The Analysis of Image Decomposition and Reconstruction Based on Contourlet Transform

Chen Rong[1, a]

[1]Nanchang Normal University,Nanchang,China

[a]xinsea@163.com

Keywords: image, decomposition, reconstruction, Contourlet.

Abstract. We introduce a new approach to image decomposition and reconstruction. We propose a double filter bank structure, named the pyramidal directional filter bank,by combining the Laplacian pyramid with a directional filter bank. Contourlet transform is a multi-scale and multi direction method of two-dimensional image. It has the multi direction and multi resolution, local positioning, strong expressing ability and anisotropic features,compared to other multiscale geometric analysis method. The Contourlet transform is made up of decomposition by Laplasse Pyramid and directional filter. First of all, Laplasse Pyramid transform for image multiscale decomposition, get low pass and band-pass sampling image, difference map of original image and low-pass sampling image, namely the low-frequency sub image and high frequency component. Then,directional filter bank（ DFB） to high frequency sub-band decomposition into 2^j directional subband. Multiscale decomposition of the low frequency subband repeated Laplasse Pyramid can realize image decomposition and multi direction, to avoid spills image low-frequency information effectively.This paper mainly introduces the working principle of contourlet transform, and also introduced the application of contourlet transform.

Introduction

Contourlet transform is based on Wavelet transform, contourlet transform is a method of image which is widely used in image processing. Advantages of contourlet transform with multi-scale and multi-resolution, can handle the one-dimensional signal effectively, but in the two-dimensional image processing have shown great limitations,it can not fully express the detail features of image edge and texture and so on.Contourlet transform improves the defect existing in wavelet transform,wavelet transform can only deal with the horizontal direction, vertical direction and the diagonal direction information.

Contourlet transform can obtain the other direction information in additional to horizontal direction, vertical direction and the diagonal direction information.Contourlet transform preserves the idea of multi-scale wavelet transform, realizes the decomposition of arbitrary scale in an arbitrary direction. Contourlet transform is better to describe the image details, such as contour and texture information, optimize the effect of wavelet transform.Contourlet transform is an extension of the wavelet transform in the two-dimensional field, it uses a directional filter banks which can not be separated.Properties of multi scale and multi direction based on the contourlet transform.Make use of less coefficient of contourlet transform can capture the image edge information along one-dimensional contour of image.Compared with the wavelet transform model, contourlet transform changes model and allows us to combine the visual information of the three basic parameters of scale, space and direction together. Contourlet transform inherits the advantage of wavelet transform, which is the equivalent of a realization way of the other.

The principle of Contourlet transform

Contourlet transform which proposed by Do and Vetterli is that a representation method of multiscale and multiresolution image, can efficiently capture the image edge and contour

information.Contourlet transform mainly includes two modules: Laplasse Pyramid (LP) and directional filter banks (DFB).Contourlet transform is the multiscale and multidirection transform of discrete image,in this transformation, analysis of several multi-scale and multi direction.In the Laplasse Pyramid decomposition,for the first time to capture the point continuity,then using the directional filter,to make continuous points into linear structure,finally a structure similar to the contour line is used to describe the image.DFB is used to capture the image of the high frequency part,in DFB rarely deal with the low frequency part,so to remove the low frequency part.We remove the low-frequency part of the sub image, by the method of multi resolution of Laplasse Pyramid , so the DFB can only deal with the high frequency part. Like wavelets, contourlets have a seamless translation between the continuous and the discrete worlds via a multiresolution analysis framework and iterated filter banks.

In the Laplacian Pyramid decomposition at each level the original image happens in a high-pass and a low-pass filters. the resulting is a downsampled low-pass version of the original image, and of difference between the original image and the prediction.the contourlet transform is implemented efficiently via iterated filter banks with fast algorithms. Figure 1 shows the multi scale decomposition.

Directional filter banks (DFB) are to decompose according to the direction of signal.Directional filter bank for reconstruction is good,each level of high frequency components can be obtained by LP decomposition,the high frequency component make analysis of the direction,DFB has fully demonstrated the high frequency part, LP decomposition to decompose the signal into high frequency part and the low frequency part,Contourlet transform makes full use of the characteristic of both.In this paper, low frequency sub image and high frequency sub bands were separated by using the Contourlet transform.Figure 2 shows *pyramidal directional filter bank* (PDFB) structure. Figure 3 shows contourlet transform n levels decomposition.

