA approach, although it has more excellent features, but it still has some problems, need further study. Therefore, it can be from the basic principles of Bandelet transformation, combined with the specific needs of image processing applications, for some new improvements and enhancements, so that it can be in the field of image processing a wider range of promotion. (3) In the second generation Bandelet transform, the exhaustive serial search method is used to find the optimal geometric direction, and the computational complexity is high. This is a serious problem. How to combine with other tools to carry out more widely used, it is worth in-depth study. (4) Bandelet is more widely used in other image processing applications, such as image enhancement,

image fusion, etc., this research is still in the initial stage, can be further in-depth study.

Conclusion

The basic principle and approximation of Bandelet transform are studied. Based on the geometric flow and the horizon model, the basis flow integral of Bandelet transform is analyzed. On the basis of binary wavelet transform, the standard orthogonal basis of Bandelet transform is constructed. The bandlet approximation feature is analyzed, and the Bandelet optimal framework of image edge approximation is realized by using this property.

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