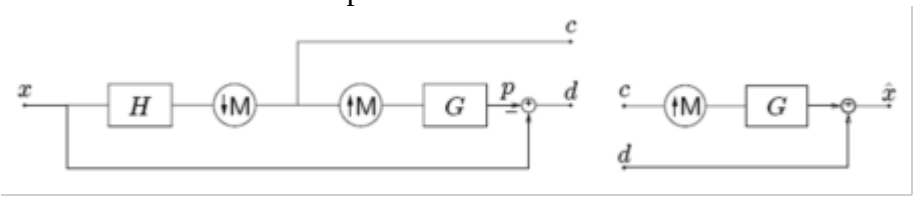


Fig.1 Laplacian pyramid scheme

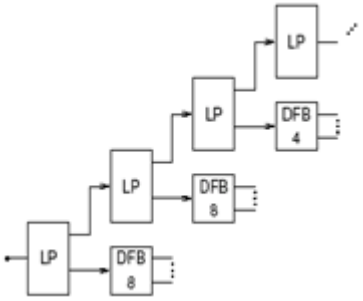
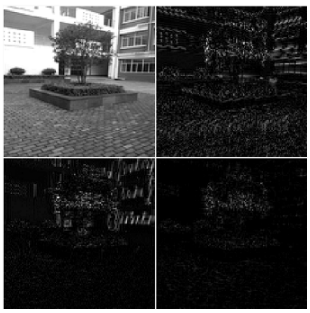


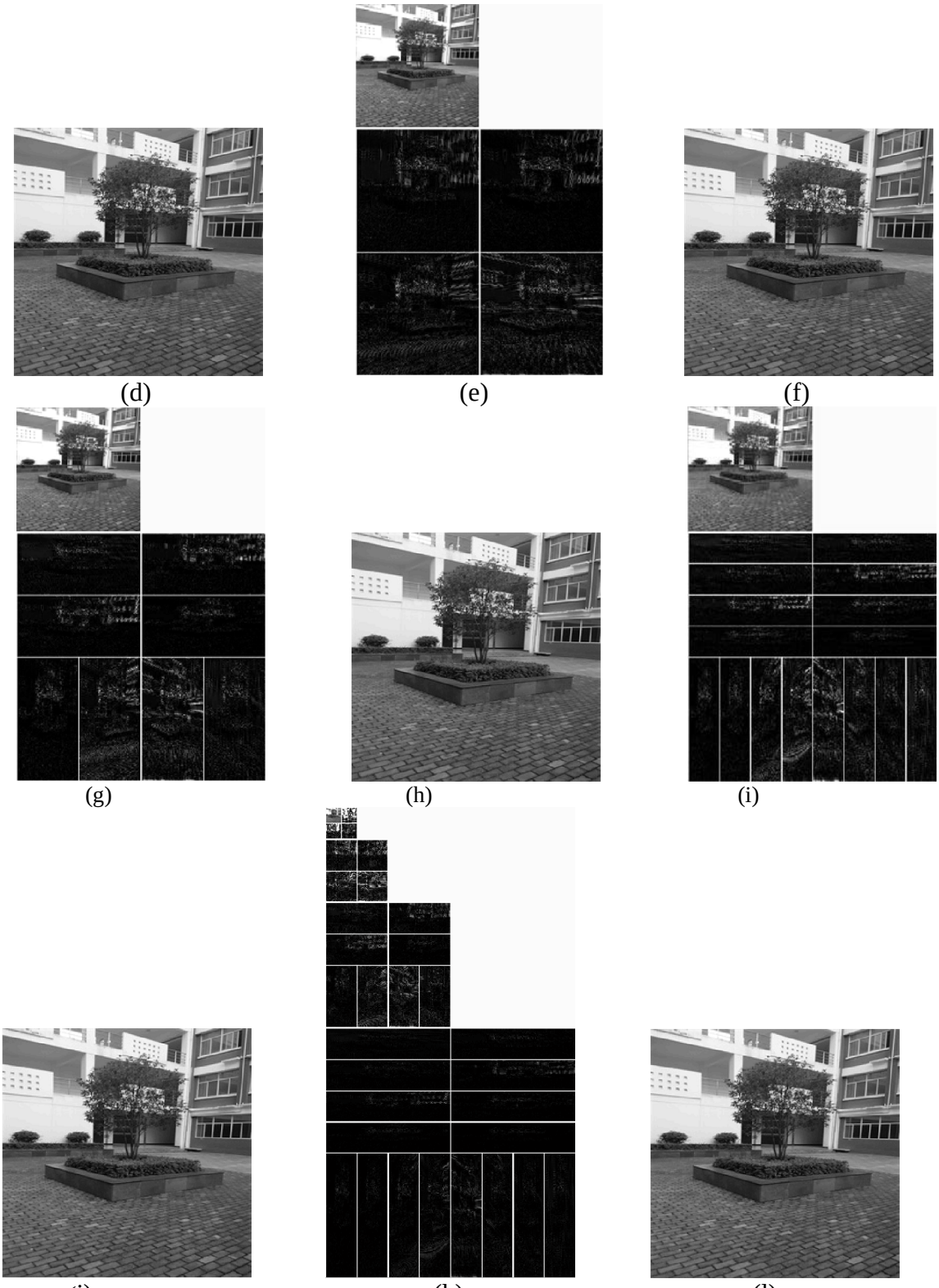
Fig. 2 PDFB structure

(a)

(b)



(c)



(d) (e) (f)

(g) (h) (i)

(j) (k) (l)

Fig.3 Contourlet transform n levels decomposition. (a)RGB image(b)Input gray image(c)Contourlet coefficients nlevels=0 (d)Reconstructed image nlevels=0 (e)Contourlet coefficients nlevels=2 (f)Reconstructed image nlevels=2 (g)Contourlet coefficients nlevels=3 (h)Reconstructed image nlevels=3 (i)Contourlet coefficients nlevels=4 (j)Reconstructed image nlevels=4 (k)Contourlet coefficients nlevels=[0,2,3,4] (l)Reconstructed image nlevels=[0,2,3,4].

Conclusion

The result is called the contourlet transform, which provides a flexible multiresolution, local and directional expansion for images. The contourlet transform is realized efficiently via a double iterated filter bank structure. Contourlet transform overcomes the weakness of wavelet transform in dealing with high-dimensional signals. the original images are decomposed with contourlet transform.

Fund Project

Project supported by the key discipline of Nanchang Normal University,China (Grant No.NSXK20141001). At the same time, Project supported by the Reform in Education of Nanchang Normal University,China (Grant No.JGKT-14-18).

References

[1] M. N. Do.Directional multiresolution image representations.PhD thesis,Swiss Federal Institute of Technology, Lausanne, Switzerland, December2001.

[2] M. N. Do and M. Vetterli. Pyramidal directional filter banks and curvelets.In Proc. IEEE Int. Conf. on Image Proc., Thessaloniki, Greece, Oct. 2001.

[3] M. N. Do and M. Vetterli. Contourlets. In J. Stoeckler and G. V. Welland,editors, Beyond Wavelets. Academic Press, New York, 2002. to appear,http://www.ifp.uiuc.edu/~minhdo/publications.

[4] M. N. Do and M. Vetterli. Framing pyramids. IEEE Trans. Signal Proc.,2002. to appear, http://www.ifp.uiuc.edu/~minhdo/publications.

[5] Yang Sen-quan, Chen Jin-run.Multi-threshold denoising algorithm based on scale correlation of contourlet transform[J].Computer Knowledge and Technology,10(13), 2014:3100-3102

[6] Burt P,Adelson E.The Laplacian pyramid as a compact image code[J].Communications,IEEE Transactions on,1983，31 (4): 532-540.

[7] Ji Jian,Xu Shuang-xing,Li Xiao.An adaptive thresholding image denoising method based on morphological component analysis and contourlet transform[J].PR&AI,27(6),2014:561-568

[8] Zhang Jinhua,Sun Ting.Face recognition algorithm based on contourlet transform and PCA[J].Journal of Zhoukou Normal Unoversity,31(5),2014:117-120